


# Bibliography

Okay folks ... the bibliography. Every page is numbered exactly like the illustrated guide. Every source is summarized with bulleted points.

## Some housekeeping notes

### Color coding

- I will highlight something if it's important.
- If there is a **GROSS** photo this is your warning before clicking on the link.
-  is some action you can take on a website.
- *Organism*
- *Title of article*
- **Definition** or **important word**
- **Disease** or **infection** or **illness** or **medical condition** or **syndrome**
  - These terms all basically mean the same thing ... there is some kind of damage to your body.
- **Disease in animals**
- **Geography**
- **People** or **Institutions**
- **Numbers**
- I know it's lots of colors. They won't be used all the time. I'll use them to make a point. And the reason I use them is that color aids in memorizing ... when I scan my own Microsoft Word notes I can find a specific item by its color.

### Font coding

- Courier New is used for verbatim (word for word) statements from the source.

### Wikipedia

- It may appear that I'm overly reliant on Wikipedia but that's because I extensively use their images.
- The one caution about Wikipedia is that you don't know who the author is. Is it a professor? Is it the 8-year old kid from across the street who runs a lemonade stand? Is it a corporation that edits the article to avoid looking bad? Plus, you don't know if the information is being updated. That being said, for medical or scientific topics the references in Wikipedia overwhelmingly tend to be from medical journals or science journals written by MDs (medical doctors) or PhDs (university professors).

### The 'Book Rule'

- There are a number of books mentioned in the bibliography. For those of you who buy books in print, please buy every 20<sup>th</sup> book at your local book store. They are more expensive than amazon, yes, but they make neighbourhoods beautiful.


### Caveat

- This is not medical advice. Speak to your doctor.

**Okay, you are now in the deep end of the pool. Dive! Dive! Dive!**

# Page iv - Titanic

## CQD

- Summary
  -  You can listen to a 3-second audio clip of what CQD (Come Quickly Danger) sounds like in the dots and dashes of Morse Code.
  - Imagine the year is 1912 and you are radio operator on the ship, *Carpathia*. You would have heard this distress call from the *Titanic*.
- Source
  - Wikipedia
    - <https://en.wikipedia.org/wiki/CQD>

## *Titanic: The final messages from a stricken ship.*

- Summary
  - This article describes the Morse code messages sent by the *Titanic* radio operators.
- Verbatim
  - "No sickness. All well. Notify all interested in poker." (Before the iceberg)
  - "Come at once. We have struck a berg. It's a CQD, old man." (After the iceberg)
- Source
  - BBC News
    - 10 April 2012
    - <https://www.bbc.com/news/magazine-17631595>
- Author
  - Sean Coughlan

## CHAPTER 1 – THE COLD, HARD FACTS OF DEATH AND DISEASE

Page 1

# Page 2 – Death by Definition

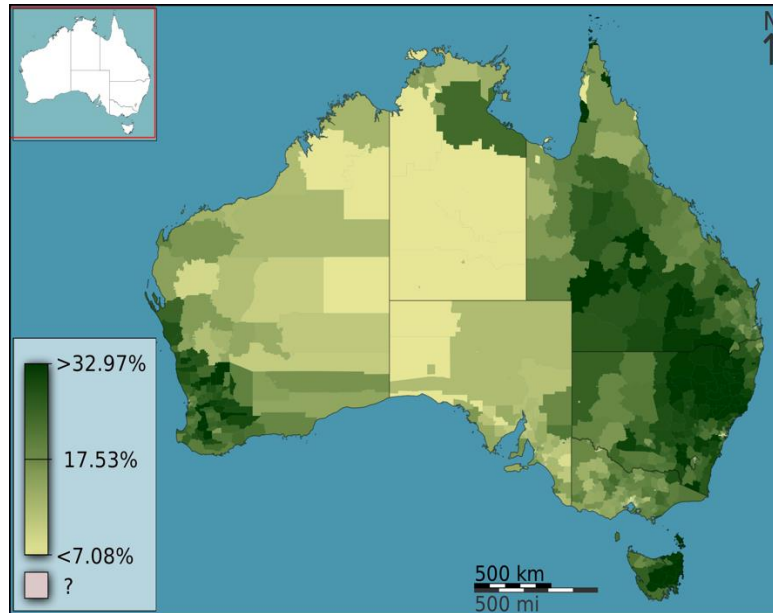
## Epidemiology

### *Principles of Epidemiology in Public Health Practice, 3<sup>rd</sup> Edition – An Introduction to Applied Epidemiology and Biostatistics*

- Summary
  - This is a 512-page epidemiology course from the CDC (Centers for Disease Control and Prevention).
  - Despite the dry title, it is very readable. If you spend an hour with it, your knowledge of epidemiology will increase markedly. There are lots of pop quizzes to test your knowledge.
- Verbatim
  - The first paragraph perfectly describes the broad role of **epidemiologists**: (the bold blue color is my addition):

- “Recently, a news story described an inner-city neighborhood’s concern about the rise in the number of cases of children with **asthma**. Another story reported the revised recommendations for who should receive **influenza** vaccine this year. A third story discussed extensive disease-monitoring strategies being implemented in a city recently affected by a massive **hurricane**. A fourth story described a finding published in a leading medical journal of an association in workers exposed to a particular chemical and an increased risk of **cancer**. Each of these news stories included interviews with public health officials or researchers who called themselves epidemiologists. Well, who are these epidemiologists, and what do they do? What is epidemiology?” (Page 1-1)
    - **Get it? The CDC doesn’t just do infections. They keep track of practically everything that harms human beings.** See page 50 of this bibliography to learn about the organization of the CDC.
- The course is divided into 6 lessons
  - **Lesson 1: Introduction to Epidemiology**
    - Epidemiology definition. (page 1-2)
    - **The Epidemiology Intelligence Service (EIS) trains ‘disease detectives’ who search for clues about disease transmission. Their logo is a shoe with a hole in the sole, implying that these detectives walk the streets searching for clues.** (page 1-17)
    - The following are defined: pandemic, epidemic, outbreak, endemic, hyper-endemic, cluster, sporadic. (page 1-72)
  - **Lesson 2: Summarizing Data**
    - Mode, median, and mean (average) are described with examples. (Page 2-16 to 2-27)
    - 95% Confidence Interval (Page 2-50)
  - **Lesson 3: Measures of Risk**
    - Incidence is defined. (Page 3-1)
    - Prevalence is defined. (Page 3-16)
  - **Lesson 4: Displaying Public Health Data**
    - Tips for making a good Table. (Page 4-4)
    - All about Graphs. (Page 4-23)
    - Scatter plots. (Page 4-43)
    - Pie charts. (Page 4-52)
    - Decision trees. (Page 4-58)
  - **Lesson Five: Public Health Surveillance**
    - What is surveillance? (Page 5-2)
    - **Notifiable infectious diseases.** This is a table of about 100 diseases that the CDC gets notified about if someone falls ill. (Table 5-1 on Page-7)
  - **Lesson 5: Investigating an Outbreak**
    - Deciding whether to investigate. (Page 6-3)
    - There are examples of outbreaks of Hepatitis A, pneumonia, and food poisoning.
    - More definitions:
      - Relative Risk (Page 6-40)
      - Odds Ratio (Page 6-46)
    - **Epidemiologic clues to bioterrorism – these are 17 tip-offs.** (Table 6.6 on Page 6-38)
- Glossary
  - At the very end is a glossary containing 23 pages of epidemiology definitions.
  - For example, what is a **fomite**?
    - “foe might”
    - It is an inanimate object that can spread disease. For example, needles shared by IV (intravenous) drug users can spread the **HIV/AIDS virus** or the **Hepatitis C virus**.
  - I discovered a term I’d never heard of, **choropleth map**, in the glossary (under ‘M’). Check out the map of Australia in the next source.
- Source
  - **CDC (Centers for Disease Control and Prevention)**
    - November 2011
    - **You can download the pdf.**

- <https://stacks.cdc.gov/view/cdc/6914>
- Authors
  - Almost all the authors are **epidemiologists** with a Master of Public Health (MPH) degree.



### Choropleth map

- Summary
  - This is a type of map that uses shading to show data.
  - For example, this multi-shaded map of Australia shows the density of **Anglican Christians**.
  - With such a map, a variety of information can be represented, whether it be epidemiology or religion or whatever.
  - Try these Google Images searches:
    - *choropleth map coronavirus*
    - *choropleth map election*
  - Yeah, you read that correctly – choropleth, not chloropleth. The Greek word *khora* means *place*, and *plethos* means *multitude*. So choro-pleth means place-multitude.
- Source
  - Wikipedia
    - [https://en.wikipedia.org/wiki/Choropleth\\_map](https://en.wikipedia.org/wiki/Choropleth_map)

### List of epidemics and pandemics

- Summary
  - There are 2 tables with a list of epidemics and pandemics.
  - 🖱 In the first table, click on the word at the top of each column to display the data however you want:
    - alphabetical
    - number of deaths
    - date
    - location
  - 🖱 Go to the second table under the 'Chronology' heading. Click on 'Disease' at the top of the table – this is particularly useful for looking at the chronology of **Bubonic Plague**, **Cholera**, **Ebola**, **Influenza**, **Malaria**, **Smallpox**, **Yellow Fever** and other nasties.
- Source
  - Wikipedia

- [https://en.wikipedia.org/wiki/List\\_of\\_epidemics\\_and\\_pandemics](https://en.wikipedia.org/wiki/List_of_epidemics_and_pandemics)


## Outbreak movie

### Outbreak

- Warner Brothers
  - <https://www.warnerbros.com/movies/outbreak>
- imdb
  - <https://www.imdb.com/title/tt0114069/>
- Rotten Tomatoes
  - <https://www.rottentomatoes.com/m/outbreak>

## Patient #1 and #2

### A Novel Coronavirus from Patients with Pneumonia in China

- Summary
  - The clinical course of 3 Covid patients in a Wuhan hospital is described in this paper.
  - **Clinical course** is a fancy way of saying, *What series of events happened to this patient, from start to finish?*
- Patients
  - Patient #1
    - **49-year old female.**
    - Retailer in the Wuhan seafood market.
    - 23 December 2019: Cough and chest pain.
    - 27 December 2019: **Respiratory distress** which is a fancy way of saying hard to breath or feeling short of breath. The patient was **admitted** to the hospital. When you're *admitted* that basically means you're sick enough to get a hospital bed.
    - 4 days later: Worse.
    - A **CT scan** of the chest showed **Pneumonia**. A CT scan is a fancy X-ray that is far more detailed than a standard X-ray.
    - 15 January 2020 – **Discharged**, which means the patient got better and was sent home. You might not be 'cured' but you no longer need a hospital bed.
  - Patient #2
    - **61-year old male.**
    - Frequent visitor to the Wuhan seafood market.
    - 20 December 2019: Cough and fever.
    - 27 December 2019: Admitted to the hospital.
    - Ends up on a **ventilator** which means a tube is put into your lungs and a machine breathes for you. Also known as **mechanical ventilation**.
    - His **Chest X-Ray (CXR)** is shown in Figure 1. A fancy synonym is **chest radio-graph**. Same same.
      -  Click on Figure 1 to enlarge it. The lungs looks very cloudy – that's abnormal.
    - 9 January 2020: **Died**.
  - Patient #3
    - **32-year old male.**
    - No details.
    - 27 December 2019: Admitted to the hospital
    - 15 January 2020: Discharged.
- Verbatim
  - Three adult patients presented with severe pneumonia and were admitted to a hospital in Wuhan on December 27, 2019. Patient 1 was a 49-year-old

- woman, Patient 2 was a 61-year-old man, and Patient 3 was a 32-year-old man. Clinical profiles were available for Patients 1 and 2.
- Patient 1 reported having no underlying chronic medical conditions but reported fever (temperature, 37°C to 38°C) and cough with chest discomfort on December 23, 2019. Four days after the onset of illness, her cough and chest discomfort worsened, but the fever was reduced; a diagnosis of pneumonia was based on computed tomographic (CT) scan. Her occupation was retailer in the seafood wholesale market.
  - Patient 2 initially reported fever and cough on December 20, 2019; respiratory distress developed 7 days after the onset of illness and worsened over the next 2 days (see chest radiographs, [Figure 1](#)), at which time mechanical ventilation was started. He had been a frequent visitor to the seafood wholesale market.
  - Patients 1 and 3 recovered and were discharged from the hospital on January 16, 2020. Patient 2 died on January 9, 2020. No biopsy specimens were obtained.
- Source
    - The New England Journal of Medicine (NEJM)
      - 24 January 2020
      - <https://www.nejm.org/doi/full/10.1056/NEJMoa2001017>
  - The author team
    - The authors were part of the **China Novel Coronavirus Investigating and Research Team**.
    - Authors (surname in red)
      - Na **Zhu**, Ph.D.
      - Dingyu **Zhang**, M.D.
      - Wenling **Wang**, Ph.D.
      - Xingwang **Li**, M.D.
      - Bo **Yang**, M.S.
      - Jingdong **Song**, Ph.D.
      - Xiang **Zhao**, Ph.D.
      - Baoying **Huang**, Ph.D.
      - Weifeng **Shi**, Ph.D.
      - Roujian **Lu**, M.D.
      - Peihua **Niu**, Ph.D.
      - Faxian **Zhan**, Ph.D.
      - Xuejun **Ma**, Ph.D.
      - Dayan **Wang**, Ph.D.
      - Wenbo **Xu**, M.D.
      - Guizhen **Wu**, M.D.
      - George F. **Gao**, D.Phil.
      - Wenjie **Tan**, M.D., Ph.D.
  - Principal author
    - The **principal author** is usually the first in the list of authors (but sometimes the last). When a famous scientist is being nice, they will allow their graduate student to be the first name.
  - Want to learn some Latin?
    - For simplicity, a long list of names is shortened to the name of the first author plus the two Latin words **et al** which means **and others**.
      - So in this case, **Zhu et al** = **Zhu and others**.
      - That way you can say to someone, “Have a look at the paper by Zhu et al that came out in the New England Journal of Medicine.”
  - What do those initials mean?
    - **M.D.**
      - **Medical Doctor**
      - That’s your standard ‘doctor’ working in a hospital or clinic.
      - The periods are optional so it can be **MD** or **M.D.**
    - **Ph.D.**
      - **Philosophy Doctor**

- This is basically all the professors at a university. It could be a physics professor like **Albert Einstein**, or a paleontology professor like **Dr. Alan Grant** in *Jurassic Park*, or an archeology professor like **Dr. Jones** (Harrison Ford) in *Indiana Jones*, or a virology professor who spends their whole life studying viruses.
  - **D. Phil**
    - Doctor of **Philosophy**
    - This is exactly the same as a Ph.D. but the letters are in different order.
  - **M.D., Ph.D.**
    - This is a Medical Doctor who has done a ton of scientific research so is also a PhD. These doctors tend to be insanely knowledgeable about a particular illness. They may do less clinical work in order to do lab work. Or simply work 40 hours a week in the hospital, 40 hours a week in the lab, and get divorced.
- Here are more initials you may encounter
  - **D.D.S.**
    - Doctor of **Dental Surgery**. That's a dentist.
  - **D.V.M.**
    - Doctor of **Veterinary Medicine**. That's a vet.
  - **D.O.**
    - This has 2 meanings.
    - Doctor of **Osteopathic Medicine**. This is essentially the same training as an MD.
    - Doctor of **Optometry**. This is the optometrist who examines your eyes. Don't confuse the optometrist with the ophthalmologist ("off thal mall ah jist") who is an eye surgeon M.D.
    - I find *ophthalmologist* so hard to spell that I literally say out loud, "O, P, H, T, H" every single time I spell it.
  - **M.B.B.S.**
    - If you get trained as a medical doctor in the United Kingdom, you get these initials. It's Latin for *Medicinae Baccalaureus, Baccalaureus Chirurgiae* which means Medicine Bachelor, Bachelor Surgery.
  - **B. Pharm** or **BPharm**
    - That's your standard pharmacist who has a **Bachelor of Pharmacy**.
  - **D. Pharm** or **PharmD**
    - That's a B. Pharm who did lots more training to become a **Doctor of Pharmacy**. They are found in specialized locations like an Intensive Care Unit (ICU) in a hospital where drug doses are complicated so the MD's need help.
  - **N.D.**
    - **Naturopathic Doctor**. This is a doctor who tends to prescribe natural medicines from plants, as a generality.
  - **B.Sc.**
    - **Bachelor of Science**. That's your standard 4-year university degree.
  - **M.Sc.**
    - **Master of Science**. That's usually 1 or 2 years long, after completion of a B.Sc. Then you do a Ph.D. afterwards if you want to have a career in 'academia.' Get it? BSc → MSc → PhD.
  - **M.PH.**
    - **Master of Public Health**. This is basically epidemiology and it's a degree that many MDs get as additional training.
  - Obviously, we infer meaning. When someone says, *My stomach hurts I'm going to the doctor*, we know they are not going to see a physics professor.

## Journals

### Summary

- Scientists and doctors document the details of experiments or illness in **science journals** and **medical journals**.

- Some of the notable ones are:

### *The New England Journal of Medicine*

- Summary
  - **The New England Journal of Medicine (NEJM)** is a famous journal in medicine and is kind of synonymous with high-quality medicine at **Harvard University** which is located in the city of Cambridge which is in the state of Massachusetts which is one of the six New England states. Hence the name of the journal and my run-on sentence.
  - As a generality, only high-quality papers are published in the *NEJM*. If you did an experiment comparing the taste of granola with and without raisins, you're not getting published in the *NEJM*.
  - This was the journal for Patients #1 and #2 in the previous source.
- Source
  - <https://www.nejm.org>

### *Cell*

- Summary
  - As you might expect, *Cell* is all about what goes on inside cells.
  - There are sister journals devoted to specific topics like **Cell Genomics** which is ridiculous amounts of detail on DNA and genetics, or **Cancer Cell** which is the cutting edge of cancer biology and treatment.
- Source
  - <https://www.cell.com>





## nature

- Summary
  - This is one of the most famous journals.
  - Yes, it is called **nature** – with a lower case 'n.'
  - Lots of medical research is published in it.
  - There are specific ones like **nature genetics** or **nature neuroscience**.
- Source
  - <https://www.nature.com>
- Source
  - The photo is the 25 August 2016 cover, just to show it's a lower case 'n.'
  - It's from Wikipedia.
    - [https://en.wikipedia.org/wiki/Nature\\_\(journal\)](https://en.wikipedia.org/wiki/Nature_(journal))
    - Photo credit: ESO/M. Kornmesser

## Science

- Summary
  - Just a ton of science is covered here. There are specific ones like **Science Robotics** or **Science Immunology**.
- Source
  - <https://www.science.org>

Hmmm ...

- If you see a paper in **The New England Journal of Medicine**, **Cell**, **nature**, or **Science**, chances are you can't read it! That's because they are usually written in the highly technical language of the authors of that subject. That essentially means the *most accurate* information is the *least understandable*. That's a big problem during a pandemic. That being said, sometimes they are very readable, you just have to check it out. That being said, it's way easier for the expert on a topic to 'just check it out' because they know exactly where to find that information since they already read that journal.
- I get an email daily from **nature** and every featured topic is summarized in one paragraph of understandable English. Clicking the link to the actual article, sometimes it is easy to read, sometimes nearly impossible.

## When you can't figure out the name of the journal ...

Journal List > HHS Author Manuscripts > PMC4667727

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PMCID: PMC4667727  
NIHMSID: NIHMS739612  
PMID: [25679971](#)



Author 1  
Understanding Bleeding  
Anita McElrov. MD. PhD. Assistant Professor

Actions  
Search in PMC  
Search in PubMed  
View in NLM Catalog  
Add to Search

Clin Adv Hematol Oncol. Published in final edited form on Jan 1. Clin Adv Hematol Oncol.

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4667727/>

One more thing for obsessive people ...

- Journal names are often abbreviated so you don't know the full name.  Click on this link <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4667727/> ... the name of the journal is **Clin Adv Hematol Oncol** ...  click on the journal name and then click on "View in NLM Catalog" .. a new page will open and you can see the full name of the journal which is **Clinical Advances in Hematology & Oncology**. This is very useful.

## How scientific articles are organized

A brief summary of how scientific papers are organized

- The traditional style of a scientific paper is like so:
  - **Abstract**
    - This is a 1-paragraph summary of the experiment.
  - **Introduction**

- This is usually a few pages describing the current scientific knowledge on a topic, followed by unanswered questions, followed by a **hypothesis** (proposed explanation) for a particular question.
- **Materials & Methods (M&M)**
  - Sometimes just called 'Methods.'
  - This is the steps taken in the science lab.
- **Results**
  - This is the results of the experiment.
  - Usually some statistics are involved to prove there was a 95% Confidence Interval ... meaning 95% confident the results are valid. By the total opposite logic, the likelihood of the results being due to chance alone are 5%.
- **Discussion**
  - The results are discussed, specifically whether the hypothesis (proposed explanation) was proved or not. And usually a few thoughts on future experiments.

# Page 3 – Paranoid Tourist Map of Wuhan

## City of Wuhan

I used these for my drawings:

- [https://en.wikipedia.org/wiki/Huoshenshan\\_Hospital](https://en.wikipedia.org/wiki/Huoshenshan_Hospital)
- [https://en.wikipedia.org/wiki/Huanan\\_Seafood\\_Wholesale\\_Market](https://en.wikipedia.org/wiki/Huanan_Seafood_Wholesale_Market)
  - This is the Wuhan seafood market.
- [https://en.wikipedia.org/wiki/Ring\\_roads\\_of\\_Wuhan#Inner\\_Ring\\_Road](https://en.wikipedia.org/wiki/Ring_roads_of_Wuhan#Inner_Ring_Road)
- <https://en.wikipedia.org/wiki/Wuhan>
- [https://en.wikipedia.org/wiki/Wuhan\\_Tianhe\\_International\\_Airport](https://en.wikipedia.org/wiki/Wuhan_Tianhe_International_Airport)
- [https://en.wikipedia.org/wiki/Wuhan\\_Institute\\_of\\_Virology](https://en.wikipedia.org/wiki/Wuhan_Institute_of_Virology)
- [https://en.wikipedia.org/wiki/Wuhan\\_Metro](https://en.wikipedia.org/wiki/Wuhan_Metro)

## Huoshenshan Hospital

*New 1,000-bed Wuhan hospital takes its first coronavirus patients*

- **Summary**
  - There's a 1-minute video with time-lapse photos showing the construction of the **Huoshenshan Hospital**. Kinda cool.
- **Source**
  - The Guardian
    - This newspaper is published in Manchester, England. It is my go-to source for global news and it's easy to navigate on an iPhone.
    - 4 February 2020
    - <https://www.theguardian.com/world/2020/feb/04/new-1000-bed-wuhan-hospital-takes-its-first-coronavirus-patients>
- **Author**
  - The 'author' of this particular article is Agence France-Presse which is a news agency in France.

- [https://en.wikipedia.org/wiki/Agence\\_France-Presse](https://en.wikipedia.org/wiki/Agence_France-Presse)

### Coronavirus hospital with 1,000 beds opens after just 10 days

- Summary
  - The Huoshenshan Hospital was built by 7000 carpenters, plumbers, and electricians.
  - There are many photos of the hospital under construction.
- Source
  - Metro
    - 3 February 2020
    - <https://metro.co.uk/2020/02/03/coronavirus-hospital-1500-beds-opens-just-10-days-12171879/>
      - This is reference no. 12 in *Huoshenshan Hospital – Wikipedia*.
- Author
  - Richard Hartley-Parkinson

### Summary of the above

- **Huoshenshan Hospital**
  - It is located in the Caidian District, near Zhiyin Lake.
    - There are 13 districts in Wuhan. I only drew 5 of them in my map.
    - The Caidian District (not shown) is west of the gray-colored Hanyang District.
  - 23 January 2020 – 2 February 2020 = 11 days = Construction.
    - 23<sub>1</sub> 24<sub>2</sub> 25<sub>3</sub> 26<sub>4</sub> 27<sub>5</sub> 28<sub>6</sub> 29<sub>7</sub> 30<sub>8</sub> 31<sub>9</sub> 1<sub>10</sub> 2<sub>11</sub> = 11 days
    - 23 January – Construction begins at night.
    - 2 February – last brick laid.
  - 3 February 2020 = the next day = 1<sup>st</sup> patient.
    - Modeled after a hospital in Beijing built in 6 days for **SARS**, the coronavirus pandemic of 2003.
    - Each room is a **negative Pressure room** (see page 160 in *Zoo Inside You* and this bibliography).
    - 1400 Health Care Workers.
    - 1000 beds.
    - 30 ICU beds.
  - **People's Liberation Army (PLA)** run it.
    - Composition of the PLA:
      - 2,000,000 regular force
      - 500,000 reserves
- **Leishenshan Hospital**
  - Southwest of the Wuchang district.
  - I didn't draw it.
  - 8 February 2020 – opened.
  - 1500 beds.

## Samples taken at the seafood market

### Experts: nCoV spread in China's cities could trigger global epidemic

- Summary
  - **2019-nCoV** is one of several names for the **SARS-2-Coronavirus** of the **COVID pandemic**.
    - 2019 was the year of discovery.
    - n means novel, as in new.
    - CoV means CoronaVirus.

- Verbatim
  - In outbreak investigation developments, **China CDC** today released more information about environmental sampling in the seafood market at the center of the outbreak, which also sold a variety of live animals, including several wildlife species. Of 585 samples, 33 had evidence of **2019-nCoV**, according to Xinhua, China's state news agency.
- Source
  - **Center for Infectious Disease Research and Policy (CIDRAP)** (“Sid rap”)
    - CIDRAP is part of the **University of Minnesota**.
    - 27 January 2020
    - <https://www.cidrap.umn.edu/news-perspective/2020/01/experts-ncov-spread-chinas-cities-could-trigger-global-epidemic>
- Authors
  - **Lisa Schnerring**, News Editor, CIDRAP
    - <https://www.cidrap.umn.edu/ongoing-programs/news-publishing/news-publishing-staff>
  - **Dr. Michael Osterholm**, who has a PhD in environmental health and a Master of Public Health (MPH) in epidemiology, is the director of **CIDRAP**. He is on the Covid-19 Task Force of **President Biden** and is extraordinarily knowledgeable about epidemics and pandemics.
    - [https://en.wikipedia.org/wiki/Michael\\_Osterholm](https://en.wikipedia.org/wiki/Michael_Osterholm)

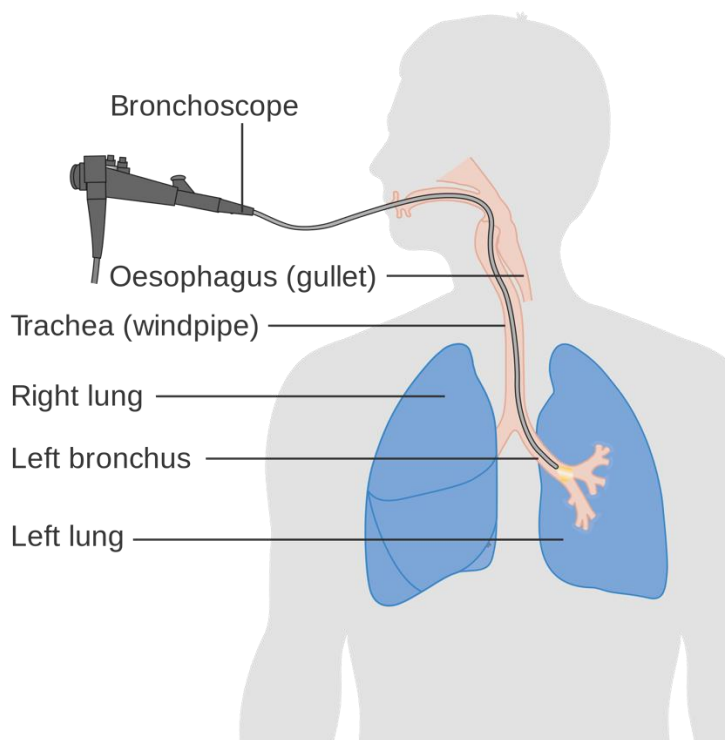
## Wildlife in the Wuhan seafood market

### A new coronavirus associated with human respiratory disease in China

- Summary
  - There was more than just seafood in the market.
  - The **coronavirus** was isolated from the lungs of a 41-year old male who worked at the Wuhan seafood market – more formally known as the **Wuhan Huanan Wholesale Seafood Market**.
  - The virus was obtained by a special technique called **Broncho-Alveolar Lavage (BAL)** (described below) that essentially ‘washes’ the airways and air sacs in the lungs with fluid, and then the fluid is sucked out and sent to the laboratory for examination.
    - The major airways are called **bronchi** (“brong eye”).
    - The air sacs are called **alveoli** (“al vee oh lie”). There are **300 million** air sacs in each lung, for a total of **600 million**.
  - This technique is called a **Broncho-Alveolar Lavage (BAL)**. Details to follow.
    - “Brong koh”
    - “Al vee oh lar”
    - “Lah vah zh” (It’s kinda hard to pronounce the last part. Smear the z with an h).
    - *Lavage* is the French word for *washing*.
- Verbatim
  - The patient studied was a 41-year-old man with no history of hepatitis, tuberculosis or diabetes. He was admitted to and hospitalized in the **Central Hospital of Wuhan** on 26 December 2019, 6 days after the onset of disease. The patient reported fever, chest tightness, unproductive cough, pain and weakness for 1 week on presentation.
  - Metagenomic RNA sequencing<sup>4</sup> of a sample of bronchoalveolar lavage fluid from the patient identified a new RNA virus strain from the family **Coronaviridae**, which is designated here ‘**WH-Human 1’ coronavirus** (and has also been referred to as ‘**2019-nCoV**’).
- Verbatim (the bold is added by me)
  - Epidemiological investigations by the **Wuhan Center for Disease Control and Prevention** revealed that the patient worked at a local indoor seafood market. Notably, in addition to **fish** and **shellfish**, a variety of live wild animals—including **hedgehogs**, **badgers**, **snakes** and **birds (turtledoves)**—were available for sale in the market before the outbreak began, as well as **animal carcasses** and **animal meat**. No **bats** were available for sale. While

- the patient might have had contact with wild animals at the market, he recalled no exposure to live poultry.
- City officials closed the market on Jan 1, and sampling took place from Jan 1 to Jan 12.
  - Source
    - nature
      - 3 February 2020
      - Volume 579, pages 265–269
  - Options for viewing the paper:
    - <https://www.nature.com/articles/s41586-020-2008-3>
      - This is the full article in nature.
    - <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7094943/>
      - This is the same article in PubMed which is part of the National Library of Medicine (a ginormous database used by doctors and scientists).
      - It's easier to see the tables and images in this version.
  - Authors:
    - Fan Wu,<sup>1</sup> Su Zhao,<sup>2</sup> Bin Yu,<sup>3</sup> Yan-Mei Chen,<sup>1</sup> Wen Wang,<sup>4</sup> Zhi-Gang Song,<sup>1</sup> Yi Hu,<sup>2</sup> Zhao-Wu Tao,<sup>2</sup> Jun-Hua Tian,<sup>3</sup> Yuan-Yuan Pei,<sup>1</sup> Ming-Li Yuan,<sup>2</sup> Yu-Ling Zhang,<sup>1</sup> Fa-Hui Dai,<sup>1</sup> Yi Liu,<sup>1</sup> Qi-Min Wang,<sup>1</sup> Jiao-Jiao Zheng,<sup>1</sup> Lin Xu,<sup>1</sup> Edward C. Holmes,<sup>1,5</sup> and Yong-Zhen Zhang<sup>1,4,6</sup>
  - And here is where the authors are from:
    - <sup>1</sup> Shanghai Public Health Clinical Center, Fudan University, Shanghai, China
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    - <sup>5</sup> Marie Bashir Institute for Infectious Diseases and Biosecurity, School of Life and Environmental Sciences and School of Medical Sciences, The University of Sydney, Sydney, New South Wales, Australia
    - <sup>6</sup> School of Public Health, Fudan University, Shanghai, China
  - Of note:
    - The last author, Yong-Zhen Zhang, is from the China CDC in Beijing. Don't confuse that with the USA CDC in Atlanta – they are totally different agencies.

## Bronchoscopes and other scopes



That black thing is a **broncho-scope** (brong – kow – scope”).

- The skinny tube contains **fiber optics**. The tube goes into the lungs ... in the image above it's sitting in the **left main bronchus**. There's a camera at the tip of the tube. The image is seen on a tv monitor.
- If the tube is flexible it's called a **flexible broncho-scope**.
- If the tube is rigid it's called a **rigid broncho-scope**.
- The umbrella term for all such devices is **endoscopy** (“en doss copy”) and different body parts are looked at:
  - **Arthroscopy** (“arth ross copy”)
    - This is used by orthopedic (bone) surgeons to look at your joints. For example, your knee is ‘scoped’ to repair a **torn ligament** like an **ACL (Anterior Cruciate Ligament)**. Now there are 2 devices, each rigid and about 2 feet long. One is the camera. Another has cutting tools or pliers at the tip. The **surgeon** is using both hands, one for each. Or the **surgical assistant** (example, me) is working the camera.
    - Why *arthr*? Because arth means joint. Hence arthro-scope (joint look). And this is also why a crab with jointed legs is an arthro-pod (joint legs).
  - **Bronchoscopy** (“brong coss copy”)
    - The bronchi (airways) in the lungs are sampled for evidence of **pneumonia** or other lung diseases.
  - **Colonoscopy** (“colon oss copy”)
    - This looks at the lining of your colon to detect **Colon Cancer**.
    - The colon is the large intestine.
  - **Esophago<sup>4</sup>-gastro<sup>2</sup>-duodenoscopy<sup>6</sup> (EGD)**
    - That's the winner at 12 syllables. Has anyone, ever, in the history of universe, inserted a superscript for the number of syllables into that word? I think not – you have witnessed a unique event.
    - “Ee so fay go” – “gas trow” – “do oh den oss caw pee.”
    - The tube goes into your mouth, down your throat, down your foodpipe (esophagus), into your stomach, then into the intestines. It's quite a long-range reconnaissance.
    - Several structures can be looked at during that journey: esophagus, stomach (the ‘gastro’ part), and the duodenum (“do oh deen um”) which is the first part of the small intestines.

- Skill required.
- **Gastroscopy** (“gas tross copy”)
  - Basically the same setup as Esophago-gastro-duodenoscopy but only interested in looking at the lining of your stomach, say for **ulcers**.
- **Laparoscopy** (“lap are oss copy”)
  - This gains access to the abdominal cavity. It’s pretty cool. The first thing to do is blow carbon dioxide (CO<sub>2</sub>) gas into the abdominal cavity to convert it into a movie theatre. You are the star of the movie. Well, your innards.
  - How is this done? A 1 cm (roughly ½ inch) incision with a scalpel right through all abdominal wall layers (whose 10 names you have to memorize in medical school). Next a shiny metal tube called a **trochar** a.k.a. **trocar** (“trow car”) is inserted through that incision. Now the gas is connected via the trochar so the abdominal wall swells (slowly) to a small beach ball. Voila! It’s a movie theatre inside. Then the trochar comes out.
  - Now the instruments go inside (via incisions for each of them). One is the camera, another is forceps (glorified pliers), and another is cautery (“cot er ee”) that cuts and burns at the same time so there’s no bleeding. Now ready for surgery!
  - Maybe your **inflamed gall bladder** is removed a.k.a. laparoscopic cholecystectomy which is lotsa syllables so it’s shortened to ‘lap chole’ (“lap koh lee”). That would be done by a **general surgeon** whose speciality is the digestive organs. Or maybe a totally different operation by a totally different specialist – an **OB/GYN (Obstetrician/Gynecologist)** might remove the **uterus** (womb) because of **uterine fibroids** (they can cause heavy bleeding; but this surgery would be avoided if a woman still wanted children).
  - When you wake up you’ll see 3 or 4 incisions in the skin of your abdomen. We sutured them up when the instruments were removed.
  - And ... this will make sense now ... there are at least 2 tv monitors ... one for the surgeon and one for the assistant ... because they may be on opposite sides of the patient so they each need their own tv. Or sometimes we are side by side. We can’t touch the tv though. The tv is not sterile. We are sterile (we are wearing a sterile gown and sterile gloves). So we ask a **circulating nurse** (who is not sterile) to move the tv. The **scrub nurse** who is sterile (because she scrubbed at the sink then gowned and gloved just like us) hands all the instruments to the surgeon. The instruments, including the scope, are all sterile. It’s quite a production.
  - In the grand scheme of things, this is called **Minimally Invasive Surgery (MIS)**. Making 3 or 4 small cuts in your abdominal wall is less invasive than a 1 foot long (30 cm) incision that opens you right up like a taco shell.
  - **And many other ‘-oscopy’ types of surgeries.**
- “We’ve booked you for endoscopy” is what the hospital will tell you.
- **Point is, that patient in Wuhan had a bronchoscopy to find evidence of what was causing their unusual pneumonia. And bronchoscopy is a subset of endoscopy.** Now you know good words to stump your opponents in Charades. Try to act out ‘bronchoscopy.’
- <https://en.wikipedia.org/wiki/Bronchoscopy>
- <https://en.wikipedia.org/wiki/Endoscopy>

### Bronchoalveolar Lavage (BAL) in the ICU

- Summary
  - This is a 6-minute video that instructs medical doctors on how to perform a Broncho-Alveolar Lavage (BAL).
  - It’s technical.
  - The doctor holds a bronchoscope which will go into the lungs of the patient.
  - At 2m:38s you can see all the instruments involved.
  - At 4m:34s is the view inside the lungs.
  - Do not try this at home on your Pomeranian.
- Source
  - American Thoracic Society



- <https://www.thoracic.org/professionals/clinical-resources/video-lecture-series/bronchoscopy/bronchoalveolar-lavage-in-the-ICU.php>

- Authors

- Aaron M Cheng, MD
- Amy Morris, MD
- Patricia Kritek, MD
- Justin Andros, MD
- Megan Sherman, MD
- Sara Kim, MD
- Mark Tonelli, MD
- David Park, MD
- Maya Sardesai, MD
- Rosemary Adamson, MD

## Seafood market size

### Coronavirus outbreak leads to widespread panic in China

- Verbatim

- The market occupies up to 540,000 square feet of land, which is about seven soccer fields.

- Source

- The Johns Hopkins Newsletter
  - Feb 6 2020
  - <https://www.jhunewsletter.com/article/2020/02/coronavirus-outbreak-causes-widespread-panic-in-china>

- Author

- Yanni Gu

### UNITED STATES SECURITIES AND EXCHANGE COMMISSION FORM - Walmart Inc. Form 10-K for the Fiscal Year Ended January 31, 2022.

- Summary

- The average square footage of a Walmart Supercenter is on page 7 of the report.
  - Minimum square feet 69,000
  - Maximum square feet 260,000
  - Average square feet 178,000 (I rounded this up to 180,000)
- I guess the Securities and Exchange Commission (SEC) knows this sort of thing?

- My simple addition math

180,000 square feet Walmart Supercenter  
 180,000 square feet Walmart Supercenter  
 + 180,000 square feet Walmart Supercenter  
 = 540,000 square feet Wuhan seafood market

- Source

- United States Securities and Exchange Commission
  - <https://d18rn0p25nwr6d.cloudfront.net/CIK-0000104169/c68fb8be-2602-4f2a-ae0-261b4f04b970.pdf>
  - This is reference no. 12 in Walmart – Wikipedia
    - <https://en.wikipedia.org/wiki/Walmart>

# Page 4 – Wuhan Institute of Virology (WIV)

## Wuhan Institute of Virology



中国科学院武汉病毒研究所  
 WUHAN INSTITUTE OF VIROLOGY, CAS

This is the **Wuhan Institute of Virology** home page.

- <http://english.whiov.cas.cn>

*Inside the Chinese lab poised to study world's most dangerous pathogens*

- Summary
  - There are photos of **hazmat suits** and the central monitor room of the **National Bio-safety Laboratory** in Wuhan.
  - Cost to build was 300 million yuan (US\$ 44 million).
- Verbatim
  - There are already two BSL-4 labs in Taiwan, but the National Bio-safety Laboratory, Wuhan, would be the first on the Chinese mainland.
- Source
  - *nature*
    - 23 Feb 2017
    - <https://www.nature.com/articles/nature.2017.21487>
- Author
  - David Cyranoski

## Research areas

*Wuhan Institute of Virology > Home > Research Areas > Brief Introduction*

- Summary
  - **The Wuhan Institute of Virology** does research in 5 different areas
    1. Etiology and Epidemiology of **Emerging Infectious Diseases (EID)**
      - What does 'Etiology' mean?
        - *Etiology* is a fancy medical word meaning *cause* or *origin*.
      - What is an Emerging Infectious Disease?
        - Well, it could be some disease never encountered before. For example, back in the 1980's **AIDS** was new to the scene. The cause was the **HIV virus**, though after lots of research was done, there was apparently evidence of it as far back as the 1950s.
        - Or an 'emerging' infectious disease could be something that is already known but a new mutant has arisen. The CDC (as in **USA CDC**) refers to that as **re-emerging**. For example, the **coronavirus** has been recognized for decades. But the 2019 version – what we call **SARS-CoronaVirus-2** – is a new version of the virus that is causing **COVID-19**, a new version of the infection.

- Point is, the Wuhan Institute of Virology is on the lookout for new problems, or old problems with a new face.
- What is the challenge?
  - The major challenge is an unpredictable Emerging Infectious Disease (EID) outbreak.
- What is the origin of Emerging Infectious Diseases?
  - 70% wildlife or insects.

## 2. Molecular virology

- Viruses are super small. Molecules are even smaller. So 'molecular virology' looks at how viruses interact with cells at a molecular level.
  - How do they *get inside* the cell?
  - How do they *replicate* once inside?
  - And once new copies have been made, how do they *get out*?
- All that is molecular virology.

## 3. Immuno-virology

- This is the study of the how the immune system *attacks* a virus. Or how a virus *evades* the immune system. This is a war millions of years old, starting long before humans.

## 4. Analytical Pathogen Microbiology

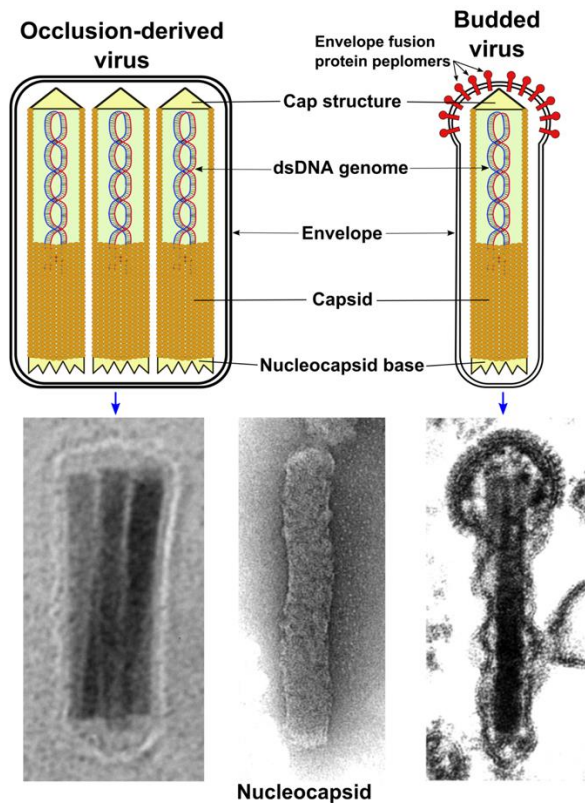
- That's a fancy term meaning, *detection*.
- And 'pathogen' usually refers to a bacteria or virus.

## 5. Agricultural and Environmental Microbiology

- In the grand scheme of things, insects destroy our crops, so we kill the insects with pesticides. But the pesticides can harm the environment so an alternative is to kill the insects with a virus or bacteria.
- Get it? We artificially introduce a virus or bacteria to kill the insects.
- *Baculo-virus* is one such virus. It cannot replicate in mammals or plants. But it can replicate in insects and kill them. It is a **viral insecticide**.

- Source

- Wuhan Institute of Virology
  - [http://english.whiov.cas.cn/Research2016/Brief\\_Introduction2017/](http://english.whiov.cas.cn/Research2016/Brief_Introduction2017/)



### Baculoviridae

- Summary
  - That's a *baculo-virus* (mentioned in point 5 of the previous article) that is used to deliberately infect insect pests. The black and white photos were taken with an electron microscope. It sort of looks like licorice.
  - The virus is beyond small. It will get inside individual cells of the insect and make copies of itself → The cells will die. → The insect will die.
- Source
  - Wikipedia
    - <https://en.wikipedia.org/wiki/Baculoviridae>

### Chapter 4 - Baculoviruses and Other Occluded Insect Viruses

- Summary
  - You can't read this but you can access it in the next article (*Advances in Insect Physiology*).
- Source
  - *Insect Pathology, Second Edition*
    - 2012
    - Pages 73-131
    - <https://www.sciencedirect.com/science/article/pii/B978012384984700004X>
- Authors
  - Robert Harrison
    - United States Department of Agriculture, Agricultural Research Service, Beltsville, Maryland, USA
  - Kelli Hoover
    - Pennsylvania State University, Pennsylvania, USA

### Advances in Insect Physiology

- Summary

- 🖐️ Scroll ¾ down the page. In the right column is a drawing of a *baculo-virus* infecting the cells of the respiratory system of a butterfly or moth. The virus resembles that image from Wikipedia – it kinda looks like licorice.
- Source
  - Science Direct
    - 2016
    - <https://www.sciencedirect.com/science/article/pii/B978012384984700004X>

### Emerging Infectious Diseases

- Summary
  - Just to confuse your life, Emerging Infectious Diseases (EID) is an area of research by the **Wuhan Institute of Virology** and it is also the name of a medical journal published by the **CDC** – as in, the **USA CDC**. Don't confuse that with the **China CDC**.
  - The link below is to the CDC journal. It's a great way to see how the CDC is deeply involved in tracking all manner of infectious diseases.
  - 🖐️ In the vertical menu on the left side .. click on 'Past Issues' to read about nasty organisms dating back to 1995. It's partly technical, partly readable.
- Source
  - Centers for Disease Control and Prevention (CDC)
    - <https://wwwnc.cdc.gov/eid/>

# Page 5 – Wuhan Bridges

## Bridges spanning the Yangtze River in Wuhan

I used these for my drawings

- [https://en.wikipedia.org/wiki/Wuhan\\_Yangtze\\_River\\_Bridge](https://en.wikipedia.org/wiki/Wuhan_Yangtze_River_Bridge)
- [https://en.wikipedia.org/wiki/Second\\_Wuhan\\_Yangtze\\_River\\_Bridge](https://en.wikipedia.org/wiki/Second_Wuhan_Yangtze_River_Bridge)
- [https://en.wikipedia.org/wiki/Erqi\\_Yangtze\\_River\\_Bridge](https://en.wikipedia.org/wiki/Erqi_Yangtze_River_Bridge)
- [https://en.wikipedia.org/wiki/Tianxingzhou\\_Yangtze\\_River\\_Bridge](https://en.wikipedia.org/wiki/Tianxingzhou_Yangtze_River_Bridge)

## Suspension bridges

*Understanding the World's Greatest Structures: Science and Innovation from Antiquity to Modernity*

- Summary
  - This is a phenomenal teaching course by a **professor of civil engineering** at the West Point Military Academy, describing the principles to build arches, domes (like the **Pantheon** in Rome), cathedrals (like **Notre Dame** in Paris), bridges, and other structures. You don't need engineering knowledge to watch it.
  - There are 24 video lectures in this particular course. Lecture 15 is *Suspension Bridges – The Battle of the Cable*. The professor literally builds bridges in front of you and shows the loads that the roadway (deck) must deal with. And you learn about this guy named **John Augustus Roebling** who was like the Mozart of wires. His ingenious wire designs were used to make the **Brooklyn Bridge** and **Golden Gate Bridge** – both suspension bridges.

- You learn about structures and **load paths**. You cannot look at world the same afterwards. Even a highway overpass becomes interesting – it is supported by columns (which are 1 of the 6 load-bearing members).
- Here's a quote from the course: "You can't push a cable." That means a cable carries load entirely in tension.
- Source
  - **The Great Courses**
    - These courses are kinda pricey so I wait for them to go on sale. I have at least 50 of them – they are awesome learning.
    - <https://www.thegreatcourses.com/courses/understanding-the-world-s-greatest-structures-science-and-innovation-from-antiquity-to-modernity>
- Author
  - **Stephen Ressler, PhD**, West Point Military Academy

### LOAD PATH METHOD IN THE OPTIMUM DESIGN OF CABLE SUPPORTED BRIDGES

- Summary
  - Figure 3 shows the load path (forces) for the Golden Gate Bridge (a **suspension bridge**).
  - Figure 6 shows the load path (forces) for a **cable-stayed bridge**.
  - I don't really understand but they are cool diagrams.
- Source
  - No date is given.
  - No journal is given.
  - <http://www.scienzalibera.it/attachments/article/54/Load%20path%20method%20in%20the%20optimum%20design%20of%20cable%20supported%20bridegs.pdf>
- Authors
  - Fabrizio PALMISANO - Politecnico di Bari, Studio Vitone & Associati, Italy
  - Amedeo VITONE - Politecnico di Bari, Studio Vitone & Associati, Italy
  - Claudia VITONE - Politecnico di Bari, Italy
  - Vito Antonio MININNI - Consultant Engineer, Italy

## Cable-stayed bridges

### Cable-stayed bridge

- Summary
  - There are many photos of cable-stayed bridges.
  - Let's face it, people drove over these bridges while spreading coronavirus in Wuhan. And the same could be said of dozens of other cities in the world.
  - Check out the cool **Øresund Bridge** that is the second image on the right side. Did it spread coronavirus from Denmark to Sweden? Or from Sweden to Denmark? Probably. Oh, I drove over the Øresund Bridge yesterday. How cool is that?
- Source
  - Wikipedia
    - [https://en.wikipedia.org/wiki/Cable-stayed\\_bridge](https://en.wikipedia.org/wiki/Cable-stayed_bridge)

# Page 6 – China Lockdown

## How to say 'China' in Chinese

## 中国

I asked my Chinese friend Victor how to pronounce it. If you have problems, please take it up with him.

### China flag



#### *Flag of China*

- Summary
  - There are lots of cool historical flags of China.
  - Halfway down the page is a fuchsia construction sheet which is pretty cool, just from a pure artistic point of view.
- Source
  - Wikipedia
    - [https://en.wikipedia.org/wiki/Flag\\_of\\_China](https://en.wikipedia.org/wiki/Flag_of_China)

#### *CIA World Factbook*

- Summary
  - This is a short description of the Chinese flag.
- Source
  - CIA
    - <https://www.cia.gov/the-world-factbook/countries/china/flag>

### Autonomous Region (A.R.)

#### *Autonomous regions of China*

- Summary
  - There is a simple map of the 5 **Autonomous Regions (A.R.)** in China.
  - In the first table is a list of the 'designated minority' in each region.
- Source
  - Wikipedia
    - [https://en.wikipedia.org/wiki/Autonomous\\_regions\\_of\\_China](https://en.wikipedia.org/wiki/Autonomous_regions_of_China)

### Yangtze River



That's the Yangtze River in China.

## Yangtze

- Summary
  - The Yangtze River flows through Wuhan.
  - The stupendous **Three Gorges Dam** goes right across it.
  - 3915 miles / 6300 km.
- Source
  - Wikipedia
  - <https://en.wikipedia.org/wiki/Yangtze>

## Largest cities in the world

### List of largest cities

- Summary

Population (2018)		
#1	Tokyo, Japan	37 million
#2	Delhi, India	28 million
#3	Shanghai, China	25 million
- Source
  - Wikipedia
    - [https://en.wikipedia.org/wiki/List\\_of\\_largest\\_cities](https://en.wikipedia.org/wiki/List_of_largest_cities)
- Source of source
  - Wikipedia's source in Column 3 is the **United Nations Department of Economic and Social Affairs: World Urbanization Prospects 2018**.
    - One UN site was under maintenance.
    - One UN site was an archive.
      - <https://web.archive.org/web/20200211222646/https://population.un.org/wup/Publications/Files/WUP2018-Highlights.pdf>

## G4 Expressway

### G4 Beijing –Hong Kong – Macau Expressway

- Summary



- The **G4 Expressway** a.k.a. **G4 Beijing–Hong Kong–Macau Expressway** is for vehicles going from Beijing to Wuhan to Hong Kong. Or the other way.
- 2272 km / 1411 miles.
- [https://en.wikipedia.org/wiki/G4\\_Beijing–Hong\\_Kong–Macau\\_Expressway](https://en.wikipedia.org/wiki/G4_Beijing–Hong_Kong–Macau_Expressway)

## High-speed rail

### Route

- [Beijing–Guangzhou](#) high-speed railway.
  - More accurately, the Beijing–Guangzhou–Shenzhen–Hong Kong high-speed railway.
  - [Guangzhou](#) is a port city 167 km (104 miles) northwest of Hong Kong.
- 2298 km journey.
- 300 km/h train speed.
- **8 hour** journey instead of **22 hours**.
- 35 stops.
- 105 euros 2<sup>nd</sup> class.
- Source
  - [https://en.m.wikipedia.org/wiki/Beijing–Guangzhou\\_high-speed\\_railway](https://en.m.wikipedia.org/wiki/Beijing–Guangzhou_high-speed_railway)
  - [https://en.m.wikipedia.org/wiki/Wuhan–Guangzhou\\_high-speed\\_railway](https://en.m.wikipedia.org/wiki/Wuhan–Guangzhou_high-speed_railway)

### Locomotive

- **CRH380-AL** a.k.a. **Hexie** (means, *Harmony*).
- Accusations of using Japanese bullet train technology. Okey dokey.
- Aluminum body
  - 9 tonnes.
  - 17% of weight of entire car.
- Aerodynamic head.
- Pressurized.
  - 0.12 psi P change. Not sure what this means. Maybe with doors closed.
- The locomotive is made by **CRRC Changchun Railway Vehicles** which is in the city of Changchun, population 9 million. Never heard of it. How have I never have heard of a city of 9 million people? Because China has 1 billion 400 million people. Wow.
  - <https://www.crrcgc.cc/ckgfen/g7984/s15646/t265188.aspx>
  - [https://en.wikipedia.org/wiki/CRRC\\_Changchun\\_Railway\\_Vehicles](https://en.wikipedia.org/wiki/CRRC_Changchun_Railway_Vehicles)

### Locomotive motor

- **YQ-365 electric motor**
  - Features
    - It's a **traction motor**.
    - AC/DC
    - 4142 rpm.
  - Source
    - <https://www.directindustry.com/prod/crrc-zhuzhou-electric-co-ltd/product-162644-1756994.html>
    - There's a link to a CSR promotional video. 4 minutes.
    - They have robotics on the go in their factory.
  - Made by **CRRC Zhuzhou locomotive**.
    - Formerly, **CSR Zhuzhou Electric Co.** (no link)
    - Subsidiary of **CRRC**.
      - [https://en.wikipedia.org/wiki/CRRC\\_Zhuzhou\\_Locomotive](https://en.wikipedia.org/wiki/CRRC_Zhuzhou_Locomotive)
      - <https://en.wikipedia.org/wiki/CRRC>

## Wuhan Metro

### Layout

- 9 lines
  - Line 1
    - Completely elevated.
  - Line 2
    - *Under the Yangtze River.*
    - 48 meters (approximately 150 feet) deep
    - 1.3 km long
    - 3 months drilling through clay by boring machine.
    - A tunnel, I assume.
    - Fanhu Station - Hankou Station.
- 228 stations

### Gauge

- 4 FT 8 ½ “
  - London Underground
  - NYC Subway
  - Paris Métro
  - Wuhan Metro
- 4 FT 11 27/32”
  - Moscow Metro

### Coronavirus

- Wuhan Metro shut down 23 January – 27 March 2020.

### Source

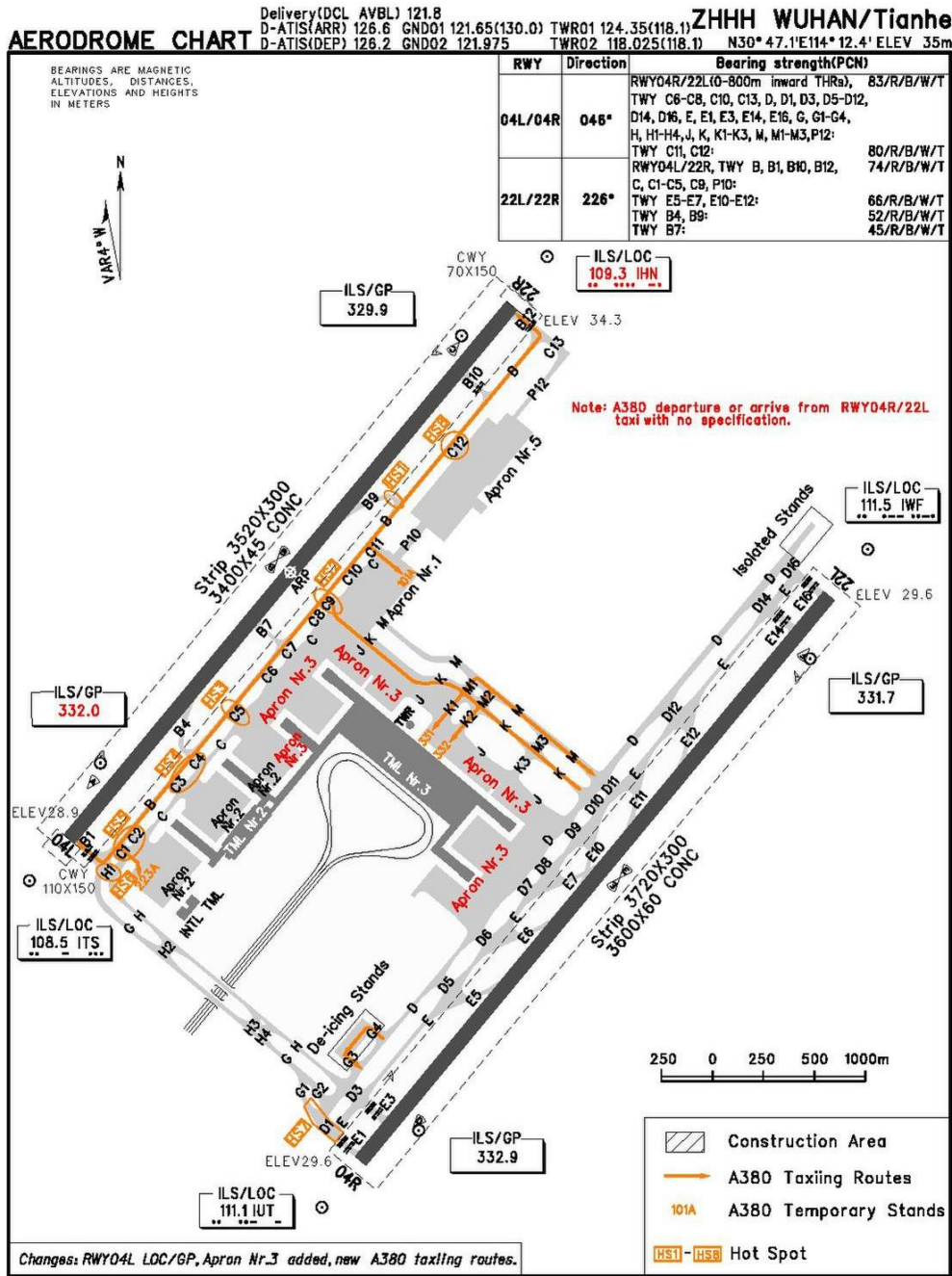
- Railway Technology
  - <https://www.railway-technology.com/projects/wuhan-metro/>
- [https://en.wikipedia.org/wiki/Wuhan\\_Metro](https://en.wikipedia.org/wiki/Wuhan_Metro)

## Wuhan Tianhe International Airport



### Wuhan Tianhe International Airport

- Summary
  - *Tianhe* means *sky river*. What a great word.
  - See the funky thing in the foreground looks like a **joystick**? That's the tower where the **Air Traffic Controllers (ATC)** communicate with the **pilots**. ATC also has a commanding view of the runways.
  - **Wuhan** is the capital city of **Hubei province**.
  - With respect to *coronavirus*, the airport was part of the 'Hubei lockdown.'
- What is the point of this detail on airports?
  - Number 1, it's fun.
  - Number 2, airports and airplanes are a fantastic way to turn an *epidemic* into a *global pandemic*.
- Source
  - Wikipedia
    - [https://en.wikipedia.org/wiki/Wuhan\\_Tianhe\\_International\\_Airport](https://en.wikipedia.org/wiki/Wuhan_Tianhe_International_Airport)



2017-3-1 EFF1703291600 中国民用航空局CAAC ZHHH AD2.24-1A

This is an 'aerodrome chart' for the Wuhan airport. Aero-drome is a fancy word for airport, though the definition is more subtle than that.

- This is the take-home message
  - If there is a sidewalk in front of your house you can walk it from opposite directions. Now build that sidewalk at an airport and make it 10,000 feet long. A plane can take off (or land) from opposite ends. That's how 1 sidewalk has 2 runways. You pick the runway based on which way the wind is blowing. In the image above, there are 2 sidewalks, hence 4 runways.


There's lots to see on this chart but pay particular attention to the following:

- The charcoal-colored diagonal lines at the outside edges are the runways (RWY).
  - The charcoal line on the right is labelled at the bottom and top:
    - 04R

- This is **runway “zero four right.”**
- The **Air Traffic Controller** would say to the **pilot**:
  - *You are cleared to land on runway zero four right.*
- The **pilot** must repeat that back:
  - *Cleared to land on runway zero four right.*
- The number ‘0’ is added to the end of ‘04’ so it’s actually 040. That means **040 degrees** on a compass (think, a circle). A circle is divided into 360 degrees:
  - 90° is East
  - 180° is South
  - 270° is West
  - 360° is North
- Look at the runway. It’s at 40 degrees (basically, north east).
- But those numbers are not exact. They are rounded off for ease of communication and in order to paint huge numbers on the runway.
- **22L**
  - This is **runway “two two left.”**
  - It’s written upside down on the chart (and on the actual runway) because that’s the direction the pilot will approach from and read it. It’s also to the left of the other runway as the pilot sees them from the cockpit.
  - A 0 is added to 22 so it’s actually 220 which is **220 degrees** (basically, south west).
- The charcoal line on the left is labelled at each end:
  - **04L**
    - This is **runway “zero four left.”**
    - It’s **040 degrees**.
  - **22R**
    - This is **runway “two two right.”**
    - It’s **220 degrees**.
- North is indicated by the **N** with an arrow in the top left corner of the chart.
- The thing on the aero-drome chart that looks like a key (or the **tab from a can of sardines**) has nothing to do with planes. It’s the road where cars drop off and pick up passengers.
  - Try to find that sardine can tab in the photo of the airport, which is actually oriented in the opposite direction as the chart.
- The **dark gray rectangular area** is labelled **TML Nr. 3** which is Terminal 3.
- And just on top of Terminal 3 is a **gray dot** labelled **TWR**. That’s the Tower where the Air Traffic Controllers are.
- About 1/3 down on the right, the chart states in red letters, **Note: A380 departure or arrive from RWY04R/22L taxi with no specification**. The A380 airplane uses runway 04R / 22L at the Wuhan airport.

**If you want to see the aero-drome chart in high resolution**, click on the link below, then click on the image that is 1210 x 1652 pixels.

- [https://en.wikipedia.org/wiki/Wuhan\\_Tianhe\\_International\\_Airport](https://en.wikipedia.org/wiki/Wuhan_Tianhe_International_Airport)

 For something cool, do a Google Earth search of *Wuhan Tianhe International Airport*. Zoom in on the runways. You can see the **runway numbers**. They are HUGE so the pilot can see them from a few hundred feet up in the air. Plus, you can see the **skid marks** on the runways.

Airbus A380



### Airbus A380

- Summary
  - That's an **A380**. It is made by **Airbus**.
  - It can carry **525** passengers but is certified for **853** passengers. That's a lotta pretzels.
- Airport math
  - What is the wingspan (tip to tip) of the A380?
    - **262 feet (80 meters)**
  - What is the width of Runway 04R / 22L at the Wuhan airport?
    - **196 feet (60 meters)**
  - Therefore the wingspan is wider than runway:
    - **262 feet wingspan – 196 feet runway width = 66 feet**
    - **80 meter wingspan – 60 meter runway width = 20 meters**
  - Therefore ...
    - **33 feet of wingspan** on either side of the runway.
    - **10 meters of wingspan** on either side of the runway.
- Source
  - **Airbus**
    - <https://www.airbus.com/en/products-services/commercial-aircraft/passenger-aircraft/a380>
  - Wikipedia
    - [https://en.wikipedia.org/wiki/Airbus\\_A380](https://en.wikipedia.org/wiki/Airbus_A380)

### Wuhan Airport to Enter "Two Runways" Era, Welcoming First A380 on April 20

- Verbatim
  - Wuhan airport has started constructing a new 3,600-meter long, 60-meter wide runway since August 2013, which is capable of accommodating the world's largest wide-body A380 superjumbo.
- Source
  - China Aviation Daily
    - 22 March 2016
    - <http://www.chinaaviationdaily.com/news/51/51494.html>
- Author
  - Lena Ge

## Three Gorges Dam



### Three Gorges Dam

- Summary
  - Three Gorges Dam is on the Yangtze River, west of Wuhan.
- Source
  - Wikipedia
    - [https://en.wikipedia.org/wiki/Three\\_Gorges\\_Dam](https://en.wikipedia.org/wiki/Three_Gorges_Dam)

### Three Gorges Dam discharges water

- Summary
  - This 1-minute YouTube video shows the incredible force of water exiting the Three Gorges Dam.
- Source
  - CGTN
    - 29 June 2020
    - <https://www.youtube.com/watch?v=xGsUYLADo4s>

## Francis turbine



### Francis turbine

- Summary
  - This is the **turbine** that spins **75 RPM** (revolutions per minute) at the Three Gorges Dam. There are **32 turbines**.
  - Look at those puny humans. The turbine is **HUGE**. I love ♥♥♥ this photo.
- How it Works
  - Water spins turbine → turbine is wrapped in a magnet → magnet spins inside a huge coil of copper wire → electromagnetic field is 'induced' → electrons flow → electrons power your blender to make smoothie.
- Source
  - Wikipedia
    - [https://en.wikipedia.org/wiki/Francis\\_turbine](https://en.wikipedia.org/wiki/Francis_turbine)

### Working of Francis turbine

- Summary
  - This is a 4-minute animated video showing how water flows through a **Francis turbine**. It's pretty cool.
- Source
  - Lesics
    - <https://www.youtube.com/watch?v=3BCiFeykRzo>

### How Francis Turbines Work (Hydropower)

- Summary
  - This is an 11-minute animated video comparing 3 types of turbine:
    - Francis
    - Kaplan
    - Pelton
- Source
  - saVRee
    - <https://www.youtube.com/watch?v=prXe3VAf7n4>



# Page 7 – Plague Yearbook

See the individual pages on each 'student' in the yearbook for lots of details.

## Bacteria versus Virus

### Background

- A **bacteria** is a cell. You need a microscope to see it.
  - Bacterium = singular
  - Bacteria = plural
  - No one will arrest you for just saying 'bacteria' all the time.
- A virus is waaaaaay smaller than a bacteria, so you need an electron microscope to see it. See pages 90 - 92 for details on the parts of a virus.

### *'Virus' vs. 'Bacteria' - The key differences between two common pathogens*

- Summary
  - This is a super basic summary.
- Verbatim
  - Bacteria are giants when compared to viruses.
- Source
  - Merriam Webster dictionary
    - <https://www.merriam-webster.com/words-at-play/virus-vs-bacteria-difference>

### *Viruses or Bacteria - What's got you sick?*

- Summary
  - Very basic answer by the CDC.
- Source
  - CDC (Centers for Disease Control and Prevention)
    - <https://www.cdc.gov/antibiotic-use/pdfs/VirusOrBacteria-Original-P.pdf>

### *What's the difference between a bacterial infection and a viral infection?*

- Summary
  - This is a super basic explanation of the differences between bacteria and viruses by the Mayo Clinic which is an awesome resource by the way for just about anything medical.
- Source
  - Mayo Clinic
    - 14 November 2020
  - <https://www.mayoclinic.org/diseases-conditions/infectious-diseases/expert-answers/infectious-disease/faq-20058098>
- Author
  - Pritish K. Tosh, M.D.

# Page 8 – Typhus – Class of 430 B.C.

## Typhus varieties & vectors

### *Typhus fevers*

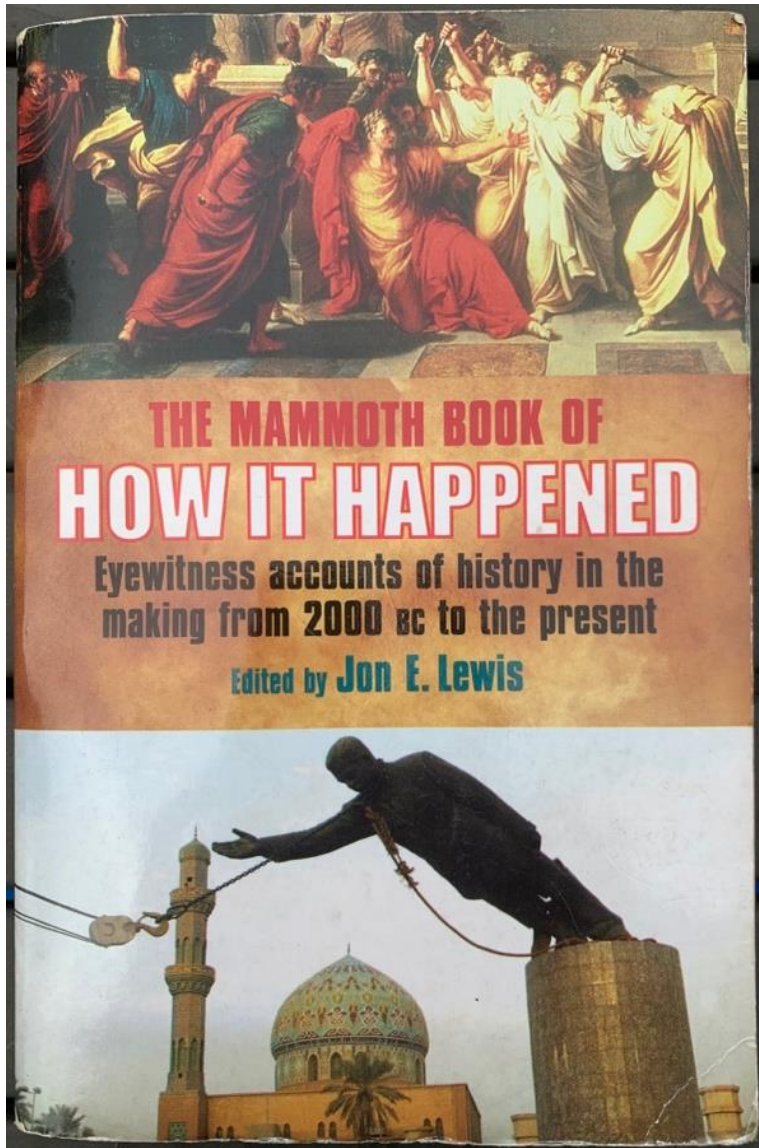
- Summary
  - This describes the 3 varieties of Typhus. Not too crazy with detail, just the Goldilocks amount.

<u>Variety</u>	<u>Vector</u>
<b>Louse-borne Typhus</b> a.k.a. <b>Epidemic Typhus</b>	body louse ← You read about this.
<b>Flea-borne Typhus</b>	flea
<b>Scrub Typhus</b>	chigger a.k.a. bush mite
- Source
  - CDC
    - 13 November 2020
    - <https://www.cdc.gov/typhus/index.html>

## Historical information on the Plague of Athens

### History recap

- 1200 BC The Trojan War – this 10-year battle was compressed into a few weeks in the movie *Troy*.
- 480 BC Spartans battle Persians – the movie *300*.
- 430 BC Plague of Athens which was maybe Epidemic Typhus.



*The Mammoth Book of How It Happened*

- Summary

- This book contains the exact words of people who were present at famous historical events. It's the closest you'll ever get to a time machine.
- Here are some of the events:
  - **The Plague in Athens**
    - This is the account of **Thucydides**, the Athenian general and historian.
    - The birds and animals which scavenge around corpses never went near the many dead bodies lying about unburied, or if they did so and touched the body, they died.
  - **Gladiatorial Games, Rome**
    - The men had nothing with which to protect themselves, for their whole bodies were open to the thrust, and every thrust told.
  - **Titanic survivor**
    - The ship was turning gradually on her nose - just like a duck that goes for a dive. I had only one thing on my mind - to get away from the suction. The band was still playing. I guess

all of them went down. They were playing 'Autumn' then. I swam with all my might.

- Source
  - Constable Publishing
  - 2006
  - Edited by Jon. E. Lewis
  - 620 pages
  - Amazon.com
    - <https://www.amazon.com/Mammoth-Book-How-Happened-Books/dp/1845292650>

### Plague of Athens

- Summary
  - There is a photo of a **creepy mannequin** that is a reconstruction of an 11-year old girl whose skeleton was found in a mass grave. She is presumed to have died during this plague.
- Source
  - Wikipedia
    - [https://en.wikipedia.org/wiki/Plague\\_of\\_Athens](https://en.wikipedia.org/wiki/Plague_of_Athens)

## Thucydides

### Thucydides

- Summary
  - **Thucydides** was the historian and general from Athens during the **Plague of Athens** in 430 B.C.
  - "Thoo koo thee thees."
- Source
  - Wikipedia
    - <https://en.wikipedia.org/wiki/Thucydides>

## Here's how you say his name in Greek

This is according to my Greek friends Fares and Alan. Fares speaks with a Greek accent whereas Alan speaks with a Canadian accent and has a blatantly non-Greek name. I therefore favored Fares.

Alpha Α α	Iota Ι ι	Rho Ρ ρ
Beta Β β	Kappa Κ κ	Sigma Σ σ
Gamma Γ γ	Lambda Λ λ	Tau Τ τ
Delta Δ δ	Mu Μ μ	Upsilon Υ υ
Epsilon Ε ε	Nu Ν ν	Phi Φ φ
Zeta Ζ ζ	Xi Ξ ξ	Chi Χ χ
Eta Η η	Omicron Ο ο	Psi Ψ ψ
Theta Θ θ	Pi Π π	Omega Ω ω

[www.1728.com](http://www.1728.com)

That's the **Greek alphabet**. It has 24 letters. Alpha is the first letter. Omega is the last letter.

- <http://www.1728.org/greek.htm>

This is how you spell **Thucydides** in Greek:

Θουκυδίδης

Θου κυ δι δης .... Let's break it up into 4 syllables.

Θ	theta	th as in "the"	"Thoo"
Ο	omicron	as in "Oakley"	
υ	upsilon	u as in "up"	
κ	kappa	k as in "kangaroo"	"koo"
υ	upsilon	u as in "up"	
δ	delta	d as in "dog"	"thee" *
ι	iota	i as in "iPhone"	
δ	delta	d as in "dog"	"thees" *
η	eta	e as in "eel"	
ς	zeta?	z as in "zebra"	

\* But you have to kinda slip in the slightest bit of 'd' into 'th.'

Anne Frank

### The Diary of a Young Girl

- Summary
  - This is a tender and humbling diary written by Anne Frank who was 13 years old when the Nazis were deporting Jews from Amsterdam. She and her family lived in a secret alcove in their house. They were discovered, however, and Anne died in the Bergen-Belsen labor camp when she was 15.
- Source
  - Anne Frank house (in Amsterdam)
    - You can buy the book from them. This is where I bought my copy – its cover looks like the diagonal blue and red stripes on a picnic table cloth.
    - <https://webshop.annefrank.org/en/>
  - Amazon
    - There are a whole bunch of options for buying the book.
    - <https://www.amazon.com/Anne-Frank/e/B000AQ51EY>
  - Wikipedia
    - [https://en.wikipedia.org/wiki/The\\_Diary\\_of\\_a\\_Young\\_Girl](https://en.wikipedia.org/wiki/The_Diary_of_a_Young_Girl)

### Anne Frank house

- Summary
  - This is where Anne Frank lived in Amsterdam. It's a special place.
- Source
  - <https://www.annefrank.org/en/anne-frank/>

### Google Maps

- This is the location of Anne Frank house in Google Maps.
- <https://goo.gl/maps/cgw2YGWzuxpzWdTc9>

# p9 – Plague Definitions

Desert locust



### Desert locust

- Name
  - The scientific name of the desert locust is ***Schistocerca gregaria***.
    - “Shiss toe sir ka” “greg air ee ah”
  - Notice how their species name, ***gregaria***, refers to the fact they can switch from a solitary state to a ***gregarious*** (sociable) (swarming) state.
  - Getting nitpicky, when grasshoppers swarm they are called **locusts**. And getting more nitpicky, it has to be a **short-horned grasshopper**. That being said, scientific papers call them locusts regardless of solitary or swarming.
  - That photo is a female laying eggs. Each **egg pod** has 100 eggs.
  - Notice she has short antennae hence she is a ‘short-horned grasshopper.’
- Legs
  - The grasshopper has 6 legs.
  - The **front 4** legs are for **walking**.
  - The **rear 2** legs are for **jumping**.
- Source
  - [https://en.wikipedia.org/wiki/Desert\\_locust](https://en.wikipedia.org/wiki/Desert_locust)
  - And all the other sources below.

Egyptian locust



*Anacridium aegyptium*

- Summary
  - That fancy name means it's an **Egyptian locust** a.k.a. **Egyptian grasshopper**.
  - It is a short-horned grasshopper, meaning it can swarm.
- Source
  - Wikipedia
    - [https://en.wikipedia.org/wiki/Anacridium\\_aegyptium](https://en.wikipedia.org/wiki/Anacridium_aegyptium)

## Ancient Egyptian drawing of locust



*Locust*

- Summary
  - This locust was drawn on the wall of the burial chamber of the **Egyptian pharaoh Horemhab** who ruled around 1300 BC.



- It is unclear if it is a desert locust or Egyptian locust as both are found in North Africa.
- Source
  - Wikipedia
    - <https://en.wikipedia.org/wiki/Locust>

## Swarms

### FAO and partners stress urgent need on Desert Locust Response

- Summary
  - A typical locust swarm is 150 million locusts per square kilometer (km<sup>2</sup>).
  - To make that real, imagine you drew a □ large square on the ground, and each side of the square is 1000 steps. One step is roughly 1 meter (3 feet, 3 inches). So more precisely, each side of the square is 1000 meters (1 kilometer) (3280 feet) (0.62 miles). Inside the square are 150 million locusts devouring everything in sight.
  - This swarm can eat as much as 35,000 people in one day. That's how famine occurs.
- Source
  - Food and Agriculture Organization of the United Nations (FAO)
    - 2020
    - <https://www.fao.org/africa/news/detail-news/en/c/1260476/>
    - This is reference no. 5 in *Wikipedia – desert locust*.

## Swarming neuro-science

### Summary of the science

- Solitary grasshopper → Gregarious (swarming) locust.
- This is accomplished by 2 chemical compounds (details to follow):
  - **Guaiacol**
  - **Serotonin**

### Exploitation of gut bacteria in the locust

- Pronunciation
  - Guai-acol
    - “gway” (rhymes with way) “ah call”
    - It's hard to spell so I put a hyphen in there: guai-acol.
- Summary
  - Bacteria in the gut of the locust break down the plant material the locust consumes.
  - A particular species of gut bacteria, *Enterobacter agglomerans*, produces **guai-acol**, which causes the locusts to swarm.
  - Guai-acol is a key component of a **pheromone**, a chemical messenger released into the air. That means it is volatile – it evaporates. That's how the locusts in a swarm influence each other.
  - Guai-acol's formal chemical name is **2-methoxy-phenol**.
    - “2” “meth ox ee” “fee noll”
    - If you've ever taken an organic chemistry course, the **phenol** compounds are alcohols (but you don't drink them) that have a distinctive odor. That's because they are evaporating and going into your nose. But in the case of the locust, the phenol compound is influencing its nervous system to alter behaviour to swarming.
- Materials & Methods
  - The scientists did experiments on the desert locust.
  - They fed them **freeze-dried grass** and **bran** that had been exposed to **gamma radiation** (think, what **Dr. Bruce Banner** was exposed to so he became **The Incredible Hulk**).
  - The radiation killed any bacteria in the grass and brain.

- Then they fed the irradiated food to the locusts.
- Then they compared the feces of locusts fed irradiated food versus a regular diet.
- They were able to isolate the *guia-acol*. This proved the gut bacteria *Enterobacter* made it. I'm 90% sure I got that right.
- Most memorable comment
  - "Faecal pellets from axenic locusts smelled markedly different from those from locusts with a normal gut biota."
- Source
  - *nature*
    - Volume 403: 851
    - 24 February 2000
    - <https://www.nature.com/articles/35002669>
- Authors
  - Rod J. Dillon
  - Chris T. Vennard
  - A. Keith Charnley
    - Department of Biology and Biochemistry, Microbial Pathogenicity Group, University of Bath, Bath, UK

### *Serotonin Mediates Behavioral Gregarization Underlying Swarm Formation in Desert Locusts*

- Some background
  - **Serotonin** is a **neuro-transmitter** (chemical spitball) that allows brain cells to communicate.
  - It is found in both humans and grasshoppers.
- Summary
  - This was an experiment on desert locusts.
  - The scientists tickled the hind legs of the locusts to simulate being in swarm.
  - Crowding of locusts → tactile stimulation of hind legs → serotonin release from nervous system → change color, eat more, breed more easily, mutual attraction.
  - Serotonin is not released into the air. It stays inside the nervous system.
- Verbatim
  - Desert locusts, *Schistocerca gregaria*, show extreme phenotypic plasticity, transforming between a little-seen solitarious phase and the notorious swarming gregarious phase depending on population density. An essential tipping point in the process of swarm formation is the initial switch from strong mutual aversion in solitarious locusts to coherent group formation and greater activity in gregarious locusts. We show here that serotonin, an evolutionarily conserved mediator of neuronal plasticity, is responsible for this behavioral transformation, being both necessary if behavioral gregarization is to occur and sufficient to induce it. Our data demonstrate a neurochemical mechanism linking interactions between individuals to large-scale changes in population structure and the onset of mass migration.
- Source
  - *Science*
    - 30 January 2009
    - <https://www.semanticscholar.org/paper/Serotonin-Mediates-Behavioral-Gregarization-Swarm-Anstey-Rogers/2eb8e5b4d5793003cd56b1952dd9897a31ded14c>
      - This is reference no. 2 in *Wikipedia – locust*.
- Authors
  - **Michael L. Antsey**
    - He is quoted in the BBC article just below.
  - Stephen M. Rogers
  - **Ott R. Swidbert**
    - He is quoted in the BBC article just below.
  - Malcolm Burrows

- Stephen J. Simpson

### Locust swarms 'high' on serotonin.

- Summary
  - This is a BBC (British Broadcasting Corporation) news report summarizing the paper above.
  - There were interesting comments from the scientist authors.
- Verbatim
  - "The question of how locusts transform their behaviour in this way has puzzled scientists for almost 90 years," said co-author **Dr Michael Anstey**, from Oxford University.
  - "Serotonin profoundly influences how we humans behave and interact," said co-author **Dr Swidbert Ott**, from Cambridge University. "So to find that the same chemical is what causes a normally shy, antisocial insect to gang up in huge groups is amazing."
- Source
  - BBC
    - 29 January 2009
      - This is 1 day before the article appeared in *Science* (immediately above) so I guess the BBC got a sneak peek.
    - <http://news.bbc.co.uk/2/hi/science/nature/7858996.stm>
      - This is reference no. 12 in *Wikipedia - locust*.
- Author
  - James Morgan

## 8th Plague of Egypt - Locusts

### Plagues of Egypt

- Summary
  - There are 10 plagues mentioned in the Bible's Old Testament *Book of Exodus* in Chapter 10, verses 1 – 20.
  - The 8<sup>th</sup> plague was locusts.
- Verbatim (the bold was added by me)
  - "This is what the LORD, the God of the Hebrews, says: 'How long will you refuse to humble yourself before me? Let my people go, so that they may worship me. If you refuse to let them go, I will bring **locusts** into your country tomorrow. They will cover the face of the ground so that it cannot be seen. They will devour what little you have left after the hail, including every tree that is growing in your fields. They will fill your houses and those of all your officials and all the Egyptians—something neither your fathers nor your forefathers have ever seen from the day they settled in this land till now.'" (Standard King James Version)
- Verbatim
  - Els, if thou refuse to let my people goe, behold, to morrow will I bring the **locusts** into thy coast. (1611 King James Version)
    - [https://www.kingjamesbibleonline.org/1611\\_Exodus-Chapter-10/](https://www.kingjamesbibleonline.org/1611_Exodus-Chapter-10/)
- Source
  - Wikipedia
    - [https://en.wikipedia.org/wiki/Plagues\\_of\\_Egypt](https://en.wikipedia.org/wiki/Plagues_of_Egypt)
    - The quote from *Exodus* is about ½ way down the web page.

## Pestilence the 5<sup>th</sup> Plague



### Plagues of Egypt

- Summary
  - This 1886 painting by Gustave Doré is pestilence affecting livestock. I don't know what bacteria (or other organism) caused it.
  - It's at the very end of the Wikipedia page.
- Source
  - [https://en.wikipedia.org/wiki/Plagues\\_of\\_Egypt](https://en.wikipedia.org/wiki/Plagues_of_Egypt)

## Four Horsemen of the Apocalypse



### Four Horsemen of the Apocalypse

Occupation: **Death**                      **Famine**                      **War**                      **Conquest**  
 Horse: **Pale**                              **Black**                      **Red**                      **White**

### • Summary

- The painting is by **Victor Vasnetov** in 1887.
- **Revelation is the last book of the New Testament.**
- **Chapter 6 has 17 verses, of which verses 1-8 concern the Four Horsemen of the Apocalypse.**
- In the boxes below is an excerpt from the *King James Version* of 1611 (which I like because it's written in Early Modern English).
  - Of note, the horses the painting are in **reverse order** to the verses in *Revelation*, begging the question: Why didn't Victor Vasnetov draw them as they appear in *Revelation*? Maybe he did but the original painting was reversed? But a Google Images search shows all the images like the above. Only one image has the horses in the opposite order (as they appear in *Revelation*). Is it the only correct one? And why am I agonizing over this, anyways?

#### White Horse = conquest

**1** And I sawe when the Lambe opened one of the seales, and I heard as it were the noise of thunder, one of the foure beastes, saying, Come and see.

**2** And I saw, and behold, a **white horse**, and hee that sate on him had a bowe, and a crowne was giuen vnto him, and hee went forth conquering, and to conquere.

#### Red Horse = war

**3** And when hee had opened the second seale, I heard the second beast say, Come and see.

**4** And there went out **another horse that was red**: and power was giuen to him that sate thereon to take peace from the earth, and that they should kill one another: and there was giuen vnto him a great sword.

### Black Horse = famine

5 And when hee had opened the third seale, I heard the third beast say, Come and see. And I beheld, and loe, a **blacke horse**: and hee that sate on him had a paire of balances in his hand.

6 And I heard a voice in the midst of the foure beastes say, A measure of wheate for a penie, and three measures of barley for a penie, and see thou hurt not the oyle and the wine.

### Pale Horse = death

7 And when hee had opened the fourth seale, I heard the voice of the fourth beast say, Come and see.

8 And I looked, and behold, a **pale horse**, & his name that sate on him was Death, and hell followed with him: and power was giuen vnto them, ouer the fourth part of the earth to kill with sword, & with hunger, and with death, and with the beastes of the earth.


- Source

- [https://en.wikipedia.org/wiki/Four\\_Horsemen\\_of\\_the\\_Apocalypse](https://en.wikipedia.org/wiki/Four_Horsemen_of_the_Apocalypse)
- [https://en.wikipedia.org/wiki/Four\\_Horsemen\\_of\\_the\\_Apocalypse\\_\(painting\)](https://en.wikipedia.org/wiki/Four_Horsemen_of_the_Apocalypse_(painting))
- [https://en.wikipedia.org/wiki/Viktor\\_Vasnetsov](https://en.wikipedia.org/wiki/Viktor_Vasnetsov)
- [https://www.kingjamesbibleonline.org/1611\\_Revelation-Chapter-6/](https://www.kingjamesbibleonline.org/1611_Revelation-Chapter-6/)
  - This is the King James Version of 1611, written in Early Modern English in those boxes above.
  - **King James** was born in **Edinburgh Castle** in Edinburgh, Scotland. I stood in the very bedroom where he was born. It's a small room. I tried to figure out which way the bed of his mother, **Mary Queen of Scots**, was facing at the time of his delivery. People thought I was weird.



*Death on the Pale Horse*

- Summary

-  **Zoom in on that photo.** Death looks pretty determined. You know it's gonna be a bad day when you see Death coming up your driveway. But you know what? I looked again. He actually looks kind

- of lost. Like he got the wrong address and doesn't know if it's 1745A or 1745B at the duplex. What would Death do in that situation? Burn the whole thing to the ground. Problem solved.
- That's another painting by **Gustav Doré** (1832 – 1883). He was a **French artist** who drew bleak black and white sketches.
  - Source
    - [https://commons.wikimedia.org/wiki/File:Gustave\\_Doré\\_-\\_Death\\_on\\_the\\_Pale\\_Horse\\_\(1865\).jpg](https://commons.wikimedia.org/wiki/File:Gustave_Doré_-_Death_on_the_Pale_Horse_(1865).jpg)
    - [https://en.wikipedia.org/wiki/Gustave\\_Doré](https://en.wikipedia.org/wiki/Gustave_Doré)

You can also buy books decorated with the art of Gustave Doré. I have the first two.

- *The Doré Bible Illustrations*
  - [https://www.amazon.com/gp/product/B00A3YE55Y/ref=db\\_s\\_a\\_def\\_rwt\\_bibl\\_vp\\_i2](https://www.amazon.com/gp/product/B00A3YE55Y/ref=db_s_a_def_rwt_bibl_vp_i2)
- *Rime of the Ancient Mariner*
  - <https://www.amazon.ca/Rime-Ancient-Mariner-Gustave-Doré/dp/0486223051>
- *Milton's Paradise Lost*
  - <https://www.amazon.ca/Dorés-Illustrations-Paradise-Lost-Gustave/dp/0486277194>

# Page 10 - Plague

## GROSS Plague photos

### Plague Symptoms

- Summary
  - There are 3 photographs from the CDC showing:
    - **Bubonic Plague** – swollen lymph nodes in the groin.
      - Verbatim
        - The bacteria multiply in the lymph node closest to where the bacteria entered the human body.
    - **Septicemic Plague** – a **GROSS** foot that is black because the infected tissue is dead.
    - **Pneumonic Plague** – a chest x-ray.
- Source
  - CDC
    - Last updated 15 November 2021
    - <https://www.cdc.gov/plague/symptoms/index.html>

### Bubonic Plague

- Summary
  - Lymph nodes are about the size of a pea, normally. They are part of the immune system and are scattered all over the body. In **Bubonic Plague**, the bacteria *Yersinia pestis* is living inside the lymph nodes. Very rude. And not just one bacteria, millions of them.
  - There is a photo of swollen (and by the looks of it, ready to rupture) lymph nodes in the right groin. It's **KINDA GROSS** but it's low resolution so you prolly won't barf.
  - There is also a **GROSS** photo of some poor chap whose fingertips are black and dead. No fun.
    - This is the caption:
      - Necrosis of the nose, the lips, and the fingers and residual bruising over both forearms in a person recovering from bubonic plague that disseminated to the blood and the lungs. At one time, the person's entire body was bruised.
    - Translation:
      - **Necrosis** (“neck row sis”) means dead or dying tissue.



- **Disseminated** means to spread all over the body. In this case, the bacteria started out in the lymph nodes (**Bubonic Plague**) and spread to the lungs (**Pneumonic Plague**) and blood (**Septicemic Plague**).
  - Source
    - Wikipedia
      - [https://en.wikipedia.org/wiki/Bubonic\\_plague](https://en.wikipedia.org/wiki/Bubonic_plague)

## Plague – what's it like? It sucks.

### Plague

- Summary
  - This is a nice overview of **Plague** by the **Mayo Clinic** who always offer a basic, readable description of things. The Mayo Clinic is a good place to start if you're curious about *any* medical topic. I like to come here first when I need to refamiliarize with an illness (or maybe never heard of it). Then I dive deeper into more technical sites like **Medscape**.
- Verbatim
  - **Blood clots** in the tiny blood vessels of your fingers and toes can disrupt blood flow and cause that tissue to die. The portions of your fingers and toes that have died may need to be removed (amputated).
- Source
  - **Mayo Clinic**
    - No date given.
    - <https://www.mayoclinic.org/diseases-conditions/plague/symptoms-causes/syc-20351291>
- Authors
  - Mayo Clinic Staff

### Plague

- Summary
  - This is a great article on **Plague**. Really well written. I suggest you first read the **Mayo Clinic** article (above), then this one.
- Source
  - *Tropical Infectious Diseases: Principles, Pathogens and Practice*
    - Elsevier
    - 29 April 2011
    - <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7149940/>
- Author
  - **Paul S Mead, MD**. Division of Vector-Borne Diseases, Centers for Disease Control and Prevention, Fort Collins, Colorado.
- Guest Editors
  - **Richard L. Guerrant, MD**. Division of Infectious Diseases and, International Health; University of Virginia School of Medicine, Charlottesville, VA, USA
  - **David H. Walker, MD**. Carmage and Martha Walls Distinguished, University Chair in Tropical Diseases; Director, Center for Biodefense and, Emerging Infectious Diseases; Professor and Chair, Department of, Pathology; University of Texas Medical Branch, Galveston, TX, USA
  - **Peter F. Weller, MD FACP FIDSA**. Professor of Medicine, Harvard Medical, School; Professor, Immunology and Infectious, Diseases Department, Harvard School of, Public Health; Chief, Infectious Disease Division; Vice Chair of Research, Department of, Medicine, Beth Israel Deaconess Medical, Center, Boston, MA, USA

### Plague

- Summary
  - This is the CDC home page for **Plague**.

- There are links to:
  - **bio-terrorism** (as in, weaponized *Yersinia pestis* bacteria)
  - maps showing recent Plague outbreaks
  - transmission in the wild
  - treatment
- Plus, links for technical information for medical doctors, public health officials, and vets. You may as well check these out – it's a good way to see how 'regular' language turns into scientific language. Then it's not as intimidating.
- Source
  - CDC
    - Last updated Aug 6, 2021.
    - <https://www.cdc.gov/plague/index.html>

### Plague – CDC Yellow Book

- Summary
  - This is information on the **Plague** from a CDC publication called *The Yellow Book* that is used as a rough guide for doctors who practice 'travel medicine.' Remember, Plague still exists. You can still get it. It's just not common.
  - The doctors at travel medicine clinics are usually **primary care physicians** (like me) who have an interest in this topic. They determine what diseases are present in the country you intend to visit, and what vaccines or medicines are needed. This information is continuously updated.
  - As a generality, healthy people go to a travel medicine clinic *prior* to departing on their trip. They are given whatever meds or vaccines are needed. But if *returning* travellers are sick, they generally will get seen by an **Infectious Disease specialist** at the hospital. Yeah, as a generality.
  - The recommendations in *The Yellow Book* are written by the Infectious Disease specialists at the CDC.
- Source
  - CDC
    - Last updated June 24, 2019
    - <https://wwwnc.cdc.gov/travel/yellowbook/2020/travel-related-infectious-diseases/plague-bubonic-pneumonic-septicemic>

### Plague

- Summary
  - This is a very thorough article on **Plague**.
  - **Medscape** is a fantastic website. Highly accurate. Written by and for doctors in technical language. That being said, the sections on *Background* and *Epidemiology* are very readable and give a fantastic overview.
  - There is also a 'non-professional' version of Medscape.
- Source
  - **Medscape**
    - 2021
    - <https://emedicine.medscape.com/article/235627-overview#a4>
- Author
  - Author
    - Venkat R Minnaganti, MD is the principal author.
  - Co-Author
    - Michael Stuart Bronze, MD
  - Specialty Editorial Board
    - Francisco Talavera, PharmD, PhD
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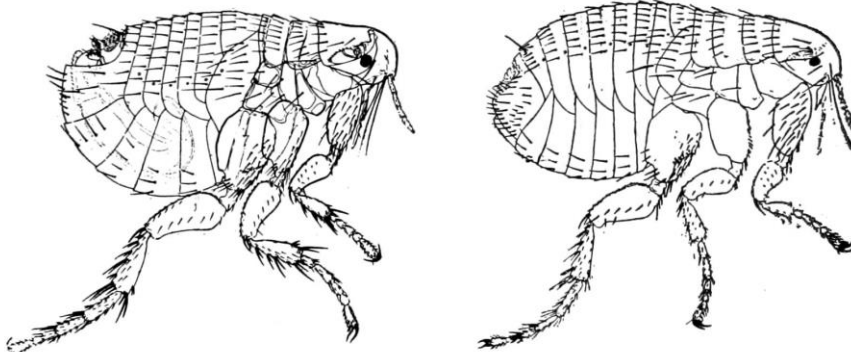
# Page 11 – Plague flea

## Plague description

### *The Mammoth Book of How it Happened*

- This book is the source of the quote, "For it began in England ..."
- The book was already mentioned on Page 8.
- Amazon.com
  - <https://www.amazon.com/Mammoth-Book-How-Happened-Books/dp/1845292650>

## Flea



*Xenopsylla cheopis*, the oriental rat flea ; male, left; female, right.

### *Oriental rat flea*

- Names
  - **Oriental rat flea** a.k.a. **Plague flea**
- Summary
  - This is the flea that spreads **Plague**.
  - Why is it called *Oriental*? Because the rat originated in the **Orient**, a geographic region that is mostly **China and India**. By the way, in the book *Murder on the Orient Express* by **Agatha Christie**, guess where the murder takes place?
  - The flea normally feeds on the blood of **rats**.
  - When the flea gets infected by the bacteria it bites **humans** → now the bacteria is inside your body → now you have Plague → now you die.
- Source
  - Wikipedia
    - [https://en.wikipedia.org/wiki/Oriental\\_rat\\_flea](https://en.wikipedia.org/wiki/Oriental_rat_flea)




### Charles Rothschild

- Source
  - That is an **Oriental rat flea** on a glass slide for viewing under a microscope.
  - Interestingly, preparing insect slides like this was the hobby of **Charles Rothschild** (1877 – 1923) of the famous banking family. See his name on the slide?
- Source
  - Wikipedia
    - [https://en.wikipedia.org/wiki/Charles\\_Rothschild](https://en.wikipedia.org/wiki/Charles_Rothschild)

## Flea digestive system

### Digestive and Excretory Systems

- Summary
  - This is a cool site showing the parts of the insect digestive system (and also waste).
  -  Hold the cursor over **any words in red**, for example, **salivary glands**, and that part will show up in red in the insect drawing.
  - The **proventriculus** is in the 5<sup>th</sup> paragraph, about 1/3 down the page.
- Source
  - North Carolina State University: Agriculture and Life Sciences: Entomology
    - <https://genent.cals.ncsu.edu/bug-bytes/digestive-system/>



### Yersinia pestis

- Summary
  - That's the **Oriental rat flea**. The bacteria *Yersinia pestis* has infected the flea. In this photo, the flea's **pro-ventriculus**, which is basically a storage area before the stomach, is blocked because it is full of bacteria.
  - Take note, the flea's pro-ventriculus is a digestive organ. Do not confuse it with the ventricles that pump blood in the human heart.
- Verbatim
  - Oriental rat flea (*Xenopsylla cheopis*) infected with the *Y. pestis* bacterium, which appears as a dark mass in the gut: The foregut (proventriculus) of this flea is blocked by a *Y. pestis* **biofilm**; when the flea attempts to feed on an uninfected host, *Y. pestis* is regurgitated into the wound, causing infection.
- Translation
  - A **bio-film** is a slimy surface formed by a great many bacteria. It's actually cutting edge biology.
- Source
  - Wikipedia
    - [https://en.wikipedia.org/wiki/Yersinia\\_pestis](https://en.wikipedia.org/wiki/Yersinia_pestis)

### Plague

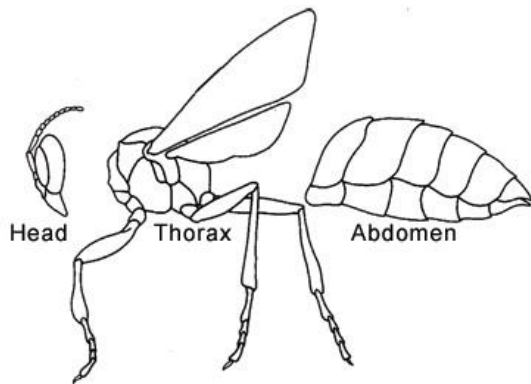
- Summary
  - This paper was already mentioned on page 10.
  - The description below is another way of describing how the proventriculus gets blocked. They describe an almost identical image to the one above.
- Verbatim
  - Pictured is a flea with a **blocked proventriculus**, which is equivalent to the gastroesophageal region in a human. In nature, this flea would develop a ravenous hunger because of its inability to digest the fibrinoid mass of blood and bacteria. If this flea were to bite a mammal, the proventriculus would be cleared, and thousands of bacteria would be regurgitated into the bite wound. Courtesy of the United States Army Environmental Hygiene Agency.
- Translation

- The **gastro-esophageal junction** is where the human stomach ('gastro') and food pipe (esophagus) meet. And by the way, when you have 'heartburn' that is called **Gastro-Esophageal Reflux Disease (GERD)**. The stomach acid creeps into the esophagus and that creates a burning sensation. Point is, both humans and fleas have a gastro-esophageal junction, telling you how ancient this type of body plan is.
- **Fibrin** is a clotting factor in the blood. The term '**fibrinoid mass**' refers to a bunch of clotted blood from whoever the flea fed on last – probably a rat. Maybe a human.
- Source
  - Medscape
    - 2021
    - <https://emedicine.medscape.com/article/235627-overview#a5>
- Author
  - Venkat R Minnaganti, MD and others.

### *Adaptive strategies of Yersinia pestis to persist during inter-epizootic and epizootic periods*

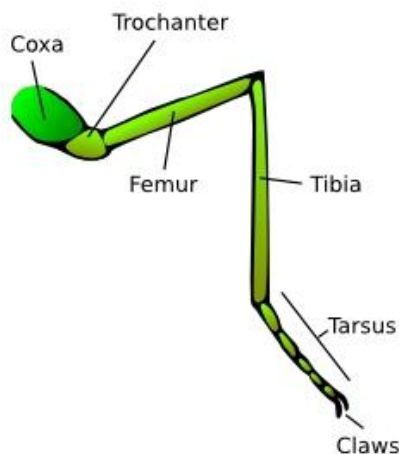
- Summary
  - This is another description of the regurgitation process in the flea.
- Verbatim
  - In 1914, Bacot and Martin described the blocked flea paradigm of *Y. pestis* transmission [4]. Under this scenario, a flea first consumes blood from a highly bacteremic host. Over time, the plague bacilli multiply within the proventriculus and midgut, eventually forming a blockage in the proventriculus, which is a globular structure lying between the flea's esophagus and midgut (stomach). The interior of the proventriculus is lined with a series of spines that prevent ingested blood cells from flowing back towards the mouth of the flea.
  - Although block formation can occur as early as 5 days post infection (d.p.i.), it is not typically observed until 2-3 weeks p.i. [ p.i. = post-infection]
  - Blockage of the gut by the proliferating *Y. pestis* and its products (biofilm) prevents newly ingested blood from reaching the midgut, thus causing the flea to starve.
- Translation
  - **Bacteremic / bacteremia** means bacteria are multiplying in the blood.
  - **Bacillus** (singular) or **bacilli** (plural) are synonyms for rod-shaped bacteria.
- Source
  - *Veterinary Research*
    - 2009 March – April
    - <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2695026/>
- Authors
  - Rebecca J. Eisen and Kenneth L. Gage
    - Bacterial Diseases Branch, Division of Vector Borne Infectious Diseases, National Center for Zoonotic, Enteric and Vector-Borne Diseases, Centers for Disease Control and Prevention, 3150 Rampart Road, Fort Collins, Colorado, USA

**Flea jumping**



### Insect anatomy

- Summary
  - This drawing looks like a **fly**.
  - A **fly** is an insect, meaning 6 legs plus a crunchy exo-skeleton. So is a **flea**. So is a **bee**. So is a **mosquito**. So is a **grasshopper / locust**. So is an **ant**. Wings are optional.
  - An insect's body is made of 3 parts:
    - Head
    - Thorax
      - The legs attach to the thorax.
    - Abdomen
- Source
  - **Purdue University – 4H Youth and Entomology**
    - Thanks 4H'ers!!
    - [https://extension.entm.purdue.edu/401Book/default.php?page=insect\\_anatomy](https://extension.entm.purdue.edu/401Book/default.php?page=insect_anatomy)



### Coxa

- Summary
  - Insects have 6 legs.
  - An insect's leg always has the same 5 parts:
    - Coxa
      - “Cox ah”
      - It attaches the leg to the thorax and is important for transferring energy.
    - Trochanter
      - “Trow can ter”
      - There is a Trochanter-Femur Joint (TFJ) that acts like a **gimbal**, meaning it allows a certain amount of rotation, kind of like those things that stabilize your iPhone for selfies while you're moving. Something like that.

- Femur
    - “fee mer”
    - Tends to be stout and thick.
  - Tibia
    - ‘tib ee ah”
    - **The pollen basket** of a honey bee attaches to the tibia. Who knew?
  - Tarsus
    - “tar suss”
    - 1-2 claws attach to it.
- Source
  - Amateur Entomologists’ Society
    - <https://www.amentsoc.org/insects/glossary/terms/coxa/>

### Gimbals in the insect leg

- Summary
  - ‘Gimbal’ is defined the article above.
  - I put this article here simply to show that **entomologists**, the scientists who study insects, look at anatomy very closely.
- Source
  - *Arthropod Structure & Development*
    - 5 October 2008
    - <https://pubmed.ncbi.nlm.nih.gov/18765299/>
- Author
  - Leonid Frantsevich, Weiying Wang. Schmalhausen-Institute of Zoology, B.Chmelnicky str., 15, Kiev-30, 01001, Ukraine

### Biomechanics of jumping in the flea

- Summary
  - If you’ve ever wondered how a flea jumps, this is the paper to read. It’s thorough and detailed. There are time-lapse photos, diagrams of the leg anatomy of the flea, and graphs.
  - Figure 3 shows the **resilin protein** that enables the huge jumps. The protein glows under uv light.
- Source
  - *Journal of Experimental Biology*
    - 2011 March
    - <https://journals.biologists.com/jeb/article/214/5/836/33598/Biomechanics-of-jumping-in-the-flea>
- Author
  - Gregory P. Sutton & Malcolm Burrows. Department of Zoology, University of Cambridge, Downing Street, Cambridge, UK

### Great Walkers

- Summary
  - **Resilin** is elastic like rubber.
  - The muscles of the **coxa** contract. It’s the leg part connected to the thorax.
- Verbatim
  - The capacity to jump is related to the presence of **resilin**, a protein of great elasticity similar to rubber.
  - The flea accumulates energy by tensing the muscles of the thorax and legs.
  - The muscles in the coxa contract, generating enormous tension. The resistance to the tension is supported by the exoskeleton.



- Within **tenths of a second**, the flea prepares itself to jump. It compresses the resilin and at the same time contracts its back legs. The back legs have a system of pads that retain the tension and accumulate energy.
- Source
  - Fossil Hunters
    - 24 April 2021
    - <https://www.fossilhunters.xyz/insects/great-walkers.html>

### Hookworm

- Summary
  - There are comments on flea leg anatomy and resilin in slide 37.
- Verbatim
  - “the flea accelerates like a bolt from a crossbow.”
- Source
  - Slideplayer
    - <https://slideplayer.com/slide/3460859/>
    - <https://slideplayer.com/slide/3460859/12/images/37/As+with+all+insects%2C+a+flea+has+three+pairs+of+legs+that+attach+to+its+thorax..jpg>

### Resilin

- Summary
  - This is a pretty technical article on the resilin protein which has elastic properties.
  - There is some detail on resilin in the flea.
  - There is a slow motion clip at 1000 frames per second of the feeding parts of a crayfish, presumably powered by resilin.
- Source
  - Wikipedia
    - <https://en.wikipedia.org/wiki/Resilin>

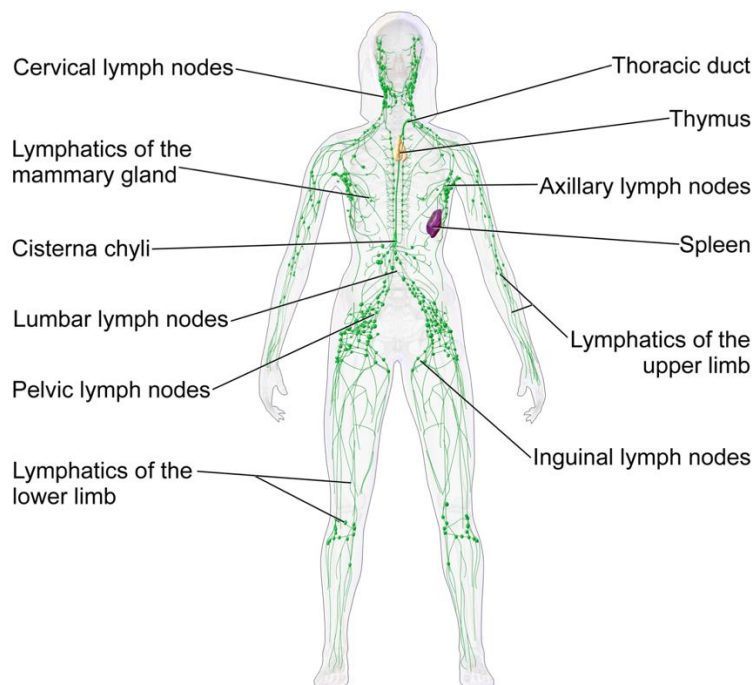
### Human leg versus insect leg (my own observations)

- What do human legs and insect legs have in common?
  - Insect legs and human legs have some names in common, for example, **femur** (thigh) and **tibia** (shin). But you couldn't just trade legs with an insect.
- Humans
  - The human skeleton is made of bone.
  - **Bone** is a mixture of calcium and exotic crystals.
  - **Our skeleton is inside us – it is an endo-skeleton.**
  - Our muscles are on the outside. Our muscles 'clothe' the bone. It's muscle you feel when you slap your thigh.
- Insects
  - The insect skeleton is not made of bone. Instead, it is made of a substance called **chitin** (“kite in”) which is oddly similar to sugar in its chemical formula. Lobsters and crabs have a similar design.
  - **The insect skeleton is on the outside – it is an exo-skeleton.**
    - ‘Exo’ is Greek for *outside*, hence an Exit sign.
  - Insect muscles are on the inside. Same for lobsters, which is why you crack open the leg and eat the muscle inside.
- Hmm ...
  - In the grand scheme of things, muscles contract and create movement. The purpose of a skeleton is to allow muscle a place to attach, and to create structure. Otherwise you'd just be an **earthworm** with muscle but no skeleton.

- Is it a bad idea to put your muscles and their blood vessels on the outside of your body so they can be easily attacked? Is it way smarter to have a hard, protective exo-skeleton on the outside? If there was a war of humans against human-sized ants, for sure we'd lose in hand-to-hand combat.

# Page 12 – Plague lymphatics

## Lymphatic fluids and vessels

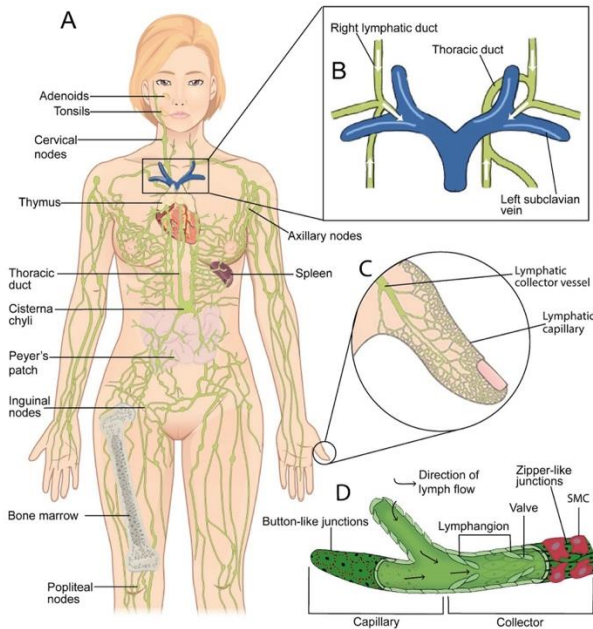


### Lymphatic system

#### • Summary

- Okay, here's the deal. Our blood vessels are not water tight. They are designed to be leaky but only a tiny bit. A tiny volume of the *fluid* portion of the blood leaks out. It drains into lymph vessels (green in the image above) which I think of as **drainage ditches**. And guess where these drainage ditches empty? Back into the blood vessels, close to the heart (image below). So the total amount of fluid remains the same, roughly speaking.
- It's more complex than this and must factor in what is called **Total Body Water (TBW)**, which is where all the water is distributed. Here is where water is found in your body:
  - Blood vessels ... in medicalesse this is called the **Intra-Vascular Volume (IVV)**
  - Inside cells ... in medicalesse this is called the **Intra-Cellular Space (ICS)**
  - Between cells ... in medicalesse this is called the **Extra-Cellular Space (ECS)**

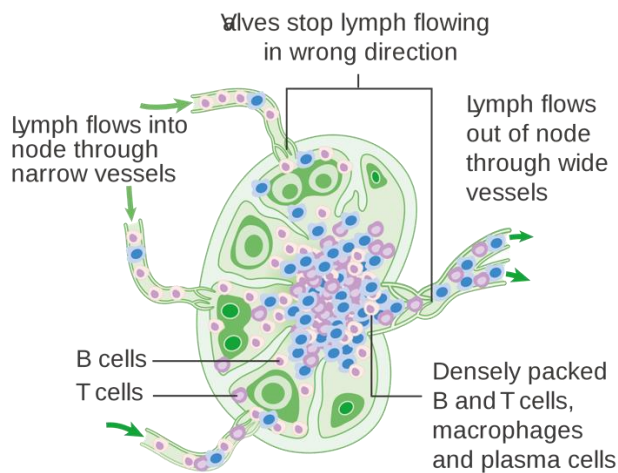
- Source
  - Wikipedia
    - [https://en.wikipedia.org/wiki/Lymphatic\\_system](https://en.wikipedia.org/wiki/Lymphatic_system)



Can you see in **Box B** where the green lymph vessels empty into the blue blood vessels? That's how the drainage ditches empty. Get it? The fluid that leaked out is returned to the blood vessels.

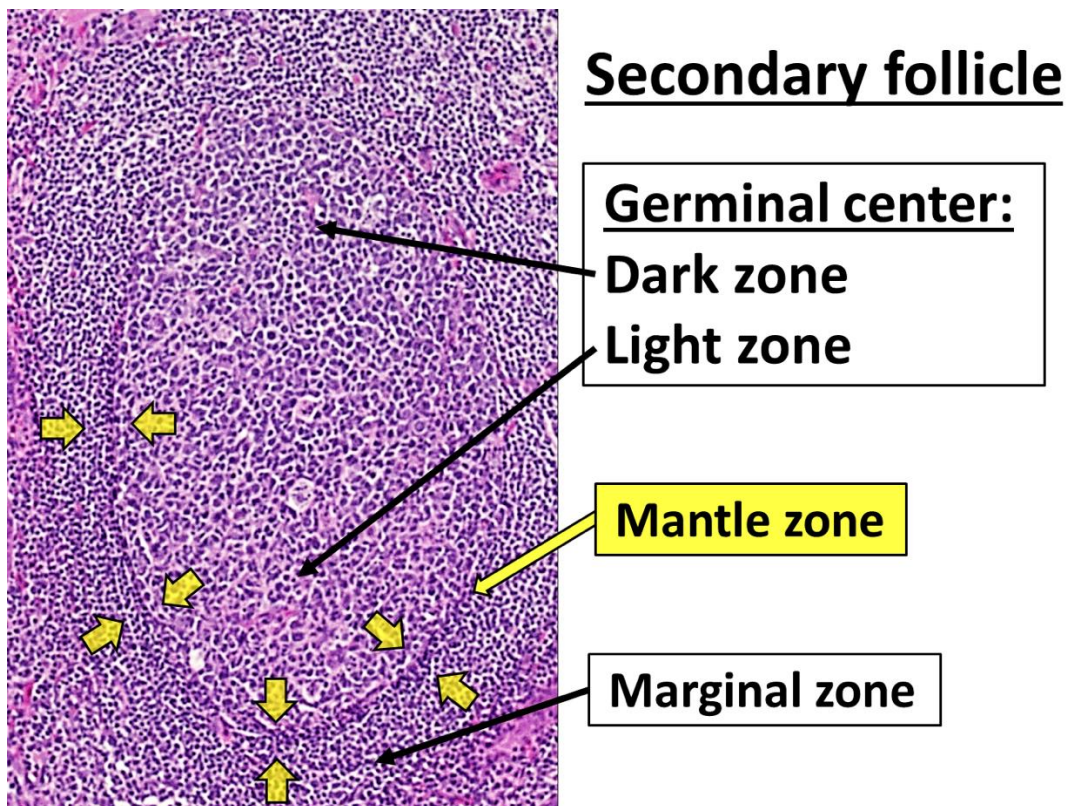
- The image is from the Wikipedia article above.

## Lymph nodes



- Lymph nodes*
- Summary

- That's a drawing of one **lymph node**. It's about the size of a pea. Guess what flows into it? **Lymphatic fluid**. You can see 3 lymph vessels on the left entering the lymph node. The lymph node itself is packed with **white blood cells** of the immune system – they are labelled here as **B cells** and **T cells**. And on the right you see the lymphatic fluid leaving the lymph node.
- Guess where the **Plague** bacteria *Yersinia pestis* ends up? Right inside the lymph node – usually in the groin – which swells and is painful. Hence the gross photos on page 10.
- In the grand scheme of things, it's within the lymph node that the white blood cells 'learn' the identity of invaders. Some of the white blood cells attack the invader – wherever it is in your body. And some of those white blood cells don't join the fight, rather they remember the invader so it's quickly recognized the next time it invades. In the case of **Plague**, the infection can be so overwhelming that you simply die. *Yersinia pestis* is not a nice bacteria. It does not sell Girl Guide cookies door to door.
- Source
  - Wikipedia
    - [https://en.wikipedia.org/wiki/Lymph\\_node](https://en.wikipedia.org/wiki/Lymph_node)



That's what a lymph node looks like under a microscope. It's jam-packed with white blood cells which are all those individual purple dots.

- Don't confuse that purple color with the **Gram stain** (page 14)! This one is a different stain called **Hematoxylin & Eosin** a.k.a. **H&E stain**, which is one of the most famous and useful stains used in Medicine.
  - "Heem ah tox ah lin"
  - "Ee oh sin"
- [https://en.wikipedia.org/wiki/Lymph\\_node](https://en.wikipedia.org/wiki/Lymph_node)
- [https://en.wikipedia.org/wiki/H%26E\\_stain](https://en.wikipedia.org/wiki/H%26E_stain)

**Cancer spread**

*Lymph nodes and cancer*

- Summary

- Cancer cells started out as normal cells. Then, deep in their DNA, the ON and OFF switches get screwed up. They keep on dividing. And dividing. And dividing. As a generality, when there are 1 billion cancer cells, it's a 'tumor mass' about the size of a pea.
- As you may know, the staging of cancer is like so:
  - **Stage 1** – confined to where it started, say in a small region of breast.
  - **Stage 2** – local spread, usually confined to the same organ or structure.
  - **Stage 3** – more spread, now to nearby structures.
  - **Stage 4** – Distant spread, say from breast to bone or lung.
- How does this 'spreading' take place?
  - It can be 'direct extension' which means it literally spreads into the healthy region right beside it. The number of tumor cells is increasing in order for this to occur.
  - It can spread in the blood.
  - It can spread in lymph vessels. That's why breast cancer can spread to the lymph nodes in the armpit (and from there to more distant regions). The medical term for the armpit is axilla, so these are **axillary lymph nodes**. A surgeon may remove the breast as well any axillary lymph nodes where cancer is present.
- All cells sit on top of what is called the **basement membrane**. When cancer has just started, even before Stage 1, the cancer cells have not yet breached the basement membrane. That's called **Carcinoma in situ**. The *in situ* means *in place* in Latin. This is the best time to detect cancer; this is the purpose of the **pap smear** to detect **Cervical Cancer**.
- Finally, **benign tumors** are not cancer. They don't *spread*. But they can *grow* big and press on things, which is when they become a problem. The cancer cells are the same size, it's just that there's more of them. The most famous of these benign tumors is the **Acoustic Neuroma** ("ah coo stick" – "ner oh ma") which is a tumor of the nerve that transmits sound impulses into the brain. When the tumor gets big enough, it can squish stuff in the brain, so that's not good.
- All of this is the field of medicine called **oncology**. Crazy complicated stuff.
- That was very much the *Reader's Digest Condensed Version* of cancer biology.
- The whole point of this explanation is that the lymphatic system – a very necessary part of the immune system – can also be the way that plague bacteria spreads, and the way that cancer cells spread. And the other point, I think, is that all these body systems are related. The more you understand one, the more you understand the others. And if I told you that **coronavirus** can spread by the lymphatics (the image above with all the green vessels), you'd understand what that means; yes, it can.
  - **SARS-CoV2 entry and spread in the lymphatic drainage system of the brain**
    - *Brain, Behaviour and Immunology*
      - July 2020
      - Mehmet Bostancıoğlu. Elysium Health Center, Gaziantep, Turkey
      - [https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7189839/#:~:text=\(2020\)%20documented%20histologically%20that%20SARS,and%20reaching%20to%20the%20brain.](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7189839/#:~:text=(2020)%20documented%20histologically%20that%20SARS,and%20reaching%20to%20the%20brain.)
      - Verbatim
        - SARS-CoV2 can infect lymph endothelial cells branching to the nasal cavity from cervical lymph nodes and reaching to the brain. (See page 144 in this Bibliography for details).

- Source

- **American Cancer Society**
  - <https://www.cancer.org/cancer/diagnosis-staging/lymph-nodes-and-cancer.html>

### Cancer staging

- Summary


- The grading system of cancer is more complicated than Stage 1 to 4. It's based on the **TNM system**.
  - **T** = size (usually diameter) of the Tumor.
  - **N** = Has the cancer spread to regional (nearby) lymph Nodes? If so, how many?
  - **M** = **Metastasis** ("met ass ta sis") – has the cancer spread to distant structures?

- The **National Cancer Institute** is part of the **National Institutes of Health (NIH)** – page 180.
- Source
  - **National Cancer Institute**
    - <https://www.cancer.gov/about-cancer/diagnosis-staging/staging>

## Page 13 – Plague maps

### Plague epidemics and pandemics

#### List of epidemics and pandemics

- Summary
  -  Go to the second table under the 'Chronology' heading. Now click on the 'Disease' column. Then scroll down to 'Bubonic plague.' You can now chronologically explore every epidemic and pandemic of *Yersinia pestis*, the bacteria causing **Plague**, starting in **541 AD** and ending in **1994 AD**. That doesn't mean Plague has disappeared. That's just where the data stops.
  - I did not put all of the epidemics in my drawing.
- Remember?
  - En-demic
    - = disease always present in a particular geographic region.
    - For example, **Malaria** in some parts of Africa. Basically, you can't get rid of it.
    - This does not apply to **Plague**. It is never anywhere permanently.
  - Epi-demic
    - = basically, a spike in the expected level of disease.
    - Think of it this way: You *expect* it to be hot in July ... but maybe one year it was *unexpectedly* hot. That's kinda like an epidemic.
    - This applies to Plague.
  - Pan-demic
    - = the epidemic spreads to other countries or continents. Like a global heat wave. Sort of.
    - This applies to Plague.
- Source
  - Wikipedia
    - [https://en.wikipedia.org/wiki/List\\_of\\_epidemics](https://en.wikipedia.org/wiki/List_of_epidemics)

### How the Plague bacteria adapts in the wild

#### Adaptive strategies of *Yersinia pestis* to persist during inter-epizootic and epizootic periods

- Summary
  - This awesome paper explains how the Plague bacteria *Yersinia pestis* persists in animals in the wild. The content is a combination of history and science. It's a bit technical but it's also readable.
- Fancy terminology
  - **Epizootic** is a fancy way of saying there are outbreaks of disease in animal populations. It's the animal equivalent of an epidemic in humans.
  - **Inter-epizootic** means the window time between the outbreaks in animals.
  - This paper was also mentioned on page 11 of the bibliography.
  - See page 19 on Ebola of the bibliography for more on this topic.
- Verbatim

- As recently as 1500–20 000 years ago, *Y. pestis* evolved from *Y. pseudotuberculosis*, a relatively benign enteric bacterium that is transmitted through contact with contaminated food and water [1]. In striking contrast to its closely related progenitor, *Y. pestis* is extremely virulent, with mortality of untreated infections in humans ranging from 50–100%, depending on the route of exposure.
- After an infectious flea bites a susceptible vertebrate host, several bacterial genes are upregulated allowing *Y. pestis* to evade the immune system and disseminate to the lymphatic system.
- Translation
  - Taxonomy is the scientific naming of living things. It's fairly common practice to shorten the Genus to just the first letter. So *Yersinia* becomes *Y.* Likewise, *Homo sapiens* becomes *H. sapiens*. See page 86 in the bibliography for details on taxonomy.
  - **Enteric** means within the guts – think intestines. Specifically, an 'enteric bacterium' is found in the intestines of an animal. It might be normal for it to live there. Or it might be an unpleasant invader.
- Source
  - *Veterinary Research*
    - 2009 March – April
    - <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2695026/>
- Authors
  - **Rebecca J. Eisen** and **Kenneth L. Gage**
    - Bacterial Diseases Branch, **Division of Vector Borne Infectious Diseases**, National Center for Zoonotic, Enteric and Vector-Borne Diseases, Centers for Disease Control and Prevention, 3150 Rampart Road, Fort Collins, Colorado, USA

## A squirrel dying of Plague ...

The photo below looks pretty normal at first glance but after reading you realize it's kind of **GROSS**.



Rock squirrel


- Summary

- This is a photo of a **rock squirrel** – which like a rat, is a rodent – that is coughing up blood. See the blood coming out its open mouth? The poor little squirrel has the Plague bacteria in its lungs, meaning it is suffering from **Pneumonic Plague** just as we humans do.
- Verbatim
  - Rock squirrel in extremis coughing blood-streaked sputum related to pneumonic plague.
- Translation
  - **Extremis** (pronounced, “extreme iss”) basically means *on death’s door* in the language of doctors and vets.
- Source
  - **Plague**
    - Medscape
      - <https://emedicine.medscape.com/article/235627-overview#a4>
      - Courtesy of **Ken Gage, PhD** (the author in the article immediately above), Centers for Disease Control and Prevention (CDC), Fort Collins, Colo.
      - This same article was mentioned on page 10 of the bibliography.

## Page 14 – Plague bacteria

### Modern photos of the Plague bacteria using an electron microscope

#### *Yersinia pestis*

- Summary
  -  These are excellent images taken by an electron microscope. You can clearly see that the *Yersinia pestis* bacteria is a **rod**. Click on the top image 1 MB file. Have a good look. It’s this invisible, microscopic thing that can kill you in less than a day.
  - Don’t get confused by the source – the **Robert Koch Institute** – of this article. **Robert Koch** (1843 – 1910) is famous in medicine but he didn’t discover *Yersinia pestis*. He is considered a founding father of *micro*-biology which is the study of *micro*-organisms using a *micro*-scope. Lotsa micro. And he was German, which is why the **Robert Koch Institute** is in Berlin.
- Source
  - **Robert Koch Institute**
    - It’s in Berlin, Germany.
    - [https://www.rki.de/EN/Content/infections/Diagnostics/NatRefCentresConsultantLab/CONSULAB/EM-images/EM\\_Tab\\_Pest\\_en.html](https://www.rki.de/EN/Content/infections/Diagnostics/NatRefCentresConsultantLab/CONSULAB/EM-images/EM_Tab_Pest_en.html)

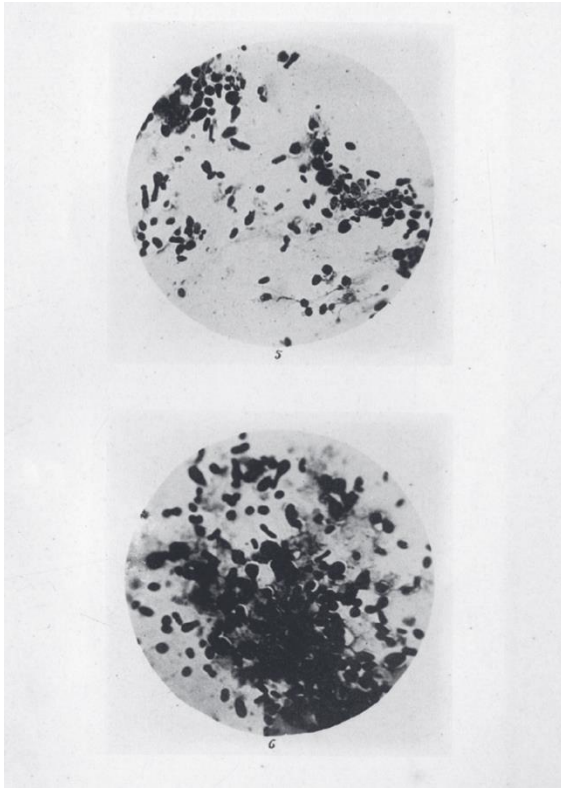




Alexandre Yersin

- Summary
  - Alexandre Yersin (1863 – 1943) discovered *Yersinia pestis*, the bacteria that causes **Plague**.
    - “Yer sin ee ah” “pest iss”
  - Alexandre was a neat guy. He was born in Switzerland in 1863, did his medical training there, then moved to Paris to study bacteria at a research institute. That institute was founded by Louis Pasteur, another giant of microbiology. When your milk is **pasteurized** (heated with steam) to kill bacteria, that’s named after Pasteur.
  - Anyways, in 1894 Alexandre was sent to Hong Kong to investigate a **Plague outbreak** (I did not draw it on my map on page 13). There he discovered the Plague bacteria in both humans and rats.
  - Then he went to Vietnam, really liked it, and continued to live there.
- Source
  - [https://en.wikipedia.org/wiki/Alexandre\\_Yersin](https://en.wikipedia.org/wiki/Alexandre_Yersin)

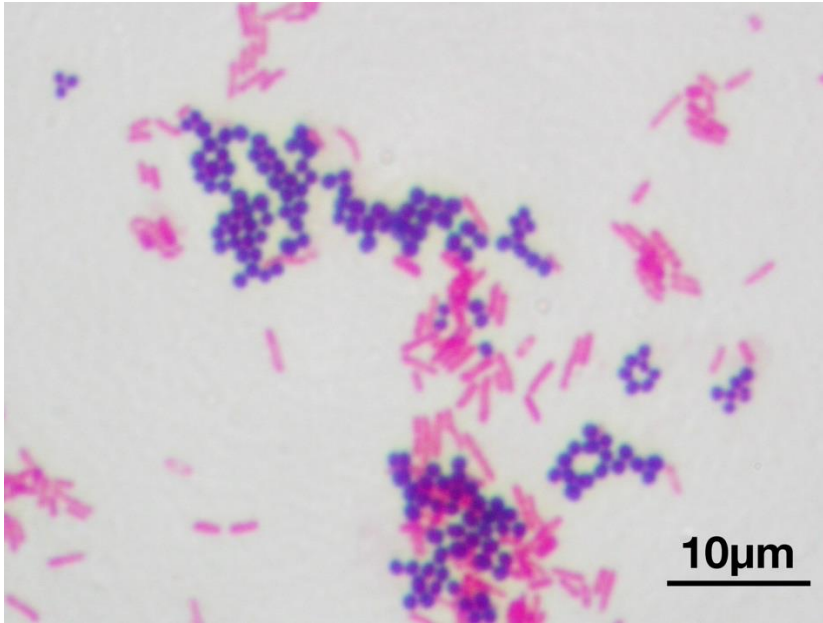
**Old school Black & White photos of the Plague bacteria  
using a light microscope**



### *Yersinia pestis*

- Summary
  - This old-school black & white photo shows hundreds of the *Yersinia pestis* bacteria that caused **Plague** in Portugal in 1899 (which is 5 years after Alexandre Yersin discovered it in Hong Kong in 1894). The bacteria are growing in a petri dish. The important thing to notice is the rod shape.
  - If you read about it, you'll see it is described as a '**gram negative**' bacteria. We will explore that in the next section.
- Source
  - Wikipedia
    - [https://en.wikipedia.org/wiki/Yersinia\\_pestis](https://en.wikipedia.org/wiki/Yersinia_pestis)
    - The image is halfway down the page.

## Gram Stain



### Gram stain

- Summary
  - What you see in that image are several dozen bacteria – the purple ones have been ‘stained’ with a dye called **Gram stain**. But it’s not an image of Plague bacteria.
- Source
  - Wikipedia
    - [https://en.wikipedia.org/wiki/Gram\\_stain](https://en.wikipedia.org/wiki/Gram_stain)

### What’s a Gram stain?

- Please listen carefully.
- A bacteria is a single cell. Imagine that it’s a rod shape. Draw it. If you have no paper, draw it in the air. The line that you drew is the **cell membrane**. It’s delicate.
- Some bacteria have an extra layer of protection called a **cell wall**.
- The cell wall can be stained with a **purple dye**. It’s kind of like spilling wine on your nice white shirt. Now it has a purple stain. This is called a **Gram stain**.
- But not all bacteria with cell walls will stain. So this serves as a simple way to divide these bacteria into ½ that can be stained purple, and ½ that don’t. Just like the image above.

### Here’s what you do in the laboratory:

- Isolate the bacteria → Pour stain (a.k.a. dye) on it → Then wash it off.
- **If the dye stays behind, it is called Gram positive.**
  - These bacteria will appear purple. Get it? The color is artificial.
- **If the dye washes away, it is called Gram negative.**
  - *Yersinia pestis* is in this category.
  - But it’s colorless! So another dye is added that is pink. The pink does not overshadow the purple.

### Stain names

- **Crystal violet** – that’s the purple color that creates the Gram stain.
- **Safranin** – that’s the pink color.
- Technically, the whole process is called Gram stain or Gram method.

### Why go to all this trouble?

- Because bacteria don’t wear a sticky name tag on their t-shirt that says:

HI, I’M FRED THE PLAGUE BACTERIA

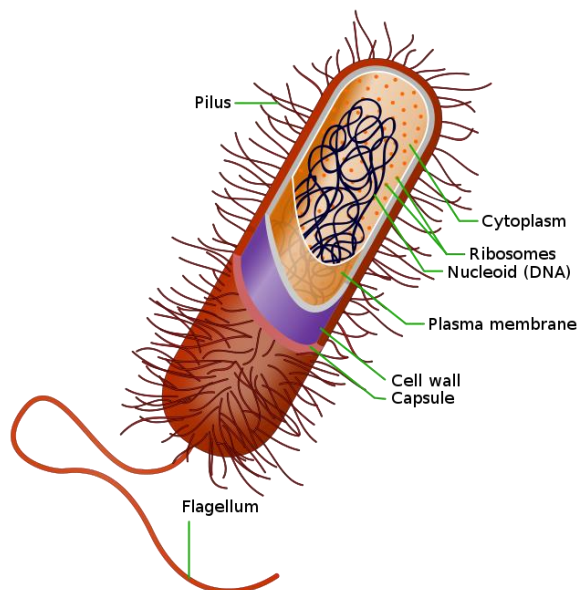
or

## HI, I'M JANET THE STREP THROAT BACTERIA

- There are only 3 shapes - **rod**, **sphere**, or **corkscrew** – for hundreds of different bacteria that infect humans, so we need tricks to identify them. The gram stain is one of those tricks.
- The stain (dye) is named after a Danish dude named **Hans Christian Gram**. It has nothing to do with the **gram**, the metric system unit for weighing small things.
  - [https://en.wikipedia.org/wiki/Hans\\_Christian\\_Gram](https://en.wikipedia.org/wiki/Hans_Christian_Gram)
- There are hair-splitly definitions like **cell membrane** versus **cell wall** versus **cell envelope** versus **capsule** versus **spore**.
  - Don't lose sleep over it. But do know that Gram stains are a cornerstone of medicine, vital in figuring out what bacteria has infected you. Rest assured, when we take a swab from your throat, it will get sent to the micro-biology department at the hospital where a Gram stain will be performed on it.

### Plague

- Summary
  - This article was mentioned on page 10. It's a well written summary of Plague.
  - **Figure 41.1**, about 1/5<sup>th</sup> down the page, has a nice color photo of **Yersinia pestis**. They are the tiny rods. They are purple! But I just told you that this bacteria is Gram negative, meaning *not purple*. What's the explanation? Well, in this case **Wright's stain** was used – it's also purple and it's known to show the structure of *Yersinia* better. That means whoever did the staining already knew the identity of the bacteria – they did not need a Gram stain to figure it out. This is also a great example that medicine can be seemingly contradictory at first glance; you need to dig for an explanation.
- Source
  - *Tropical Infectious Diseases: Principles, Pathogens and Practice*
    - Elsevier is the publisher.
    - 29 April 2011
    - <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7149940/>
- Author
  - Paul. S Mead et al.



### Bacterial cell structure

- Summary

- The **cell wall** here is **purple**. Because the wall retained Gram's purple stain, it is 'gram positive.'
- **Plasma membrane** is another name for cell membrane (the delicate line you initially drew in the air).
- The **capsule** is yet another layer.
- The **flagellum** is a whip-like tail for moving around. Not all bacteria have this. By the way, there are **religious zealots** that whip themselves – that is called self-flagellation.
- Source
  - Wikipedia
    - [https://en.wikipedia.org/wiki/Bacterial\\_cell\\_structure](https://en.wikipedia.org/wiki/Bacterial_cell_structure)

### Gram Staining Procedure Animation Microbiology - Principle, Procedure, Interpretation

- Summary
  - This is a 4-minute YouTube video on how a **Gram stain** is conducted.
  - It's way more thorough than my simple explanation.
- Source
  - Dr.G Bhanu Prakash Animated Medical Videos
    - <https://www.youtube.com/watch?v=AZS2wb7pMo4>

### Bacteria Structure and Function

- Summary
  - This guy has an amazing ability to teach.
  - This is a 64-minute YouTube video. He gets into the cell wall stuff at the 31-minute mark.
- Source
  - Ninja Nerd
    - <https://www.youtube.com/watch?v=ayFiGn2fYi8>

### The Bacterial Cell Envelope

- Summary
  - Crazy technical detail on the **cell wall / envelope** of bacteria.
- Source
  - Cold Spring Harbor Perspectives in Biology
    - 2010 May
    - <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2857177/>
- Authors
  - Thomas J. Silhavy. Department of Molecular Biology, Princeton University
  - Daniel Kahn. Department of Chemistry and Chemical Biology, Harvard University
  - Suzanne Walker. Department of Chemistry and Chemical Biology, Harvard University

## A whole bunch of rat synonyms

### Black rat

- *Rattus rattus*
- House rat
- Roof rat
- Ship rat

### Brown rat

- *Rattus norvegicus*
- Common rat
- Hanover rat

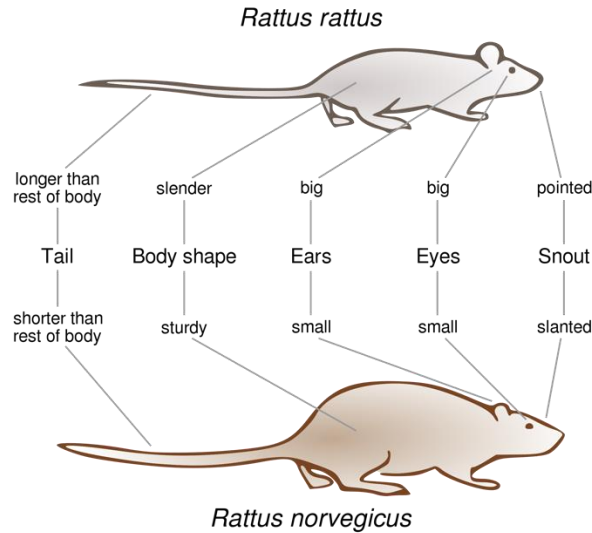
- Norway rat
- Norwegian rat
- Sewer rat
- Street rat
- Wharf rat
  - What if a wharf rat climbs onto a ship? Is it now a ship rat? Hmm, that's confusing.

## Rats – a generic description

### Rat

- Summary
  - Written in the terse style typical of *Encyclopedia Britannica*.
- Verbatim
  - **rat**, (genus *Rattus*), the term generally and indiscriminately applied to numerous members of several rodent families having bodies longer than about 12 cm, or 5 inches. (Smaller thin-tailed rodents are just as often indiscriminately referred to as mice.) In scientific usage, rat applies to any of 56 thin-tailed, medium-sized rodent species in the genus *Rattus* native to continental Asia and the adjacent islands of Southeast Asia eastward to the Australia-New Guinea region. A few species have spread far beyond their native range in close association with people. The **brown rat**, *Rattus norvegicus* (also called the Norway rat), and the house rat, *R. rattus* (also called the **black rat**, ship rat, or roof rat), live virtually everywhere that human populations have settled; the house rat is predominant in warmer climates, and the brown rat dominates in temperate regions, especially urban areas.
  - Most likely originating in Asia, the brown rat reached Europe in the mid-1500s and North America around 1750. The house rat most likely originated in India.
- Source
  - Britannica
    - Last updated 7 September 2022
    - <https://www.britannica.com/animal/rat>
- Author
  - Guy Musser

## Black rat



### Black rat

- Summary
  - Useful comparison of the **black rat** (top) and **brown rat** (bottom).
- Source
  - Wikipedia
    - [https://en.wikipedia.org/wiki/Black\\_rat](https://en.wikipedia.org/wiki/Black_rat)

## Brown rat

### Brown rat

- Summary
  - Great information.
- Verbatim
  - It is thought that as agriculture developed in China, brown rats began living close to farms, where a consistent source of food was present. From there, the species likely spread gradually to southeastern Asia, then north to Japan and Russia, before moving westward to Europe by the mid-1500s. Scientists have theorized that as Western Europe colonized other parts of the world, the brown rat followed. The animals likely reached North America about 1750.
- Source
  - Britannica
    - Last updated 13 October 2022
    - <https://www.britannica.com/animal/brown-rat>
- Author
  - Emily Kendall

### Brown rat

- Verbatim
  - In mating, female rats show a clear mating preference for unknown males versus males that they have already mated with (also known as the Coolidge effect), and will often resume copulatory behavior when introduced to a novel sexual partner.<sup>[49]</sup>
    - That's interesting.

- Source
  - Wikipedia
    - [https://en.wikipedia.org/wiki/Brown\\_rat](https://en.wikipedia.org/wiki/Brown_rat)

## ARDS

### ARDS

- Summary
  - This is a nice, basic summary of ARDS.
  - **ARDS** – pronounced letter-by-letter as “A, R, D, S” – means **Acute Respiratory Distress Syndrome**. In short, the air sacs in the lungs fill with fluid. But this isn’t water that enters the lungs like with drowning in a swimming pool. This is fluid that originates from within the body.
  - Get it? The air sacs fill with fluid instead of good ol’ oxygen. So you can’t breathe. As with every illness in medicine, ARDS can be mild / moderate / severe.
  - **ARDS is a strange entity**. You’d figure it would be the result of some specific insult to the lungs like **pneumonia**. But simply being very ill from something else can cause it, like a **major head injury**, or **third degree burns**. And you’d figure **Pneumonic Plague** would cause ARDS, right? But it’s **Septicemic Plague** – when the bacteria is multiplying in the blood – that causes ARDS. This is an example of how medicine is oftentimes not intuitive. You’re simply forced to mass memorize and only then a bigger picture emerges. That also makes medicine hard to explain, especially if there are 20 more patients to be seen and the waiting room is backing up. There just isn’t time to explain.
  - See page 147 for more details on ARDS.
- Source
  - Mayo Clinic
    - 3 August 2022
    - <https://www.mayoclinic.org/diseases-conditions/ards/symptoms-causes/syc-20355576>
- Author
  - Mayo Clinic Staff

### Plague

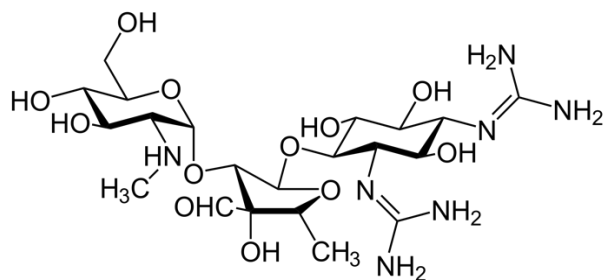
- Summary
  - This technical paper explains how **ARDS** is a complication of **Plague**.
  - A **complication** is when Bad Thing #1 leads to Bad Thing #2. Or as I like to visualize it: Bad thing #1 → Bad Thing #2. For example, a complication of a flat tire (Bad Thing #1) → is the car skidding off the road and crashing into a tree (Bad Thing #2).
  - Get it? **Plague** (Bad Thing #1) → **ARDS** (Bad Thing #2). But the arrow is not a slam dunk. It does not *necessarily* have to happen. Just like with your flat tire you may not necessarily drive into a tree.
  - This paper was already mentioned on page 10. It’s a very useful paper. And it was written in 2011, showing that you don’t always need ‘current’ information to understand something. By contrast, an **Infectious Disease specialist** needs the latest, greatest information but that’s because they are treating patients and need to be abreast of developments – how to diagnose an illness faster, how to treat it more effectively.
- Verbatim
  - **Septicemic plague** is a sudden, nonspecific febrile illness that occurs in the absence of apparent regional lymphadenitis.<sup>46, 47, 48</sup> It is characterized by rapidly progressive, overwhelming endotoxemia and dissemination of infection, and the diagnosis of plague is often not suspected until preliminary blood culture results are reported by the laboratory. Patients may have gastrointestinal symptoms such as nausea, vomiting, diarrhea, and abdominal pain, making a correct clinical diagnosis even more challenging.<sup>49</sup> If not treated early with appropriate antibiotics and aggressive supportive care, septicemic plague is usually fulminating and fatal. In the United States from 1960 to 2008, 20 of 72 primary septicemic



plague cases were fatal, yielding a case-fatality rate of 28%. Differential diagnostic possibilities include any other overwhelming systemic infection, including Gram-negative sepsis with other agents, meningococemia, and bacterial endocarditis. Some patients develop adult respiratory distress syndrome (**ARDS**), which can lead to confusion with other conditions such as hantavirus pulmonary syndrome and severe acute respiratory syndrome (SARS).

- **Bacteremia** is common in plague and can result in seeding of other organs. In addition, untreated bacteremia can reach high levels, leading to excessive release of proinflammatory mediators, such as tumor necrosis factor- $\alpha$  and other cytokines. The resulting systemic inflammatory response may lead to hypotension, disseminated intravascular coagulation, acute renal failure, **ARDS**, and irreversible shock.<sup>44</sup> Affected tissues contain inflamed microvasculature occluded by fibrin thrombi, resulting in necrosis and hemorrhage. Blockage of vessels in acral sites can lead to gangrene of fingertips, toes, ears, and nose.<sup>52</sup> These cutaneous signs may be the origin of the term “Black Death.” Patients who recover from plague typically have elevated antibodies to various antigens, including the diagnostically useful F1 antigen.
- Consequences of delayed treatment of plague include disseminated intravascular coagulation, **ARDS**, and other complications of bacterial sepsis and endotoxemia.
- Translation
  - **Bacteremia** means are bacteria multiplying in the blood. But you’re probably okay, at least for now.
  - **Septicemia** is bacteremia gone bad. Bad enough to call it **Blood Poisoning** – which is not the official medical term but it’s what we say to patients. And the bacteria have spread from the blood to other locations. Now you’re really sick and most likely need admission to the hospital for intra-venous (IV) antibiotics.
- Source
  - *Tropical Infectious Diseases: Principles, Pathogens and Practice*
    - Elsevier is the publisher.
    - 29 April 2011
    - <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7149940/>
- Author
  - **Paul S Mead, MD**. Division of Vector-Borne Diseases, Centers for Disease Control and Prevention, Fort Collins, Colorado.
- Guest Editors
  - **Richard L. Guerrant, MD**. Division of Infectious Diseases and, International Health; University of Virginia School of Medicine, Charlottesville, VA, USA
  - **David H. Walker, MD**. Carmage and Martha Walls Distinguished, University Chair in Tropical Diseases; Director, Center for Biodefense and, Emerging Infectious Diseases; Professor and Chair, Department of, Pathology; University of Texas Medical Branch, Galveston, TX, USA
  - **Peter F. Weller, MD FACP FIDSA**. Professor of Medicine, Harvard Medical, School; Professor, Immunology and Infectious, Diseases Department, Harvard School of, Public Health; Chief, Infectious Disease Division; Vice Chair of Research, Department of, Medicine, Beth Israel Deaconess Medical, Center, Boston, MA, USA

**Streptomycin**



### Streptomycin

- Summary
  - That chemical structure is **streptomycin** ("strep toe my sin"), the antibiotic that kills the **Plague** bacteria ***Yersinia pestis***.
  - Those weird shapes are called **boats** in organic chemistry. They are actually rings of carbon atoms.
  - Streptomycin is made by a soil bacteria called ***Streptomyces griseus*** ("Strep toe my sees" "griss ee us").
  - **This stuff was figured out by Selman Waksman** (b. 1888 Kyiv, Ukraine – d. 1973 Woods Hole, Massachusetts, USA). He was a **micro-biologist**.
- What antibiotics can be used to kill *Yersinia pestis*?
  - Strepto-mycin
  - Genta-micin (yes, Genta-micin)
  - Cipro-floxacin
  - Levo-floxacin
  - Moxi-floxacin
- Source
  - <https://en.wikipedia.org/wiki/Streptomycin>
  - [https://en.wikipedia.org/wiki/Streptomyces\\_griseus](https://en.wikipedia.org/wiki/Streptomyces_griseus)
  - [https://en.wikipedia.org/wiki/Selman\\_Waksman](https://en.wikipedia.org/wiki/Selman_Waksman)

### Isolation of Streptomycin-producing Strains of *Streptomyces griseus*

- Summary
  - **This was the 1946 scientific paper of Selman Waksman.**
- Source
  - *Journal of Bacteriology*
    - September 1946
    - <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC518198/?page=1>
- Authors
  - Selman A. Waksman
  - H. Christine Reilly
  - Donald B. Johnstone
    - New Jersey Agricultural Experiment Station, Rutgers University, New Brunswick, New Jersey

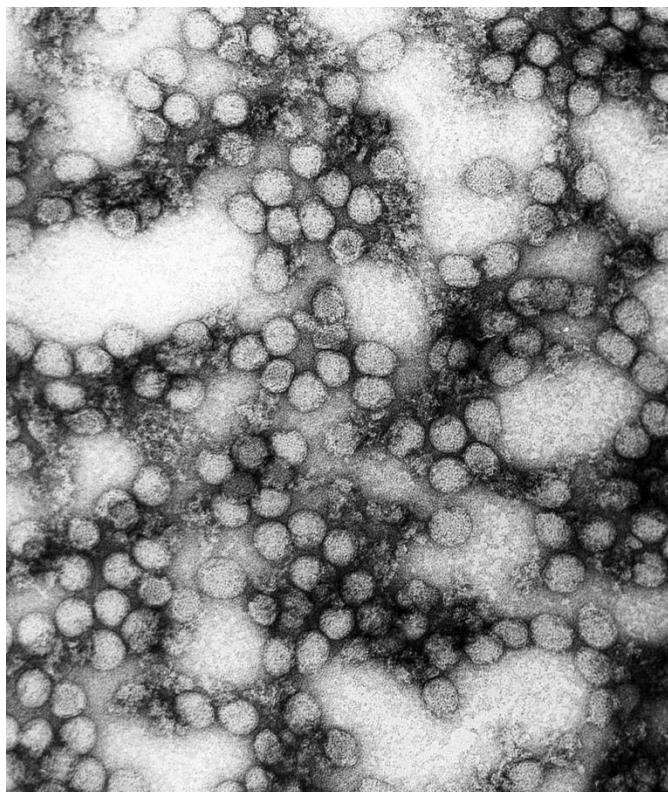
### Conformations of cyclohexane

- Summary
  - **This is technical information on the 'boat' shapes of rings made of carbon atoms.** It's a whole new level of complexity. The progression, as a student, is that there is initially a first-year university course called 'General Chemistry' that is focused on the Periodic Table of the Elements. This is followed by 'Organic Chemistry' which is focused on element #6 which is carbon and involves a massive amount of naming (a.k.a. nomenclature) that becomes crucial for doctors to understand the drugs we prescribe.
  - *Cyclo* means a ring like a circle. But it's not a perfect circle. It might look like a hexagon.
  - *Hexane* means 6 carbon atoms.
  - Cyclo-hexane means 6 carbon atoms arranged in a ring.
  - Streptomycin is not precisely a cyclo-hexane but this article gives the gist of boats.


- Source
  - **LibreTexts Chemistry** which is supported by the **University of California Davis** (a.k.a. **UC Davis**).
    - [https://chem.libretexts.org/Bookshelves/Organic\\_Chemistry/Organic\\_Chemistry\\_\(Morsch\\_et\\_al.\)/04%3A\\_Organic\\_Compounds-\\_Cycloalkanes\\_and\\_their\\_Stereochemistry/4.05%3A\\_Conformations\\_of\\_Cyclohexane](https://chem.libretexts.org/Bookshelves/Organic_Chemistry/Organic_Chemistry_(Morsch_et_al.)/04%3A_Organic_Compounds-_Cycloalkanes_and_their_Stereochemistry/4.05%3A_Conformations_of_Cyclohexane)

## Page 15 – Yellow Fever

### Yellow Fever virus viewed by an electron microscope



*Yellow Fever virus*

- Summary
  - That is an **electron microscope** photograph of the round-shaped *Yellow Fever virus*, of which about 100 are visible in the image. It is magnified 234,000 times.
  -  If you click on the image to enlarge it, each virus kind of looks like a grainy ball.
  - The best practical magnification with an **optical microscope** (that uses lenses just like in glasses or binoculars) is about 400 times. So an electron microscope is waaaaaaay more powerful.
  - See page 23 of the bibliography for details on the electron microscope.
- Source
  - Wikipedia
    - [https://en.wikipedia.org/wiki/Yellow\\_fever](https://en.wikipedia.org/wiki/Yellow_fever)

# Yellow Fever

## Yellow Fever Virus

- Summary
  - This is the CDC page on Yellow Fever. There are links to maps, transmission, symptoms, treatment (there isn't any. Eeek!), prevention, and vaccines.
- Source
  - CDC
    - Last updated June 2, 2022.
    - <https://www.cdc.gov/yellowfever/index.html>

## Travelers' Health – Yellow Fever

- Summary
  - This CDC page is similar to the one above but more directed to travelers to Yellow Fever regions, for example, Iguazu Falls (a.k.a. Iguacu Falls) in South America.
- Source
  - CDC
    - <https://wwwnc.cdc.gov/travel/diseases/yellow-fever>

## Yellow Fever

- Summary
  - This is thorough and rather technical. It describes the sequence of events leading from initial infection up to death.
- Source
  - Medscape
    - <https://emedicine.medscape.com/article/232244-overview#a1>
- Author
  - **Dana M Blyth, MD** Associate Professor, Department of Medicine, Uniformed Services University of the Health Sciences; Adjunct Assistant Professor, Department of Medicine, University of Texas Health Science Center at San Antonio School of Medicine; Staff Physician, Department of Medicine, Infectious Disease Service, Brooke Army Medical Center, San Antonio Military Medical Center, San Antonio Uniformed Services Health Education Consortium (SAUSHEC)
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### Yellow Fever

- Summary
  - This is also pretty technical.
- Most interesting comment
  - Standing water is a breeding ground for mosquitoes, so flower pots, buckets, and other containers should be drained. Children's wading pools should be emptied and stored on their sides, and tire swings should have holes drilled into the bottom to allow trapped water to drain.
- Summary
  - StatPearls
    - 7 August 2023.
    - <https://www.ncbi.nlm.nih.gov/books/NBK470425/>
- Authors
  - Leslie V. Simon. Mayo Clinic Florida.
  - Muhammad F. Hashmi. National Health Service.
  - Klaus D. Torp. Mayo Clinic Florida.

## Yellow Fever maps

### Yellow Fever maps

- Source
  - This CDC page has maps showing Yellow Fever regions in Africa and South America. Panama is included in the South America map.
  -  Click on the link below each map for more information on regions where the vaccine is recommended.
- Source
  - CDC
    - <https://www.cdc.gov/yellowfever/maps/index.html>

## Yellow fever mosquito

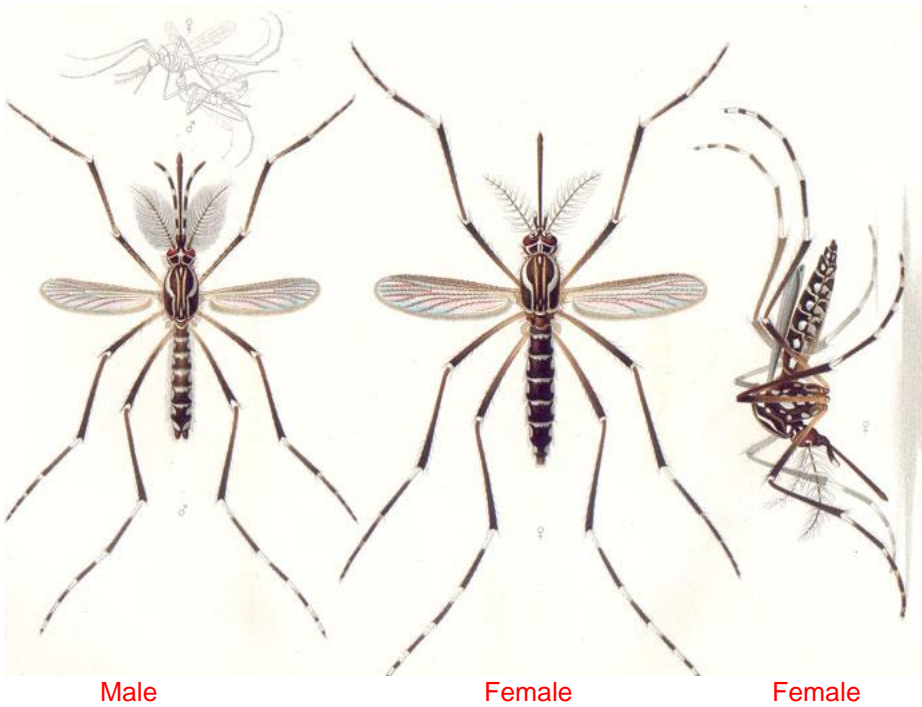
### Say it

- Yellow fever mosquito a.k.a. *Aedes aegypti*.
- "A ee dees"
- "Egypt eye" or "A jipt eye"
- Latin scholars love to put the letter 'a' in front of words. And an 'i' afterwards. That's how Egypt turned into aegypti.



That's the Yellow Fever mosquito.

- [https://en.wikipedia.org/wiki/Aedes\\_aegypti](https://en.wikipedia.org/wiki/Aedes_aegypti)



*Aedes aegypti*

- Summary
  - That's a drawing of the male and female Yellow Fever mosquito. See how their antennae are different? They smell humans with those antennae.

- Source
  - Wikipedia
    - [https://en.wikipedia.org/wiki/Aedes\\_aegypti](https://en.wikipedia.org/wiki/Aedes_aegypti)

### *Life Cycle of Aedes aegypti and Ae. albopictus Mosquitoes*

- Summary
  - This is a CDC article on the life cycle of the mosquito.
- Source
  - <https://www.cdc.gov/mosquitoes/about/life-cycles/aedes.html>

### Some background

- **The *Aedes aegypti* mosquito transmits (is the 'vector' for) 3 viruses:**
  - *Yellow Fever virus*
    - This virus can definitely kill you. It killed 22,000 French workers on the first attempt at building the Panama Canal.
  - *Dengue Fever virus*
    - "den gay" or "deng ay"
    - **Dengue Fever** is also known as **Break Bone Fever** because it feels like your bones are breaking. Ouch.
    - Here's more info on Dengue from the **CDC**.
      - <https://www.cdc.gov/dengue/index.html>
  - *Chikungunya virus*
    - A weird name. "Chick un gun ya."
    - You get pain in your joints.
    - Verbatim
      - The name "chikungunya" derives from a word in the Kimakonde language, meaning "to become contorted", and describes the stooped appearance of sufferers with joint pain (arthralgia).
    - Here's more info from the **World Health Organization (WHO)** (where the quote is from).
      - <https://www.who.int/en/news-room/fact-sheets/detail/chikungunya>

## The Yellow fever mosquito can smell humans

### Some background

- **The mosquito can detect indole in human sweat.** How cool is that?
  - "in dole" (dole rhymes with mole)

### *Genetic Analysis of Mosquito Detection of Humans*

- Summary
  - Heaps of detail on how mosquitoes find you.
  - **We humans seem to produce these odors that attract mosquitoes:**
    - 1-octen-3-ol            human breath
    - 2,3-butanedione    human sweat    "Bew tane die own"
    - indole                human sweat
  - **OR** means **Odorant Receptor**. The mosquito antenna is able to detect odors.
- Verbatim
  - These ORs tested seemed to be narrowly tuned to several odor components that emanate from humans such as 1-octen-3-ol (present in human breath),

2,3-butanedione (by-product of metabolized sweat) and indole (human sweat volatile).

- Translation
  - A **by-product**, in a medical sense, relates to metabolic pathways. Human cells are capable of thousands of chemical reactions, the sum total of which is called 'metabolism' or 'metabolic pathways.' The most familiar is the conversion of sugar into energy. Or converting waste into urine. Or breaking down sweat. These are metabolic pathways. And a by-product means that some chemical compound was generated in those pathways. In medical school we study 'medical biochemistry' which is devoted to all these metabolic pathways.
  - **Volatile** is a fancy way of saying evaporate. **Your sweat evaporates and the sweat molecules end up binding to an Odorant Receptor in the mosquito antenna.**
- Source
  - *Current Opinion in Insect Science*
    - April 2017
    - <https://www.sciencedirect.com/science/article/pii/S2214574517300342?via%3Dihub>
- Authors
  - Joshua I Raji
  - Matthew DeGennaro
    - Biomolecular Sciences Institute & Department of Biological Sciences, Florida International University, Miami

### *Supersensitive Odorant Receptor Underscores Pleiotropic Roles of Indoles in Mosquito Ecology*

- Summary
  - **This article has uber-detail on how mosquitoes detect odors.**
- Source
  - *Frontiers in Cellular Neuroscience*
    - 2019 January 24
    - <https://www.frontiersin.org/articles/10.3389/fncel.2018.00533/full>
- Authors
  - David M. Ruel
  - Esther Yakir
  - Jonathan D. Bohbot
    - Department of Entomology, The Hebrew University of Jerusalem, Rehovot, Israel

### *Insect olfaction*

- Summary
  - **A rather technical introduction to the topic of how insects detect odors. A mosquito is an insect.**
- Source
  - Wikipedia
    - [https://en.wikipedia.org/wiki/Insect\\_olfaction](https://en.wikipedia.org/wiki/Insect_olfaction)

### *Indole*

- Summary
  - **There is enough chemistry here to cause significant mental pain.**
- Source
  - Wikipedia
    - <http://en.wikipedia.org/wiki/Indole>

### *Indole*

- Summary
  - **If you wish to be thoroughly crucified with chemistry, look no further.**
  - **PubChem** is an incredible resource if you are chemistry nerd.



- Source
  - PubChem
    - <https://pubchem.ncbi.nlm.nih.gov/compound/Indole#section=Related-CAS>

### *The Worst Animal in the World*

- Summary
  - This article is dedicated to the nefarious **Yellow Fever mosquito**. It's about 50 paragraphs.
  - It is very well written which is the standard for pretty much everything in *The Atlantic Monthly*. In fact, this is a great publication for learning about everything you've never heard of, but suddenly 20 minutes later you're like, *Wow, I had no idea about that and now I feel decently up to speed.*
- Verbatim
  - Of the 3,000-plus mosquito species alive, most are fairly harmless. Only a handful are a concern for public-health officials. But *Aedes aegypti* is different. Whether in Rio de Janeiro, New Delhi, or Miami-Dade County, it will breed in clean water supplies, it will come indoors, it will make a beeline toward human odor, and it will bite when the sun is up, circumventing bed nets that protect at night. Masks to prevent the spread of COVID-19 won't make a difference. Neither will staying at home, unless you live in a closed, air-conditioned house. No other mosquito is so perfectly suited to live with, and on, human beings.
- Source
  - The Atlantic Monthly
    - 2020 August 20
    - <https://www.theatlantic.com/health/archive/2020/08/how-aedes-aegypti-mosquito-took-over-world/615328/>
- Author
  - Joshua Sokol

## Jaundice

See *All Things Blood* on page 715 of the bibliography.

## Yellow Fever vaccine

### *Yellow Fever vaccine*

- Summary
  - These are the **CDC** recommendations about who should get the **Yellow Fever vaccine**.
  - There is also a link to pregnancy because that is of importance if getting the vaccine. Or not.
- Source
  - CDC
    - <https://www.cdc.gov/yellowfever/vaccine/index.html>
    - <https://www.cdc.gov/yellowfever/maps/index.html>
      - And this is the CDC page with the maps that show countries where the vaccine is recommended.

# Construction of the Panama Canal

a.k.a.

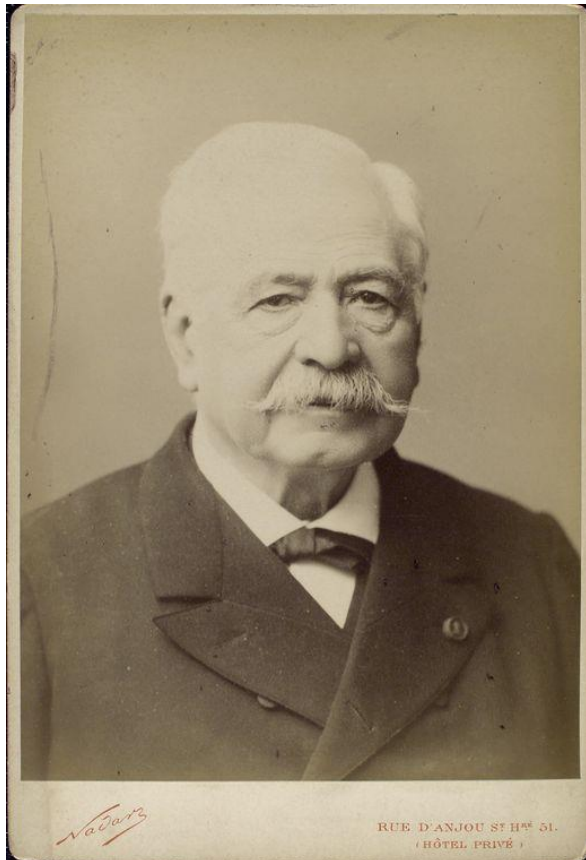
## Famous Men with Moustaches

### *The Panama Canal*

- Summary
  - An easy-to-read one page summary of the challenges in ridding the Panama Canal zone of the Yellow Fever mosquito.
  - The following steps are described:
    - Drainage
    - Brush and grass cutting
    - Oiling
    - Larviciding (that means killing mosquito larvae)
    - Prophylactic quinine (that means the drug quinine was given to the workers to protect them in advance)
    - Screening
- Summary
  - CDC
    - Last updated September 15, 2015.
    - [https://www.cdc.gov/malaria/about/history/panama\\_canal.html](https://www.cdc.gov/malaria/about/history/panama_canal.html)

### *Mosquitoes and the Panama Canal*

- Summary
  - There is a map of the canal zone, details on the deaths, and a concise 1-page overview of the efforts to overcome the mosquito that transmits Yellow Fever.
- Source
  - Insect Week
    - <https://www.insectweek.org/blog/mosquitoes-and-the-panama-canal/>
- Author
  - Chris Jeffs



### Ferdinand de Lesseps

- Summary
  - In 1874, Ferdinand vicomete de Lesseps is put in charge of construction of the Panama Canal. But it does not go well due to Yellow Fever.
  - Moustache? Yes.
- Source
  - Wikipedia
    - [https://en.wikipedia.org/wiki/Ferdinand\\_de\\_Lesseps](https://en.wikipedia.org/wiki/Ferdinand_de_Lesseps)



Walter Reed

- Summary
  - In 1900, Major Walter Reed, M.D., of the US Army confirms that the *Aedes aegypti* mosquito is the vector of Yellow Fever. Think of the vector (the mosquito) as the courier from Hell delivering a nasty parcel (the virus) to you.
  - Moustache? Yes.
- Source
  - Wikipedia
    - [https://en.wikipedia.org/wiki/Walter\\_Reed](https://en.wikipedia.org/wiki/Walter_Reed)
    - [https://en.wikipedia.org/wiki/Walter\\_Reed\\_National\\_Military\\_Medical\\_Center](https://en.wikipedia.org/wiki/Walter_Reed_National_Military_Medical_Center)



*William C. Gorgas*

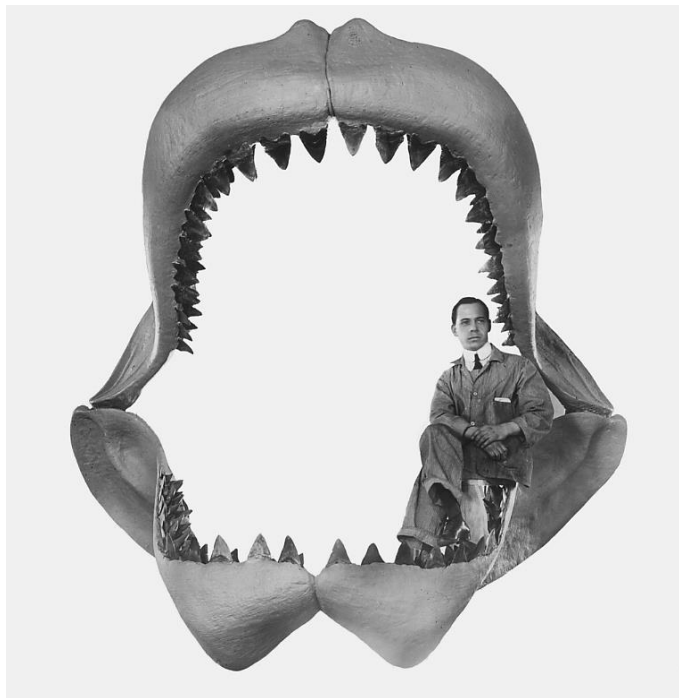
- Summary
  - In 1904, Dr. William Crawford Gorgas, the US Chief Sanitary Officer, is tasked with clearing mosquitoes from 500 square miles of jungle in the Panama canal zone.
  - Moustache? Yes.
- Source
  - Wikipedia
    - [https://en.wikipedia.org/wiki/William\\_C.\\_Gorgas](https://en.wikipedia.org/wiki/William_C._Gorgas)

*The Gorgas Courses in Tropical Medicine*

- Summary
  - There is a Gorgas Institute in Peru where doctors go to learn Tropical Medicine which is basically all the nasty infections you suffer from in tropical areas.
- Source
  - Heersink School Medicine, University of Alabama at Birmingham
    - <https://www.uab.edu/medicine/gorgas/>

# Page 16 – Megalodon

Megalodon



Megalodon – whoa. That photo was in 1909.

- <https://en.wikipedia.org/wiki/Megalodon>



That's me and Megalodon at the National Aquarium in Baltimore. I was doing a month of trauma at the Shock Trauma Hospital in Baltimore. We did not see any injuries due to Megalodon.

## Mr. Wood's Fossils

### *Edinburgh's famous fossil shop*

- This cute shop in **Edinburgh, Scotland** is where I bought my Megalodon tooth. A completely random find while walking down the street, hence the joy of travel.
- <https://www.mrwoodsossils.co.uk>

## Squalamine

### *Antivirals inspired by the shark's immune system*

- **Summary**
  - **Endo-cytosis** ("en dough site oh sis") means that a cell can contort its cell membrane (see page 14 of this bibliography) to surround a particle of food and bring it inside the cell. This is also the way a **virus** tricks a cell into letting it inside.
  - In sharks, the **squalamine** ("squall ah mean") seems to prevent the virus from pulling off that trick. So that's why sharks seem to get less viral infections. Something like that.

- Verbatim
  - No one understands why sharks are such hardy animals. It turns out that they have an unusual immune system.
  - Studies at UCLA and Northwestern showed that the antiviral effect likely came from an electrostatic remodeling of the membrane by squalamine, which can temporarily turn off endocytosis.
- Personal comment
  - **Please don't kill sharks and eat their powdered remains on the assumption it will improve your immune system. That's crap science promoted by someone who can say whatever they want on the internet, like 'doctor approved' but carefully failing to mention there was no double-blind experiment. So just eat your fruit and veggies.**
- Source
  - **Wong Research Lab**
    - <http://wonglab.seas.ucla.edu/research/immunity-and-antimicrobials/shark-immune-system/>
- Author
  - **Gerard Wong** – Department of Bioengineering, University of California, Los Angeles (UCLA)

## Page 17 – Yearbook Pause

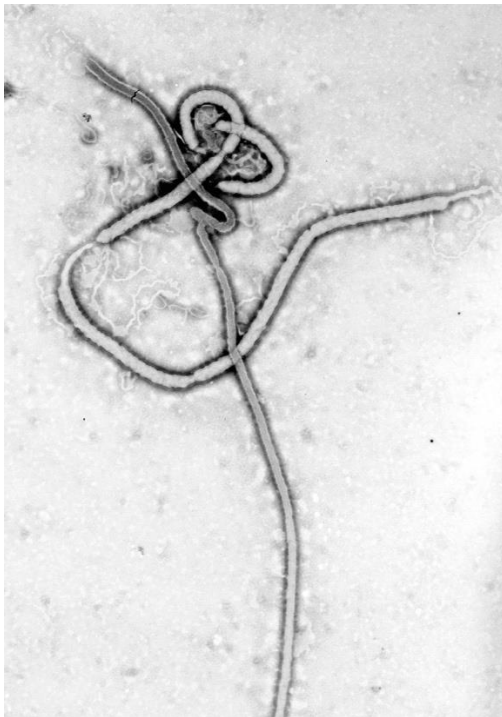
### *Division of Vector-Borne Diseases (DVBD)*

- Summary
  - This is a special group at the CDC that studies how mosquitoes, ticks, and fleas act as **vectors** to transmit disease.
- Source
  - CDC
    - <https://www.cdc.gov/ncezid/dvbd/index.html>

## Page 18 – Ebola



## Ebola virus



### Ebolavirus

- Summary
  - That is the weird, string-like *Ebola virus*. Some sources describe it as spaghetti-like. It is magnified 160,000 x.
  - The photo was taken in 1976 by Dr. Frederick Murphy, D.V.M., Ph.D., using an electron microscope. D.V.M. means Doctor of Veterinary Medicine.
- Source
  - Wikipedia
    - <https://en.wikipedia.org/wiki/Ebolavirus>
  - <https://web.stanford.edu/group/virus/filo/ebola.html>
    - This is the same image on a **Stanford University** site that gives the details of the photo that are absent from Wikipedia.
    - The link on the Stanford page does not work.

## Rivers of Africa

### Africa: rivers and lakes

- Summary
  - This is an interactive geography map that's fun and basic.
  - 🖐️ If you click on a river or lake on the map then the gray box at the right will tell you its name.
  - 🖐️ In the gray box to the right of the map, set the Quiz mode to 'practice' and keep trying and trying 10 or 20 times – you will learn all the rivers and lakes in Africa. Takes about 10 minutes! That's pretty efficient learning.
- Source
  - lizardpoint
    - <https://lizardpoint.com/geography/africa-rivers-quiz.php>



### Ebola River

- Summary
  - Okay map is kinda crappy but the point is the *flow of water goes like so*:
    - Ebola River → Mongala River → Congo River.
    - On the map I drew in the illustrated guide I skipped the Mongala Rivera. Sorry Mongala.
  - Spanish 'Rio' means river.
  - Yambuku is the village where the first Ebola outbreak occurred in 1976. The village is closer to the Dua River so maybe the illness should be called Dua instead of Ebola? Whatever.
- Source
  - Wikipedia
    - [https://en.wikipedia.org/wiki/Ebola\\_River](https://en.wikipedia.org/wiki/Ebola_River)

### Congo River

- Summary
  - This is a great map in Britannica that shows the Ebola River and the Congo River. But you cannot see the village of Yambuku where the first Ebola outbreak was.
- Source
  - Britannica
    - <https://www.britannica.com/place/Congo-River>

### Google Maps

- Summary
  - 🖱️ Search for *Yambuku Congo* in Google Maps. This is the village in Africa where Ebola first broke out in 1976. Then under 'Directions' search for *Ebola River*. Now you get a sense of where everything is by zooming in and out.



### Yambuku

- Summary
  - Those are the actual villagers during the **Ebola** outbreak in 1976. If you recall from page 2 of this Bibliography, the CDC has an **Epidemiology Intelligence Service (EIS)** – that's who was examining the villagers for evidence of Ebola.
- Source
  - Wikipedia
    - <https://en.wikipedia.org/wiki/Yambuku>

## Ebola, as in, the illness

### Ebola Disease

- Summary
  - This is the CDC home page on Ebola. There are a number of links you can dive into.
- These are synonyms
  - **Ebola**
  - **Ebola disease**
  - **Ebola virus disease**
- Source
  - CDC
    - <https://www.cdc.gov/vhf/ebola/index.html>

### Ebola Disease – Signs and Symptoms

- Summary
  - This is what Ebola feels like.
- Verbatim
  - Fever

- Aches and pains, such as severe headache and muscle and joint pain
- Weakness and fatigue
- Sore throat
- Loss of appetite
- Gastrointestinal symptoms including abdominal pain, diarrhea, and vomiting
- Unexplained hemorrhaging, bleeding or bruising
- Source
  - CDC
    - <https://www.cdc.gov/vhf/ebola/symptoms/index.html>

### Understanding Bleeding in Ebola Virus Disease

- Summary
  - Okay, Hollywood directors and screenwriters ... here's the deal with bleeding when you get Ebola. This is a really interesting interview with a pediatrician who does infectious disease. It's technical but at the same time very readable.
  - **H&O** is the abbreviation for the journal.
  - **AM** are the author's initials.
- Verbatim
  - **H&O** How do bleeding and hemorrhage manifest in patients with Ebola virus disease?
  - **AM** Most of the clinical manifestations that have been described are consistent with platelet dysfunction. Oozing from the venipuncture site, conjunctival bleeding, petechiae, and bleeding into the gastrointestinal tract all have been reported, and sometimes epistaxis or gingival bleeding.
- Translation
  - **Platelet dysfunction**
    - The job in life of platelets is blood clotting. When that goes wrong, it's platelet dysfunction.
  - **Venipuncture site**
    - This is the site in your skin where a needle was deliberately introduced into you, like when you have a blood test. It's normal to bleed for a few minutes after the needle comes out, which is why you're supposed to apply pressure with the little cotton ball. But with **Ebola**, that site keeps on oozing blood because the blood clotting is wonky.
  - **Conjunctival bleeding**
    - The **conjunctiva** ("con junk tie vah" or "con juck tih vah") is the transparent layer that covers the white of your eye. See page 79 of the guide for a description.
    - If you have **bloodshot** eyes, that's blood vessels you're seeing in the conjunctiva. As doctors, we call this '**conjunctival injection**.' Strange term. Has nothing at all to do with injecting anything with a needle.
    - **Conjunctival bleeding** means the white of the eye is actually bleeding. But it's not like a torrent.
    - **Petechiae** ("pet eek ee a") means the appearance of small red pinpoint in the skin. This is due to bleeding in the skin.
    - **Epistaxis** ("ep ee stack sis") means nosebleed.
    - **Gingival bleeding** ("jin jiv ul") means bleeding from the gums.
  - I suggest a Google Images search of all these terms. It will make much more sense.
- Source
  - Clinical Advances in Hematology & Oncology : H&O
    - 2015
    - <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4667727/>
- Author
  - **Anita McElroy, MD PhD**, Infectious Diseases, Department of Pediatrics, Emory University School of Medicine, Atlanta, Georgia;

### What is Ebola Disease?

- Summary
  - As usual, there is diversity in nature.
  - There is detail here on the 6 types of Ebola virus.
    - **Zaire ebolavirus** → this causes **Ebola virus disease** in humans.
    - **Sudan ebolavirus** → this causes **Sudan virus disease** in humans.
    - **Tai Forest ebolavirus**, → this causes **Tai Forest virus disease** in humans.
    - **Bundibugyo ebolavirus** → this causes **Ebola virus disease** in humans.
    - **Reston ebolavirus** → this infects non-human primates and pigs.
    - **Bombali ebolavirus** → this infect bats. Not much else known.
  - **Zaire is the former name of the Democratic Republic of the Congo (DRC).**
  - If you read the term 'Ebola virus' chances are extremely high it refers to the Zaire ebolavirus. The 'Zaire' bit is implied.
- Source
  - CDC
    - <https://www.cdc.gov/vhf/ebola/about.html>

### Viral Special Pathogens Branch (VSPB)

- Summary
  - This branch of the CDC investigates nasty pathogens like Ebola. That seems like a cool job, no?
- Source
  - CDC
    - <https://www.cdc.gov/ncezid/dhcpp/vspb/index.html>

### History of Ebola Virus Disease (EVD) Outbreaks

- Summary
  - This is a chronological list of Ebola outbreaks from 1976 to 2022. And also outbreaks by country. You can drown in detail here.
- Source
  - CDC
    - [https://www.cdc.gov/vhf/ebola/history/chronology.html?CDC\\_AA\\_refVal=https%3A%2F%2Fwww.cdc.gov%2Fvhf%2Febola%2Foutbreaks%2Fhistory%2Fchronology.html](https://www.cdc.gov/vhf/ebola/history/chronology.html?CDC_AA_refVal=https%3A%2F%2Fwww.cdc.gov%2Fvhf%2Febola%2Foutbreaks%2Fhistory%2Fchronology.html)

### High Profile Diseases – Ebola Virus

- Summary
  - Primates are killed by the **Ebola virus**. That means **human primates (us) and non-human primates (monkeys, chimps, gorillas)**.
  - **Creating a vaccine involves research on non-human primates.** There is also a link at the top of the page to 'Animal Welfare.'
- Verbatim 1
  - The disease course and pathogenesis of Ebola virus in rhesus and cynomolgus macaques and marmosets is very similar to that of humans. Major characteristics of this disease in nonhuman primates and humans are profound lymphopenia, disseminated intravascular coagulation and hemorrhagic and septic shock.
    - **This basically says human primates and non-human primates die exactly the same way from Ebola.**
- Verbatim 2
  - Scientists around the world are pursuing a preventive vaccine and drug treatments for the Ebola virus, and research with nonhuman primates is

providing a powerful means in this pursuit because of the animals' physiological and immunological similarities to humans.

- Source
  - National Primate Research Centers
    - <https://nprcresearch.org/primate/hot-topics/ebola.php>
- Author
  - Robert Lanford. National Primate Research Centers

# Page 19 – Ebola spread

## Ebola cycles in nature

If you read these sources in the order they are here ... things will make logical sense.

*Principles of Epidemiology in Public Health Practice, 3<sup>rd</sup> Edition – An Introduction to Applied Epidemiology and Biostatistics*

- Summary
  - The term '**reservoir**' is key to understanding the transmission of disease. The reservoir is basically where a bacteria or virus normally lives. Kinda like home sweet home. But it can leave the home and go on a road trip and infect susceptible animals (including humans). And take note, the reservoir could be water, soil, or a living thing.
  - The CDC defines 3 types of reservoirs. Things will make sense with some examples.
    - **Animal reservoir**
      - Dogs are the reservoir for the *Rabies virus*. The dog bites you. The virus, which is actually in the dog's saliva, leaves the reservoir (the dog) and gets into you (the susceptible host).
      - Fruit bats are *probably* the reservoir for the *Ebola virus*. How the virus gets into humans is kind of complex. Details to follow.
      - Sheep and goats are the reservoir for the *Anthrax bacteria*. If you contact an infected goat hide the bacteria can infect your skin or get into your lungs. See page 58 of *Hidden Zoo*.
    - **Human reservoir**
      - Humans are the reservoir for sexually transmitted infections. For example, the *Chlamydia bacteria*. The bacteria is transmitted from human A (the reservoir who currently has *Chlamydia* lurking in their genitals) → human B (susceptible host i.e., sexual partner).
      - Humans are the reservoir for the *Smallpox virus*. It was transmitted from human-to-human. Take note, humans were the reservoir. This horrific virus has actually been vaccinated out of existence, an incredible human triumph. The only place the virus exists now is in Bio-Safety Level 4 labs at places like the CDC, the purpose of which is have it around to study just in case it happens to re-emerge, which is theoretically possible.
    - **Environmental reservoir**
      - Some fungi live in the soil in the desert. When you walk through the desert you can get infected. The soil is the reservoir.
        - <https://www.cdc.gov/fungal/diseases/coccidioidomycosis/definition.html>
- Source
  - CDC

- This is the 512-page CDC teaching course mentioned on page 2 of this bibliography.
- The reservoir definitions above are on pages 1-62 and 1-63 of the course.
- <https://stacks.cdc.gov/view/cdc/6914>

### Understanding the Chain of Infection

- Summary

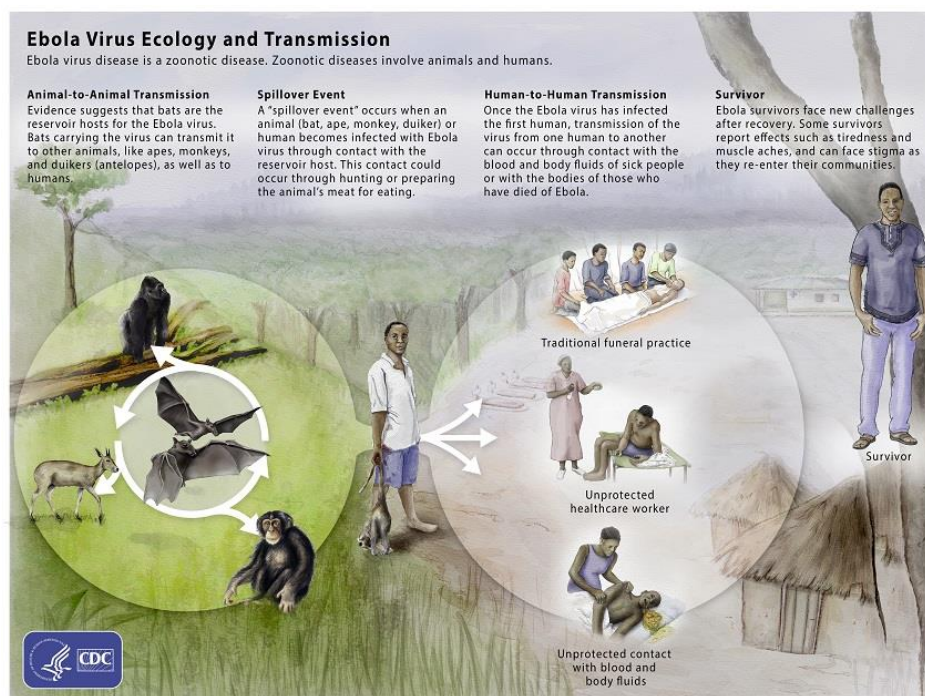
- **This a two-sentence definition of reservoir.**

- A reservoir is any person, animal, arthropod, plant, soil or substance (or combination of these) in which an infectious agent normally lives and multiplies. **The infectious agent depends on the reservoir for survival**, where it can reproduce itself in such manner that it can be transmitted to a **susceptible host**.

- Source

- ATrain Education

- <https://www.atrainceu.com/content/2-understanding-chain-infection#:~:text=A%20reservoir%20is%20any%20person,transmitted%20to%20a%20susceptible%20host.>



### What is Ebola Disease?

- Summary


- **This is a CDC poster on Ebola spread.** It describes 4 things:

- **Animal-to-Animal Transmission**

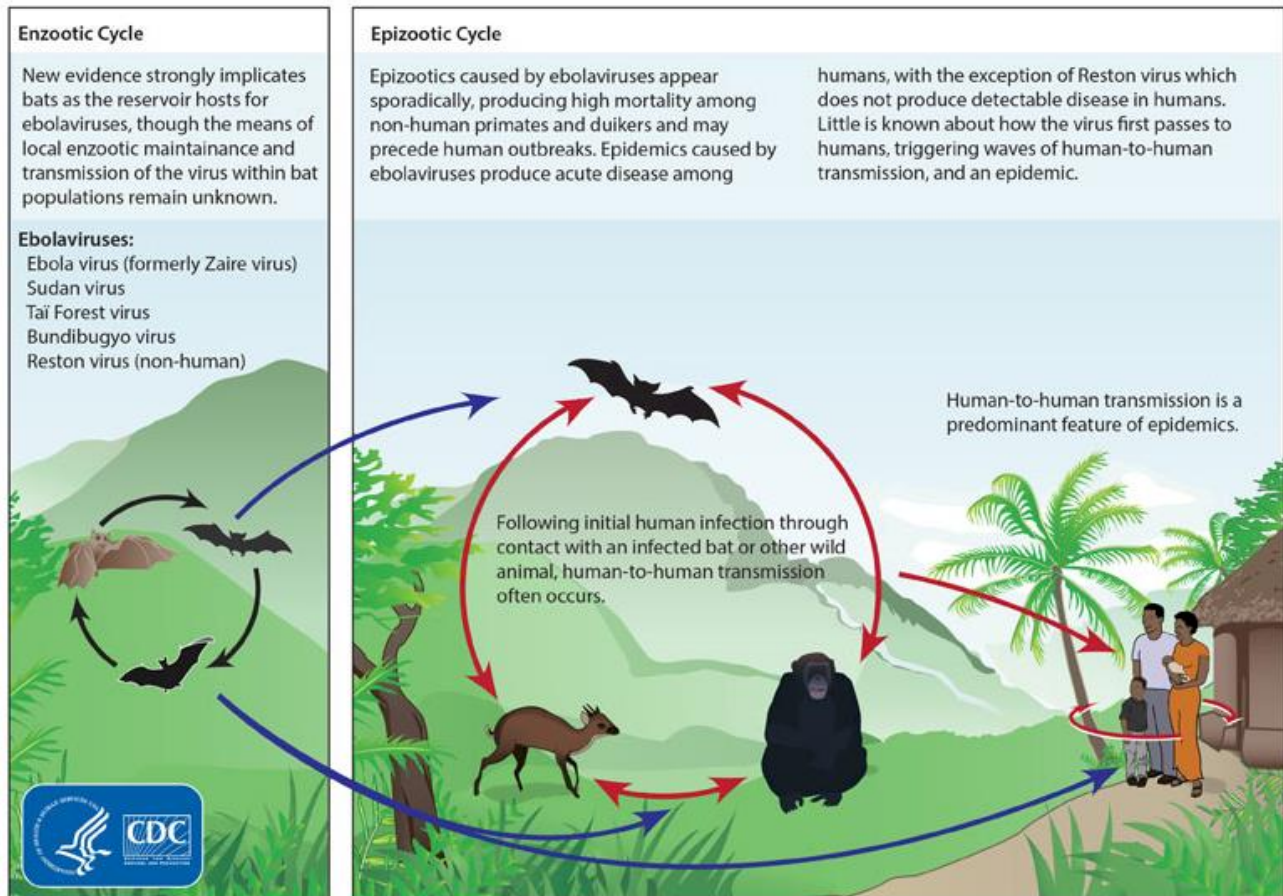
- = the bat is the reservoir and it spreads the *Ebola virus* from bats to primates (gorillas, monkeys, chimps) and the antelope called a duiker. This is thought to be what goes on. It's not a slam dunk.

- **Spillover event**

- = the virus 'spills' over from animals to humans. Imagine a teapot spilling tea (that's how I imagine it).

- **Human-to-human transmission**
  - = now we have the virus spreading between humans.
- **Survivor**
  - = these people were not killed by the virus. Ebola is not 100% fatal.
- Verbatim (from the text that's also on this webpage)
  - **Most infected animals will not get sick**; however, ebolaviruses are known to cause severe illness in nonhuman primates (such as monkeys, gorillas, and chimpanzees) similar to Ebola disease in humans.
- Source
  - CDC
    -  Click on the image to get decent resolution version.
    - <https://www.cdc.gov/vhf/ebola/about.html>

## Ebolavirus Ecology



### Ebolavirus Ecology

- Summary
  - This diagram is more nuanced and technical than the previous one.
  - **Ecology** is the interaction of animals and the environment. This diagram shows the interaction of the **Ebolavirus** with animals and humans. And the environment also includes the fruit that the bats eat (not shown).
  - **Pay attention!**



- If you recall, **endemic** means that an infectious disease is always present in humans in certain regions. For example, **Malaria** in certain regions of Africa. The term **enzootic** is the equivalent concept in animals. In the above diagram, the **Ebola virus** is 'maintained' in bats who are the **reservoir**. Because the bats infect other bats, it's considered a **cycle**.
    - By contrast, an **epidemic** in humans is a temporary event – a sudden increase in infection in a certain geographic region. The equivalent concept in animals is **epizootic**. In the diagram above, the **Ebola virus** is transmitted from bats to animals, probably via fruit the bats eat and discard. That starts an **epizootic cycle** in the chimps, gorillas, monkeys, and antelopes. And that cycle can spill over to humans and now we have an **Ebola** epidemic. But these relationships are not a slam dunk in terms of how the virus gets spread from group to group.
  - These concepts were previously mentioned in the bibliography on page 13 on **Plague** where rats and fleas are responsible for spreading the Plague bacteria.
- Source
  - CDC
    - <https://stacks.cdc.gov/view/cdc/24753>

### Posters and Factsheets

- Summary
  - There are about 40 Ebola information posters here. Fill your boots.
- Source
  - CDC
    - [https://www.cdc.gov/vhf/ebola/resources/posters-and-factsheets.html?CDC\\_AA\\_refVal=https%3A%2F%2Fwww.cdc.gov%2Fvhf%2Febola%2Fresources%2Fvirus-ecology.html](https://www.cdc.gov/vhf/ebola/resources/posters-and-factsheets.html?CDC_AA_refVal=https%3A%2F%2Fwww.cdc.gov%2Fvhf%2Febola%2Fresources%2Fvirus-ecology.html)

## Discovery of the Ebola virus

### Part one: A virologist's tale of Africa's first encounter with Ebola


- Summary
  - **Peter Piot** is the doctor credited with discovering the **Ebola virus**. This article is an excerpt from his autobiography, *No Time to Lose: A Life in Pursuit of Deadly Viruses*. 2012. W. W. Norton & Company Inc.
  - There is a photo of him and villagers.
- Verbatim
  - I examined her blood, and it was a catastrophe. The platelet count was terrifyingly low.
- Translation
  - Your blood is basically water plus red blood cells (carry oxygen), white blood cells (fight infection) and **platelets** ("plate lets") (required for blood clotting). If you have **Ebola**, the number of platelets decreases, meaning your blood cannot clot. Ebola is much more complex than this but that's the big picture.
- Source
  - Science
    - 11 August 2014
    - <https://www.sciencemag.org/news/2014/08/part-one-virologists-tale-africas-first-encounter-ebola>
- Author
  - Peter Piot

### The virus detective who discovered Ebola in 1976

- Summary

- This has photos, maps, and hand-written notes documenting that first Ebola outbreak in 1976. Nothing gross.
- Source
  - BBC News
    - 18 July 2014
    - <https://www.bbc.com/news/magazine-28262541>
- Author
  - Rob Brown

### *Ebola virus disease in the light of epidemiological triad*

- Summary
  - This nicely written review article describes the discovery of the *Ebola virus* by Dr. Peter Piot. It was initially thought to be the *Marburg virus*, which is a close cousin.
  - And it also gives the rationale for naming the virus *Ebola* rather than *Yambuku*.
- Verbatim
  - The discovery of Ebola began in Yambuku village in Zaire where a Belgian nun became ill, and a Belgian doctor sent her blood sample for investigation. Dr. Peter Piot, a clinical microbiologist, who saw this spaghetti-shaped virions under the electron microscope could not come to a conclusion. He mistook it to be the *Marburg virus* and sent the photo to other experts in the world; however, they confirmed that it was not the *Marburg virus*. The nun died and several villagers were affected by a similar illness and were dying. Piot travelled to Yambuku to investigate the epidemic through a detailed history and maps to make connections and within 3 months carried out extensive isolation of cases and contacts. They thought of naming the virus after the Yambuku village but realized that it would stigmatize the village, so they named the virus after the nearest river, the Ebola river.<sup>[8]</sup>
- Translation
  - **Virion** is a fancy word that means an entire virus, including its DNA and all its other parts. Kind of like how 'car' means the entire thing.
- Say it
  - "Vee ree on"
  - "Vye ree on"
  - Your choice.
  - <https://www.merriam-webster.com/dictionary/virion>
    -  Click to hear both.
- Source
  - Tropical Journal of Medical Research
    - January 2017
    - [https://www.researchgate.net/publication/312339888\\_Ebola\\_virus\\_disease\\_in\\_the\\_light\\_of\\_epidemiological\\_triad](https://www.researchgate.net/publication/312339888_Ebola_virus_disease_in_the_light_of_epidemiological_triad)
    - The article is hosted on ResearchGate which is a strong resource for science.
- Authors
  - Gurmeet Kaur
  - Sandeep Sachdeva
  - Diwakar Jha
  - Anika Sulania
    - Department of Community Medicine, North DMC Medical College, Hindu Rao Hospital, Delhi, Indi

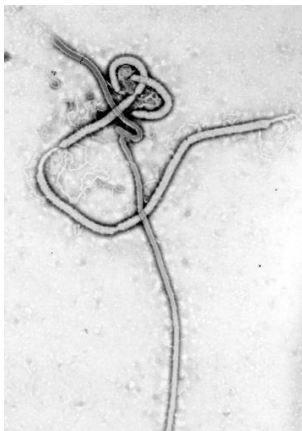
### *Viral hemorrhagic fevers*

- Summary

- Some nasty viruses screw up your blood clotting → this results in bleeding a.k.a. hemorrhaging. And you also have a fever. So they are called **Viral Hemorrhagic Fevers**. That's logical which is a rare blessing since most things in medicine have confusing names.
- This group includes:
  - *Ebola virus*
  - *Marburg virus*
    - That's why **Dr. Peter Piot** was originally thinking the 1976 illness was this virus.
  - And a few others.
- Say it
  - "Hem oh raj ick"
  - "Heem oh raj ick"
  - Your choice.
  - The word **heme** means 'blood' in medicalese (the language of medicine).
- Source
  - Mayo Clinic
    - 24 February 2021
    - <https://www.mayoclinic.org/diseases-conditions/viral-hemorrhagic-fevers/symptoms-causes/syc-20351260>
- Author
  - Mayo Clinic Staff

### *Viral Hemorrhagic Fevers (VHFs)*

- Summary
  - This is more technical.
- Source
  - CDC
    - September 2021
    - <https://www.cdc.gov/vhf/virus-families/filoviridae.html>



*Ebola virus*



*Marburg virus*

Those both look kind of string-like, don't they?

### *Filoviridae*

- Summary
  - *Ebola virus* and *Marburg virus* belong to a virus family called **Filo-viridae**. The filo part means filament, meaning they resemble a filament / string / spaghetti.
- Source
  - Wikipedia
    - <https://en.wikipedia.org/wiki/Filoviridae>

*History credits this man with discovering Ebola on his own. History is wrong*

- Summary
  - This article disagrees it was Dr Piot who made a solo discovery of the Ebola virus. It adds some useful historical context.
- Source
  - STAT
    - 14 July 2016
      - <https://www.statnews.com/2016/07/14/history-ebola-peter-piot/>
- Author
  - Helen Branswell

## Fruit bat

*Ebola Reservoir Study*

- Summary
  - The fruit bat is the suspected reservoir of the *Ebola virus*.
  - For detail on reservoirs see the first source at the top of page 19 (this page).
- Verbatim from the CDC
  - Bats are the current subject of study as *Ebola virus* is a close cousin of *Marburg virus*, which causes a similar disease in humans and is consistently found in a specific species of African fruit bat. In total, CDC-trained, local healthcare workers have captured almost 400 fruit bats for testing at Njala University for evidence of Ebola virus infection.
- Source
  - CDC
    - 9 July 2019
    - <https://www.cdc.gov/ncezid/stories-features/global-stories/ebola-reservoir-study.html>



### Megabat

- Summary
  - *Mega* means big. *Micro* means small.
  - **Megabats** are big bats.
    - They eat big things like fruit.
    - The photo is an Egyptian fruit bat. Cute, if you ask me.
  - **Microbats** are small bats.
    - They eat small things like insects.
- These are loose synonyms
  - Megabat
  - Fruit bat
  - Flying fox
- Source
  - <https://en.wikipedia.org/wiki/Megabat>
    - The photo is 2/3 down the page.

### Overview, Importance and Challenges – Chiroptera

- Summary
  - Loads of information on bats, including skeleton, echolocation, diet, and more.
- Verbatim
  - It is estimated that insectivorous bats save U.S. agriculture over \$3.7 billion dollars annually in pest control.
- Translation
  - **Insectivorous** bats eat insects.
- Source
  - Louisiana Department of Wildlife & Fisheries
    - [https://www.wlf.louisiana.gov/assets/Resources/Publications/Bats/Chiroptera\\_Overview\\_Importance\\_and\\_Challenges.pdf](https://www.wlf.louisiana.gov/assets/Resources/Publications/Bats/Chiroptera_Overview_Importance_and_Challenges.pdf)

*Comparative phylogeography of African fruit bats (Chiroptera, Pteropodidae) provide new insights into the outbreak of Ebola virus disease in West Africa, 2014–2016*

- Summary
  - This stuff is all important so it's all yellow!
  - This paper is very technical. It describes the presence of *Ebola virus* and *Marburg virus* in bats.
  - **Phylogenetics** (“fi” – fi rhymes with eye – “low” “genetics”) is fancy term describing another fancy term called **evolutionary history**. This involves family trees with many branches. For example, there are ancient, extinct giraffes. Are they related to living giraffes? Yes. Phylo-genetics examines that. So anyways, this technical paper looks at the phylo-genetics of bats that are infected by *Ebola virus* and *Marburg virus*.
  - The scientists who study these bats are looking for **anti-bodies** in the blood of bats. Do bats have white blood cells, just like humans? Yes.
    - You (or a bat) is infected by a virus → the white blood cells of the immune system recognize that the virus (an invader) is present → the white blood cells produce anti-bodies (they are Y-shaped molecules) → the anti-bodies assist in *killing* the virus → the virus *disappears* → but the antibodies *persist* in the blood and can be detected.
    - That's the generic version of events.
- Source
  - Comptes Rendus Biologies
    - That's French for *Biology Reports*.
    - 2016
    - <https://hal.sorbonne-universite.fr/hal-01382796/document>
- Authors
  - Alexandre Hassanin <sup>a,b</sup>
  - Nicolas Nesi <sup>a,b</sup>
  - Julie Marin <sup>a</sup>
  - Blaise Kadjo <sup>c</sup>
  - Xavier Pourrut <sup>d</sup>
  - Eric Leroy <sup>d</sup>
  - Guy-Crispin Gembu <sup>e</sup>
  - Prescott Musaba Akawa <sup>e</sup>
  - Carine Ngoagouni <sup>f</sup>
  - Emmanuel Nakoune <sup>f</sup>
  - Manuel Ruedi <sup>g</sup>
  - Didier Tshikung <sup>h</sup>
  - Celestin Pongombo Shongo <sup>h</sup>
  - Celine Bonillo <sup>b</sup>
- Institution
  - **What an interesting mix of institutions.**
  - <sup>a</sup> Institut de systématique, évolution, biodiversité, ISYEB–UMR 7205 CNRS, MNHN, université Paris-6 (UPMC), Sorbonne Universités, Muséum national d'histoire naturelle, 75005 Paris, France
  - <sup>b</sup> Muséum national d'histoire naturelle, UMS 2700, 75005 Paris, France
  - <sup>c</sup> Université Félix-Houphouët-Boigny, UFR biosciences, 22 BP 582, Abidjan 22, Côte d'Ivoire
  - <sup>d</sup> Centre international de recherches médicales de Franceville, BP 769, Franceville, Gabon
  - <sup>e</sup> Faculté des sciences, université de Kisangani, BP 2012, Kisangani, Democratic Republic of the Congo
  - <sup>f</sup> Institut Pasteur de Bangui, BP 923, Bangui, Central African Republic
  - <sup>g</sup> Département de mammalogie et d'ornithologie, museum d'histoire naturelle, Geneve, Switzerland
  - <sup>h</sup> Faculte de medicine veterinaire, université de Lubumbashi, Lubumbashi, Democratic Republic of the Congo

# Page 20 – Ebola out of control

These are my own notes from a conference I attended.

- Summary
  - The information on page 20 is from the notes I took at a Travel Medicine conference. The keynote speaker had been right there, boots on the ground, during the Ebola outbreak of 2014.
  - As mentioned on page 10 of the Bibliography, travel medicine is usually practiced by primary care physicians who recommend the vaccines required to visit certain countries.
- Source
  - International Society for Travel Medicine (ISTM) conference, Quebec City, Canada, May 2015
- Speakers on Ebola
  - Speaker 1: Daniel Bausch, MD, World Health Organization, Geneva. He was funny.
  - Speaker 2: English (sorry, didn't catch your name). Spoke about treatment.
  - Speaker 3: Joanne Liu, MD, pediatrician
    - Former President of Médecin Sans Frontiers (MSF) a.k.a. Doctors Without Borders.
    - She spoke to the UN General Assembly and UN Security Council.
    - Passionate, funny, speaks candidly.
    - In West Africa, 50% of patients died of Ebola. "We were basically reduced to palliative care."
    - Standing ovation after she spoke.
- Translation
  - Palliative care is the medical care provided to someone who is going to die of a terminal illness. The word is derived from the Latin word *pallium* which means *cloak*. So imagine putting a cloak on someone to comfort them, knowing there's little else you can do.
    - Online Etymology Dictionary
      - This is a good website if you want to read about word origins. Nice layout. Not too busy.
      - <https://www.etymonline.com/search?q=palliative>

# Page 21 – Smallpox

Smallpox virus



That's the **Smallpox virus**.

- It has an oblong shape and what looks like a pita inside. Kinda weird looking.
- Other Google Images searches show what look like dots on the surface.
- Magnified here 370,000 x.
- <https://en.wikipedia.org/wiki/Smallpox>

## 'Pox' word origin

### **Pox**

- *A pox o your throat, you bawling, blasphemous, incharitable dog!*
  - **The Tempest, William Shakespeare**
  - <https://www.allgreatquotes.com/the-tempest-quotes-6/>
- **Online Etymology Dictionary**
  - Various examples of pox:
    - cow-pox
    - chicken-pox
    - small-pox
    - pock
  - <https://www.etymonline.com/search?q=pox>

## Smallpox – what it's like

### **Smallpox**

- Summary
  - **GROSS photos**
    - The point of the photos is not shock value, rather to understand how brutal **Smallpox** is. The skin all over your body becomes covered by hundreds of blisters filled with pus a.k.a. **pustules** ("puss" – puss rhymes with fuss – chewls").
- Source
  - Wikipedia
    - <https://en.wikipedia.org/wiki/Smallpox>



## Smallpox

- Summary
  - **GROSS photo**
    - **Caption:** This patient with smallpox survived toxemia to succumb to secondary tissue damage days after this photo was taken. Courtesy of the US Centers for Disease Control and Prevention.
    - **Translation:** The term **toxemia** has several meanings in medicine, depending on the medical specialist using it. In this case, the toxemia refers to the original smallpox infection where it the virus is found in the blood and in the blisters. That's the **primary** infection. This is followed by **secondary** damage, meaning bacteria can now infect these open wounds on the skin. Plus when your skin is so severely ravaged like this you basically lose your nice waterproof coating and start to evaporate, meaning severe dehydration.
  - **Interesting details on the history of Smallpox.**
- Verbatim
  - The earliest evidence of smallpox comes from ancient Egypt circa 1157 BCE, where the mummified remains of a pockmarked **Ramses V** were **uncovered**. International traders spread smallpox throughout the Old World during the 4th-15th centuries CE, while European explorers and conquerors brought the disease to the Western Hemisphere in the early 16th century.
  - Smallpox directly and profoundly influenced the course of human history. Its tremendous morbidity and mortality led to indiscriminate killing of kings and warlords and tipped the balance of power with regularity in Europe and elsewhere. **As a result of smallpox infection, whole civilizations, including the Incas and the Aztecs, were destroyed in a single generation**, and efforts to ward off the disease indelibly affected the practice of religion and medicine.
- Source
  - Medscape
    - 28 July 2020
    - <https://emedicine.medscape.com/article/237229-overview#a5>
      - This is the **GROSS photo**.
    - <https://emedicine.medscape.com/article/237229-overview#a4>
      - This is the history of Smallpox.
- Author
  - **Aneela Naureen Hussain MD**, MBBS, FAFM Consulting Staff, Department of Family Medicine, South Texas Veterans Health Care System in San Antonio
- Co-authors
  - **Fazal Hussain, MD**, MPH Director of Research Operations, Department of Medicine, University of Texas Health Science Center at San Antonio, Joe R and Teresa Lozano Long School of Medicine
  - **Maqsood Alam, MD** Fellow, Department of Infectious Diseases, State University of New York Downstate Medical Center
  - **Dennis J Cleri, MD**, FACP, FIDSA, FAAM Chairman, Graduate Medical Education Committee, Professor of Medicine, Associate Professor of Infectious Diseases, Seton Hall University School of Graduate Medical Education
- Chief Editor
  - **John L Bruschi, MD**, FACP Assistant Professor of Medicine, Harvard Medical School; Consulting Staff, Department of Medicine and Infectious Disease Service, Cambridge Health Alliance
- Acknowledgements
  - **Many of these doctors are dermatologists (skin specialists).**
  - **David F Butler, MD** Professor of Dermatology, Texas A&M University College of Medicine; Chair, Department of Dermatology, Director, Dermatology Residency Training Program, Scott and White Clinic, Northside Clinic

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- **William D James, MD** Paul R Gross Professor of Dermatology, University of Pennsylvania School of Medicine; Vice-Chair, Program Director, Department of Dermatology, University of Pennsylvania Health System
- **Julie R Kenner, MD, PhD** Consultant, Clinical Research, Medical Affairs, VaxGen, Inc; Private Practice, Kenner Dermatology Center
- **Michelle Pelle, MD** Clinical Assistant Professor, Division of Dermatology, Department of Medicine, University of California at San Diego
- **Francisco Talavera, PharmD, PhD** Adjunct Assistant Professor, University of Nebraska Medical Center College of Pharmacy; Editor-in-Chief, Medscape Drug Reference
- **Victoria P Werth, MD** Professor of Dermatology and Medicine, University of Pennsylvania School of Medicine; Chief, Division of Dermatology, Philadelphia Veterans Affairs Medical Center

### Smallpox

- Summary
  - This is a thorough description of Smallpox.
  - There are links on the page to:
    - History
    - Transmission
    - Bioterrorism
    - Research
- Source
  - CDC
    - <https://www.cdc.gov/smallpox/index.html>

### Smallpox

- Summary
  - There's enough content here to keep you occupied for a full day.
- Source
  - **World Health Organization (WHO)**
    - [https://www.who.int/health-topics/smallpox#tab=tab\\_2](https://www.who.int/health-topics/smallpox#tab=tab_2)

### Preparedness in the event of a smallpox outbreak

- Summary
  - These are details on the **Smallpox Vaccine Emergency Stockpile (SVES)**. Rather intriguing stuff to incorporate into that apocalypse story you're pitching to Netflix.
- Source
  - **World Health Organization (WHO)**
    - <https://www.who.int/news-room/feature-stories/detail/preparedness-in-the-event-of-a-smallpox-outbreak>

## Antonine Plague

*The plague under Marcus Aurelius and the decline and fall of the Roman Empire*

- Summary
  - This paper argues that the **Antonine Plague** (which was **Smallpox**) may have contributed to the decline and fall of the **Roman Empire**.
- Verbatim
  - The Roman Empire of the second century was a superpower that, in relative terms, dominated its world as much as the United States does today. In 166 AD, a plague broke out od **[sic]** pandemic proportions. The pandemic ravaged the entire extent of the **Roman Empire**, from its eastern frontiers in Iraq to its western frontiers on the Rhine River and Gaul, modern France, and western Germany. The disease is identified most often as smallpox, but it may have been anthrax. The study of bacterial DNA may enable identification of this plague that ravaged the Roman Empire at recurrent intervals for more than 100 years and that had a significant role in the decline and fall of this great superpower.
  - This is kind of trivial but ...
    - See in the verbatim where it says **[sic]**? I put that in. That word sic means something was in error but copied exactly as it was written. In this case, the typo 'od' should actually be 'of'.
    - This is actually a Latin phrase, **sic erat scriptum**, meaning "thus was it written."
    - Don't say you never learned nuthin' from this bibliography.
      - <https://en.wikipedia.org/wiki/Sic>
- Source
  - Infectious Disease Clinics of North America
    - 1 March 2005
    - This is presented in **ScienceDirect** which is published by **Elsevier** (a publishing giant).
    - I could not read anything except the Abstract of this paper but it's informative, regardless.
    - <https://www.sciencedirect.com/science/article/abs/pii/S0891552003000898?via%3Dihub>
- Author
  - **Professor Rufus Fears, PhD**. Department of Classics, University of Oklahoma, Kaufman Hall, Norman, Oklahoma
    - This **history professor** is very interesting. He teaches several courses in **The Great Courses**. I have the one called *History of Freedom*. They are awesome courses but I wait for them to go on sale.
    - <https://www.thegreatcourses.com/professors/j-rufus-fears>



That's the **Angel of Death** paying a visit to **Rome** during the **Smallpox Epidemic** a.k.a. **Antonine Plague** during the reign of the **Roman Emperor Marcus Aurelius** a.k.a. **Marcus Aurelius Antoninus** who is the aging emperor at the beginning of the movie, *Gladiator*.

- [https://en.wikipedia.org/wiki/Antonine\\_Plague](https://en.wikipedia.org/wiki/Antonine_Plague)
- [https://en.wikipedia.org/wiki/Marcus\\_Aurelius](https://en.wikipedia.org/wiki/Marcus_Aurelius)
- By the way, Marcus Aurelius wrote *Meditations*, a timeless book of instructions for living a wholesome life. It reads in a way that makes you feel as if you are living, breathing, and conversing in Latin in Rome in 180 A.D.

From my grandfather Verus I learned good morals and the government of my temper.



From the reputation and remembrance of my father, modesty and a manly character.

From my mother, piety and beneficence, and abstinence, not only from evil deeds, but even from evil thoughts; and further, simplicity in my way of living, far removed the from habits of the rich.

- Here is the amazon link. You can **Look inside**. There are many versions of the book. I bought my copy at the **Capitoline Museum** in **Rome**, which is pretty close to the **Colosseum**.
- [https://www.amazon.com/Meditations-dp-1474620949/dp/1474620949/ref=dp\\_ob\\_title\\_bk](https://www.amazon.com/Meditations-dp-1474620949/dp/1474620949/ref=dp_ob_title_bk)

## Ramses V

### Ramesses V

- Summary
  -  Click on the photo of the mummified head of **Ramses V** a.k.a. **Ramesses V** and keep clicking till it's big. Check out the raised round dots on his face.
    - [https://en.wikipedia.org/wiki/Ramesses\\_V](https://en.wikipedia.org/wiki/Ramesses_V)
  -  Now compare those dots to the **GROSS photos** of known Smallpox victims. It seems a reasonable conclusion that Ramses had Smallpox.
    - <https://en.wikipedia.org/wiki/Smallpox>

### History of Smallpox

- Summary
  - There is a color photo of the mummified head of **Ramses V** a.k.a. **Ramesses V**.
  - As well, there is a photo of **Rahima Banu**, the last person on Earth to have Smallpox.
- Source
  - CDC
    - <https://www.cdc.gov/smallpox/history/history.html>

### Atlas of Ancient Egypt

- Summary
  - This book contains information on all the **Egyptian pharaohs** and dynasties. It's totally weird terminology with alternating periods and alternating kingdoms. Whatever.
  - **Ramses V** lived during the 20<sup>th</sup> Dynasty.

<u>Dynasty name</u>	<u>Dynastic period</u>
Early Dynastic Period	1-3
Old Kingdom	4-7 ( <b>Khufu, Kephren, Menkaure</b> ) They built the Pyramids.
1 <sup>st</sup> Intermediate Period	9-11
Middle Kingdom	11-14
2 <sup>nd</sup> Intermediate Period	15-17
New Kingdom	18-20 ( <b>Tutankhamun</b> a.k.a. <b>King Tut</b> , <b>Ramses V</b> )
3 <sup>rd</sup> Intermediate Period	21-25
Late Period	26-30 (26 <sup>th</sup> <i>Dynasty</i> a.k.a. 1 <sup>st</sup> <i>Persian Period</i> ) ( <b>Darius, Xerxes</b> )
2 <sup>nd</sup> Persian Period	No more dynastic numbers
Greco-Roman Period	<b>Alexander, Ptolemy, Cleopatra, Augustus</b>

- Source
  - Checkmark Books
    - 1980
    - 240 pages.
    - <https://www.amazon.ca/Atlas-Ancient-Egypt-John-Baines/dp/0871963345>
- Authors
  - John Baines
  - Jaromir Malek

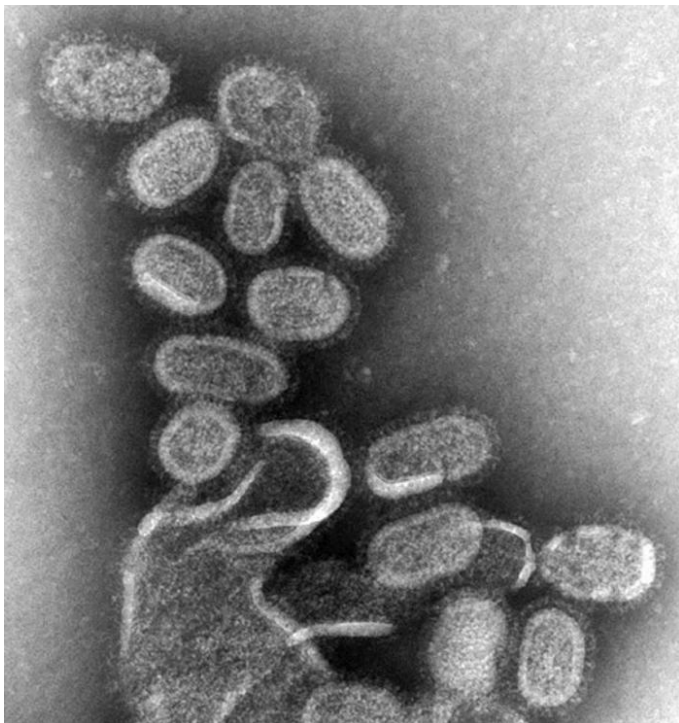
### Dynasties of Egypt

- Here are some online sources.

- **The Met**
  - As in **The Metropolitan Museum of Art** in New York City.
  - [https://www.metmuseum.org/toah/hd/phar/hd\\_phar.htm](https://www.metmuseum.org/toah/hd/phar/hd_phar.htm)
- **Britannica**
  - <https://www.britannica.com/facts/ancient-Egypt>
- **The Egyptian Museum**
  - This is in Cairo. This is the floor plan and where they have the dynastic stuff. Try to go at some time in your life. It's worth the trip.
  - <https://egyptianmuseumcairo.eg/egyptian-museum-map/?location=room-39-uf>
- **Wikipedia**
  - Frankly, this is the nicest layout of information.
  - [https://en.wikipedia.org/wiki/Dynasties\\_of\\_ancient\\_Egypt](https://en.wikipedia.org/wiki/Dynasties_of_ancient_Egypt)

## Page 22 - Spanish Influenza

### Influenza virus



That's the *Influenza virus* magnified 100,000 x.

- Think about the technology to accomplish that photo. If someone asked you to build an electron microscope, how would you do it?
- <https://en.wikipedia.org/wiki/Influenza>

## First, things first: names

These all mean the same thing

- **Spanish Flu**
- **Spanish Influenza**
- **1918 Spanish Influenza**
- **1918 Influenza Pandemic**
  - This one is the official name. It refers to a specific pandemic in 1918. And it wasn't just in Spain – it was global, which is why 'Spanish' is considered misleading. Not to mention, the pandemic may have started in Kansas in the USA (details in the next section).

And these all mean the same thing

- *Spanish Influenza virus*
- *1918 Spanish Influenza virus*
- *1918 Influenza Pandemic virus*
- *Influenza Pandemic virus*
- *Influenza virus Type A: subtype H1N1*
  - That's the most accurate name.

These are not necessarily the same thing

- *Influenza virus*
  - This is an umbrella term for all the varieties of the *Influenza virus*, namely *Type A*, *Type B*, *Type C*, and *Type D* (which doesn't even infect humans, rather cows), plus all their sub-types.
- *1918 Pandemic virus*
  - This is *Influenza Type A, sub-type H1N1*.
- Get it?
  - If you read the term, *Influenza virus*, it can refer to many things.
  - If you read the term, *1918 Pandemic virus*, it refers specifically to that nasty mutant that killed 50 million people from 1918 to 1919.

And this is the Big Picture

- *Virus* → **Pandemic**
- *1918 Influenza virus Type A: subtype H1N1* → **1918 Influenza Pandemic**

## Origin of the 1918 Influenza pandemic

*The site of origin of the 1918 influenza pandemic and its public health implications*

- Summary
  - The geographic origin of the 1918 Influenza is a best guess. Was it an army barracks in Kansas, USA? Was it Asia?
  - The bit about the army barracks in Kansas is from reference 1 which is a book, *The Great Influenza: the Epic Story of the Deadliest Plague in History* by JM Barry and published by Viking in 2004.
- Source
  - Journal of Translational Medicine
    - January 2020
    - <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC340389/>
- Author

- John M Barry. Distinguished Visiting Scholar, the Center for Bioenvironmental Research of Tulane and Xavier Universities, New Orleans, Louisiana, USA

## Queen Eugenia & King Alphonso



Alfonso XIII of Spain

- This is the Spanish king who got sick with **Influenza** in 1918.
- [https://en.wikipedia.org/wiki/Alfonso\\_XIII\\_of\\_Spain](https://en.wikipedia.org/wiki/Alfonso_XIII_of_Spain)





Queen Eugenie a.k.a. Ena a.k.a. Victoria Eugenie of Battenberg

- The queen did not sick by the sounds of it.
- [https://en.wikipedia.org/wiki/Victoria\\_Eugenie\\_of\\_Battenberg](https://en.wikipedia.org/wiki/Victoria_Eugenie_of_Battenberg)

### Victoria Eugenie: The English Queen of Spain

- Summary
  - Details of the bombing during the wedding. Lots of historical intrigue. Lots of photos.
- Verbatim
  - The celebrations were marred by an assassination attempt made on Alfonso and Ena as they rode through the streets back towards the Palace, Ena's life spared by turning her head at the last moment when a bomb exploded, her dress stained with the blood of the nearest guard who was instantly killed. It made for an inauspicious start to married life.
- Source
  - rebeccastarbrown.com - *From Normandy to Windsor, Putting the British Monarchy in Context*
    - 10 June 2017

- <https://rebeccastarrbrown.com/2017/06/10/the-english-queen-of-spain/>
- Author
  - Rebecca Starr Brown. This is her blog.

### ABC Newspaper

- Summary
  - ABC is a Spanish daily newspaper with headquarters in Madrid.
  - **1903 January 1** – The very first issue.
  - **1918 September 30** – ‘... the King is sick with the flu.’
- Source
  - <https://www.abc.es/archivo/>
  - [https://en.wikipedia.org/wiki/ABC\\_\(newspaper\)](https://en.wikipedia.org/wiki/ABC_(newspaper))

### The lie that King Alfonso XIII contracted the Spanish Flu in 1918

- Summary
  - This article says King Alphonso actually had **Scarlet Fever** which is a complication of **Strep throat** (which is caused by a *bacteria*, not a *virus*).
  - Here's some info from the **Mayo Clinic** on **Scarlet Fever**, in case you're curious.
    - <https://www.mayoclinic.org/diseases-conditions/scarlet-fever/symptoms-causes/syc-20377406>
- Source
  - archyde
  - **2020 March 26**
  - <https://www.archyde.com/the-lie-that-king-alfonso-xiii-contracted-the-spanish-flu-in-1918/>

### Spanish Flu

- Summary
  - The correct use of terminology for the pandemic is addressed.
  - Loads of historical photos.
- Verbatim
  - The 1918 influenza pandemic, also known by the misnomer Spanish flu or as the Great Influenza epidemic, was an exceptionally deadly global influenza pandemic caused by the H1N1 influenza A virus.
- Source
  - Wikipedia
    - [https://en.wikipedia.org/wiki/Spanish\\_flu](https://en.wikipedia.org/wiki/Spanish_flu)

## Spain declares neutrality in WW1

### Spain During the First World War

- Summary
  - Spain was neutral in World War 1. That's all I know.
  - There are four books at the bottom in their References if you wanna dive deep.
- Verbatim
  - The larger of two countries on the Iberian Peninsula in southwestern Europe, **Spain was staunchly neutral** in the years leading up to the Great War and remained so throughout.
- Semantics

- **Staunch** means to be firm or steadfast. In dramatic Hollywood scenes, the doctor may say, “We’ve got to staunch the bleeding!” I have never heard that said in a real hospital but will ask my surgeon friends to get it back in style.
- Source
  - [firstworldwar.com](http://firstworldwar.com)
    - **William P. McEvoy**
    - 22 August 2009
    - <https://www.firstworldwar.com/features/spain.htm>
      - This is reference no. 2 in *Spain during World War 1* – *Wikipedia*. [https://en.wikipedia.org/wiki/Spain\\_during\\_World\\_War\\_I](https://en.wikipedia.org/wiki/Spain_during_World_War_I)
      - But now it’s apparently a site impersonating the site and Safari told me to only visit at my peril. Hmm. Seems very warlike.

If you’re curious about the British bloodline ...



*Queen Victoria*

- That’s **Queen Victoria** who was the **grandmother of Queen Eugenie of Spain**.
- Victoria was born in **1819**, became Queen at the age of 18, and reigned for 63 years. Wow.
- Interestingly, the first ever black and white photograph was in **1837** which is when her reign starts, so no King or Queen prior to her had ever been photographed. Which is why in Wikipedia all the preceding monarchs are *paintings*. The photo above was taken in **1882**. Of note, this first B&W photograph was called a **daguerreotype** (“dag air oh type”), named after its inventor the **French physicist Louis Daguerre**.

- [https://en.wikipedia.org/wiki/Queen\\_Victoria](https://en.wikipedia.org/wiki/Queen_Victoria)
- <https://en.wikipedia.org/wiki/Daguerreotype>

### Royal Family Tree (849 – Present)

- Summary
  - This is a fantastic and huge family tree of all the British monarchs, starting in the year 871 AD with Alfred the Great (born in 849). 🙌 You can click on a King or Queen to get more info.
  - Some notables in the family tree are:
    - **Edward the Longshanks** – he's the nasty king in *Braveheart* and is opposed by defiant **William Wallace** of Scotland (in other words, Mel Gibson with hair extensions).
    - **Henry VIII** – he had 6 wives.
    - **Mary, Queen of Scots** – she was hung for plotting against England.
    - **James** – Interestingly, **William Shakespeare** was born in 1564, two years before James. *The Merchant of Venice* was played live before the king in 1605. And the *King James Bible* of 1611 is named after him. He was also the first king with a unified England and Scotland, so he is both **King James I of England** and **King James VI of Scotland**. I was in the tiny, stone bedroom where he was born at Edinburgh castle in Scotland. His mother was Mary, Queen of Scots. He's my favorite monarch.
    - **Edward VIII** - he abdicates (abandons) the throne for love! Bravo. He marries **Wallis Simpson** who is a divorced woman (omg) from the United States. It's a scandal. The replacement king is his younger brother **George VI** whose daughter then becomes **Queen Elizabeth II**. So if not for that scandalous love affair, we'd have had no marriage of **Prince Charles** and **Lady Diana** (well, pretty unlikely). Such are the vagaries of fate.
- Source
  - **Britroyals**
  - <https://www.britroyals.com/royaltree.asp>

# Page 23 - Influenza

Electron microscope

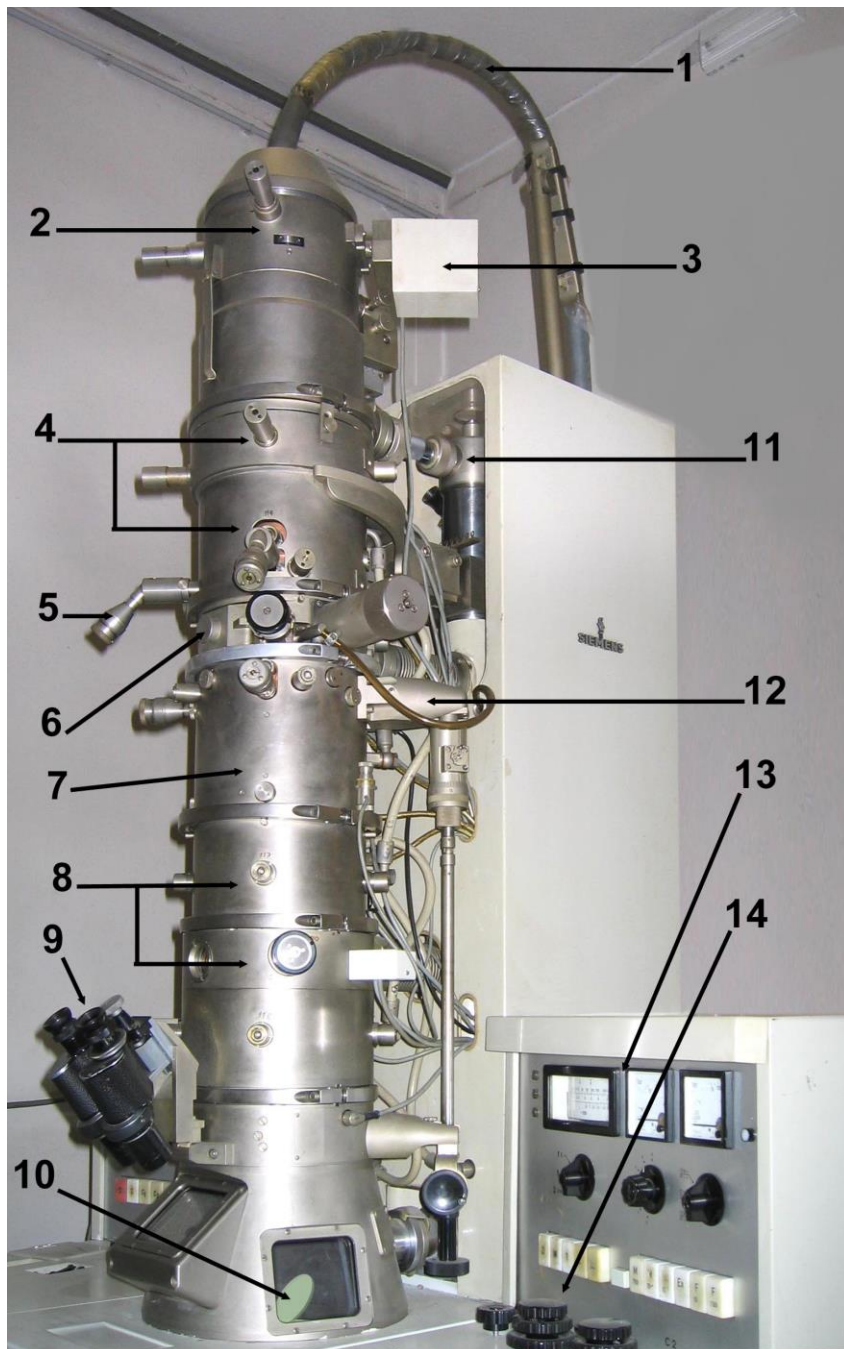


*Electron microscope*

- That's an electron microscope made by the Japanese company **JEOL**.
- [https://en.wikipedia.org/wiki/Electron\\_microscope](https://en.wikipedia.org/wiki/Electron_microscope)

*JEOL 100CX II transmission electron microscope (TEM) 100kV*

- Summary
  - These are the instructions on how to operate a **JEOL** electron microscope. It's pretty cool.
- Source
  - **Georgia Tech** – Center for Nanostructure Organization
    - <https://sites.gatech.edu/cnc/tem/jeol100/>



These are the parts of an electron microscope:

1. High tension cable
2. **Electron emitter**  
That's going to fire electrons *downwards* at the specimen.
3. Stepper motors for centering the electron beam
4. Condenser
5. Aperture controls
6. **Specimen holder**  
The specimen goes here. Quite a lot higher up than you'd figure.
7. Objective lens
8. Projector lens

9. **Optical binoculars**

Look here, please.

10. Fluorescent screen

11. Vacuum pump leads

12. **Goniometer**

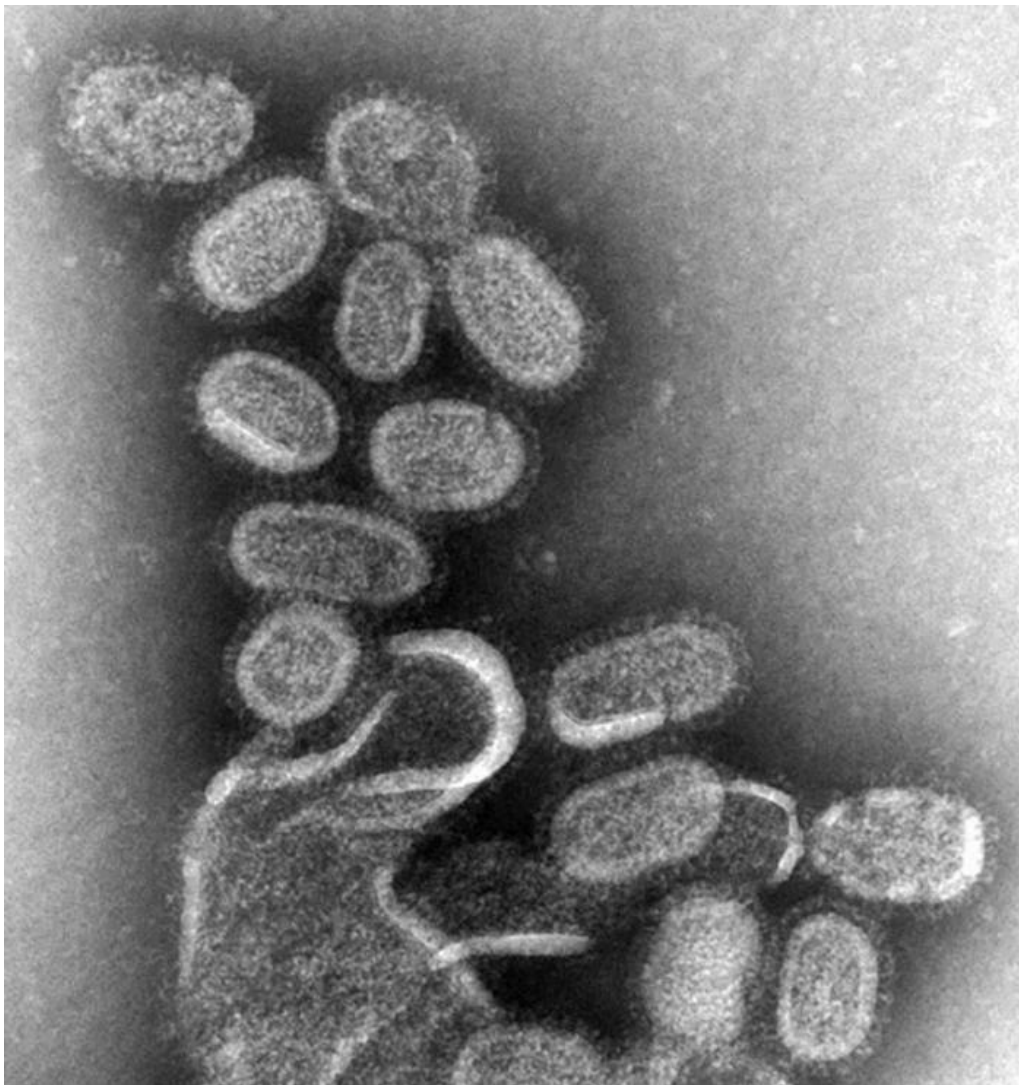
This allows the operator to tilt the angle of the specimen. Something like that.

13. Vacuum and magnification control

14. Focusing control

- This one is made by the German company **Siemens**.
- [https://en.wikipedia.org/wiki/Transmission\\_electron\\_microscopy](https://en.wikipedia.org/wiki/Transmission_electron_microscopy)

## Influenza basics



Those are **influenza viruses**. The shape can be round or rodlike. But do NOT confuse this with round or rodlike bacteria. Viruses are waaaaaaaaay smaller than bacteria.

- <https://en.wikipedia.org/wiki/Influenza>

What is influenza?

- Summary
  - This is a 2-minute animation from the **World Health Organization (WHO)** giving a great overview. It answers the question: *What's the secret to the long existence of the influenza virus?*
- Source
  - **World Health Organization (WHO)**
    - 24 March 2022
    - <https://www.who.int/multi-media/details/what-is-influenza#>

### How are influenza viruses named?

- Summary
  - This is an excellent CDC page explaining **Influenza virus Type A / B / C / D**.
  - About ¾ down the page is the naming system for sub-types like **H1N1** or **H5N1**.
- Source
  - CDC
    - <https://www.cdc.gov/flu/about/viruses/types.htm>

### Influenza D Virus in Cattle, Ireland

- Summary
  - This is to showcase that **Influenza virus Type D** a.k.a. **Influenza D virus** is found in cattle.
- Verbatim
  - We detected influenza D virus in 18 nasal swab samples from cattle in Ireland that were clinically diagnosed with respiratory disease.
- Source
  - Emerging Infectious Disease
    - This is a **CDC** journal.
    - **2018 February**
    - <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5782902/>
- Authors
  - Some of these scientists have wonderful Irish names.
  - **Orla Flynn, Clare Gallagher, Jean Mooney, Claire Irvine, Eoin Ryan**: Department of Agriculture, Food, and Marine Laboratory Services, **Celbridge, Ireland**
  - **Mariette Ducatez** École Nationale Vétérinaire de Toulouse, Toulouse, France
  - **Ben Hause** Kansas State University College of Veterinary Medicine, Manhattan, Kansas, USA
  - **Guy McGrath** University College Dublin, Dublin, Ireland

### Past Pandemics

- Summary
  - This CDC page has links to previous **Influenza virus pandemics**:
    - 1918
    - 1957
    - 1968
    - 2009
- Source
  - **CDC**
    - <https://www.cdc.gov/flu/pandemic-resources/basics/past-pandemics.html>

### Pandemic Influenza

- Summary
  - This is the CDC home page on the Pandemic Influenza (of 1918). There are many links.
  - The name of the game is:
    - Be ready for a bad **influenza virus pandemic** like in **1918**.
    - Manage **seasonal influenza**.



- The seasonal influenza is tame relative to 1918 but people still die so really it's not that tame.
- Source
  - CDC
    - <https://www.cdc.gov/flu/pandemic-resources/index.htm>

### *1918 Influenza: the Mother of All Pandemics*

- Summary
  - This is a summary of the 1918 Influenza pandemic. It's all on 1 page. It takes about 10 minutes to read. It gets into the finer points and nuance. It is not crazy technical.
- Source
  - Emerging Infectious Diseases
    - 2006 January
      - [https://wwwnc.cdc.gov/eid/article/12/1/05-0979\\_article](https://wwwnc.cdc.gov/eid/article/12/1/05-0979_article)
- Authors
  - This was the author information in 2006.
  - **Dr. Jeffery K. Taubenberger** is chair of the [Department of Molecular Pathology at the Armed Forces Institute of Pathology, Rockville, Maryland](#). His research interests include the molecular pathophysiology and evolution of influenza viruses.
  - **Dr. David Morens** is an [epidemiologist](#) with a long-standing interest in emerging infectious diseases, virology, tropical medicine, and medical history. Since 1999, he has worked at the [National Institute of Allergy and Infectious Diseases](#).

# Page 24 – Influenza

Optical microscope



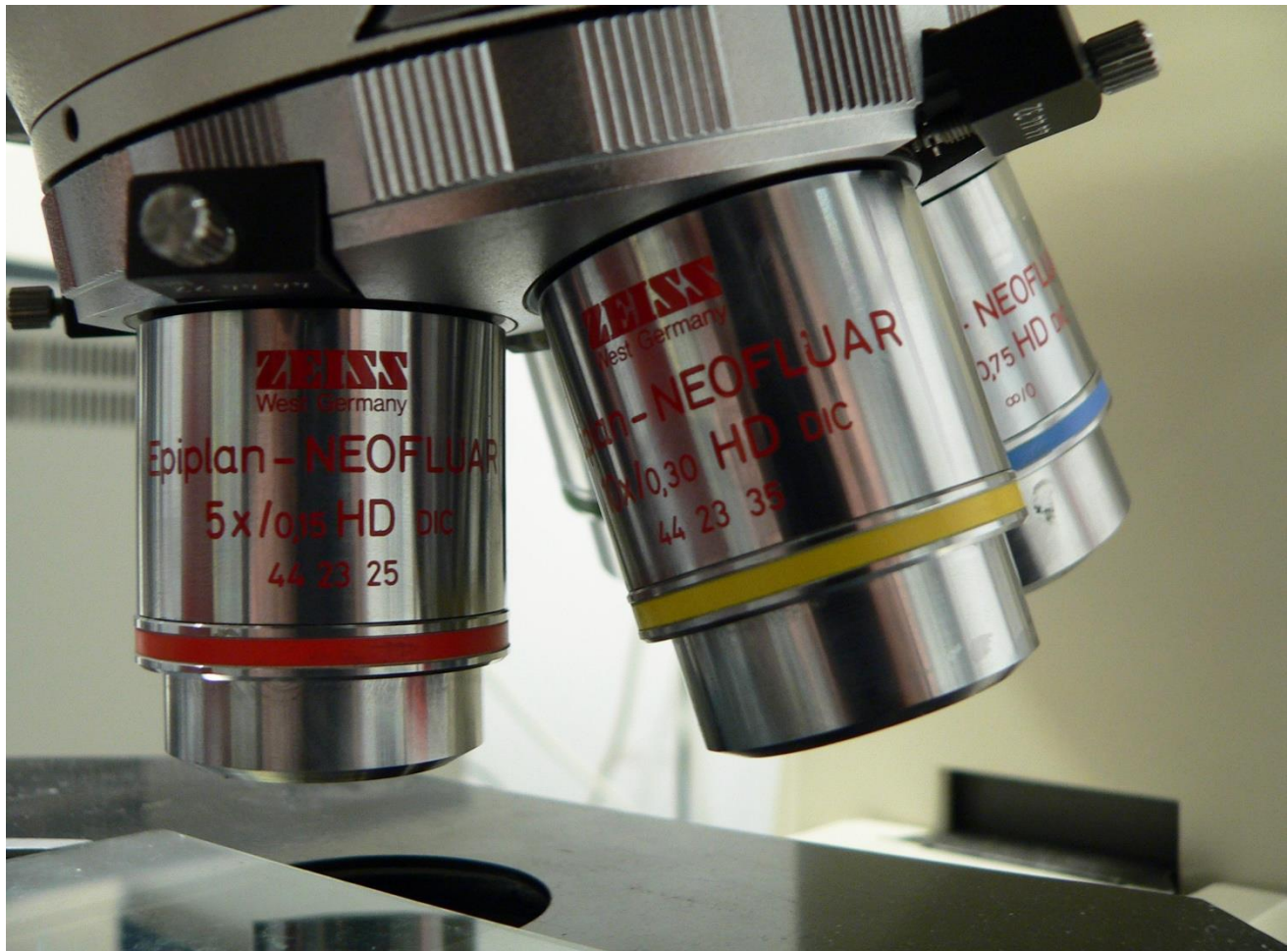
Optical microscope

▪ Summary

- That's your standard microscope. The official name is **optical microscope**. Also called a **light microscope**.
- The important parts are:
  - **1 – eye piece**. You can spread these apart so they line up with your eyeballs.
  - **3 – objective lenses**. There are usually 4 lenses – you can see two of them clearly in the photo, the others are obscured. You rotate the **turret (2)** to pick the lens with the magnification you want – 4x, 10x, 40x, 100x.
  - **4 / 5 – course focus** and **fine focus**. You turn these knobs to get a focused image.
  - **6 – stage**. The specimen is placed here on a glass slide. That means somebody took some tissue – could be human, could be a grasshopper, could be a leaf – froze it, sliced it with a very expensive mechanical knife called a microtome, then carefully laid that slice on the glass slide. Then the tissue is covered with a very thin, fragile bit of glass called a coverslip. The coverslip ensures the tissue actually stays in place on the glass slide, and of course protects the tissue for future generations of nerds.
  - **7 – light bulb**. The light shines upwards → *through* the specimen → into the objective lens (that magnifies it) → into the eyepieces → into your eyeball. This is why it's called a 'light'

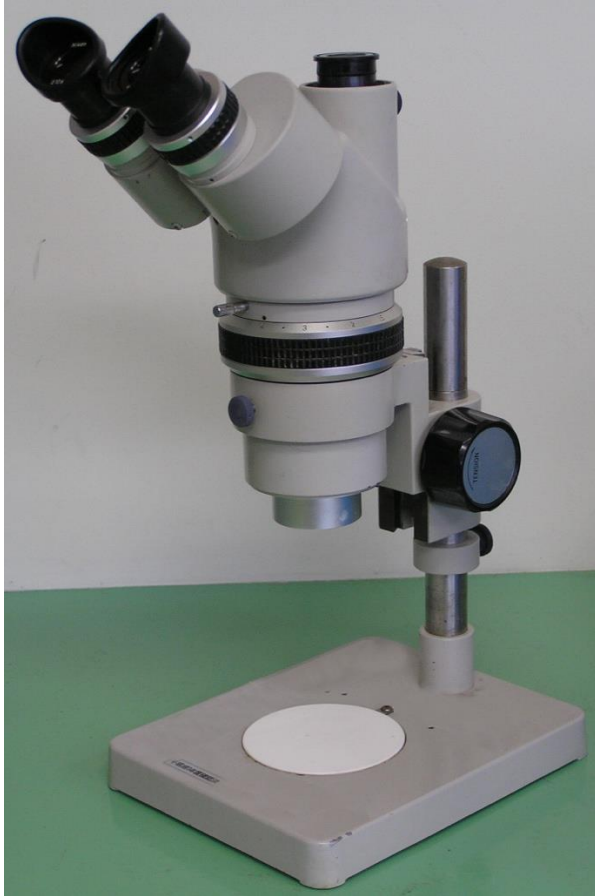
microscope. And this is why you need very thin slices of tissue, in order for light to pass through them.

- Can you see bacteria with a light microscope? Yes.
  - Can you see viruses with a light microscope? No. They are too small. You might find one exception out there but it would be some super expensive optical microscope and some really large virus, but even then it would be a crappy image. You need an electron microscope to see viruses.
- Source
- [https://en.wikipedia.org/wiki/Optical\\_microscope](https://en.wikipedia.org/wiki/Optical_microscope)



Those are **objective lenses**. **Zeiss** is a German company that specializes in optics.

- [https://en.wikipedia.org/wiki/Objective\\_\(optics\)](https://en.wikipedia.org/wiki/Objective_(optics))



That's a **stereo microscope**. You don't have to slice anything up. You can put whatever you want on the stage (the white circle) so long as it fits. Could be a caterpillar, a dollar bill, or just look at your own cuticles (which look like a crazy sand dune).

- [https://en.wikipedia.org/wiki/Stereo\\_microscope](https://en.wikipedia.org/wiki/Stereo_microscope)



That's a **US Customs agent** looking at a passport with a **stereo microscope**. The red circle on the passport says *El Salvador*.

- [https://en.wikipedia.org/wiki/Optical\\_microscope](https://en.wikipedia.org/wiki/Optical_microscope)

## Bacterial super-infection during the 1918 Influenza virus pandemic

*Predominant Role of Bacterial Pneumonia as a Cause of Death in Pandemic Influenza: Implications for Pandemic Influenza Preparedness*

### o Summary

- This important paper, co-authored by **Dr. Anthony Fauci**, showed that the lungs of the victims of the **1918 Influenza virus** were 'super-infected' by **bacteria**.
- **Figure 1** is photographs of the lung tissue of 4 deceased victims from 1918. It is not gross.
  - It's alot easier to recognize what's going on if you've already taken a course in medical school called **Histology** (the study of body tissues under the microscope).
  - 🖐️ Nevertheless ... if you zoom in on **Photograph B** you'll see hundreds of purple dots. Those are round **white blood cells** calls **neutro-phils** ("new trow" – trow rhymes with crow – "fills"). Their job in life is to kill bacteria. But in the case of these 1918 victims, they were so overwhelmed by bacteria that they died of **Bacterial Pneumonia**.

### o Verbatim

- We reviewed **hematoxylin** and **eosin**-stained slides recut from blocks of lung tissue obtained during autopsy from 58 influenza fatalities in 1918–1919. These materials, sent during the pandemic from various United States military bases to the **National Tissue Repository** of the **Armed Forces**

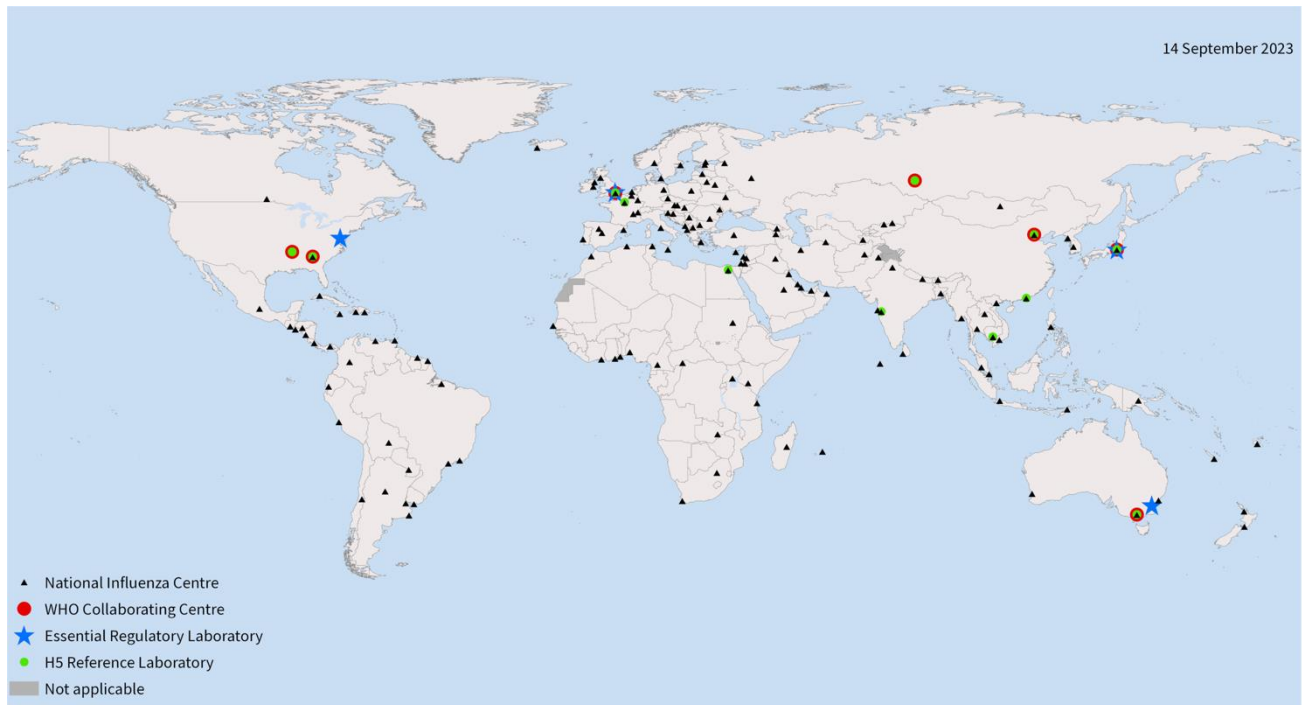
Institute of Pathology [8-10], represent all known influenza cases from this collection for which lung tissue is available.

- Translation
  - **Hematoxylin** (“heme ah tox ah lin”) is a purple dye.
  - **Eosin** (“ee oh sin”) is a pink dye.
  - They are used to stain tissues so they can be identified under a microscope.
  - Microscopes are a vital tool in medicine.
- Source
  - The Journal of Infectious Diseases
    - Volume 198, Issue 7, Pages 962–970
    - 1 October 2008
    - This version of the paper shows the cover design for that issue.
      - <https://academic.oup.com/jid/article/198/7/962/2192118>
    - This version is more readable because the font and tables are bigger.
      - <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2599911/>
- Authors
  - David M. Morens, MD
  - Jeffery K. Taubenberger, MD PhD
  - Anthony S. Fauci, MD
    - National Institute of Allergy and Infectious Diseases, National Institutes of Health, Bethesda, Maryland

## Preparation for Influenza pandemics

### Global Planning

- Summary
  - This is an overview of how the CDC plans for an Influenza virus pandemic.
  - There are links to World Health Organization (WHO) planning.
- Source
  - CDC
    - <https://www.cdc.gov/flu/pandemic-resources/planning-preparedness/global-planning.html>



The designations employed and the presentation of the material in this publication do not imply the expression of any opinion whatsoever on the part of WHO concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted and dashed lines on maps represent approximate border lines for which there may not yet be full agreement.

Data source: WHO Global Influenza Programme  
 Map creation date: 21 September 2023  
 Map production: WHO Global Influenza Programme



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## Global Influenza Surveillance and Response System (GISRS)

### Summary

- GISRS (“giz riz”) is the Global Influenza Surveillance and Response System that is operated by the World Health Organization (WHO). It is composed of 143 National Influenza Centers (the black triangles in the map above) in 114 countries. The people who work at the WHO are switched on and keep us alive. Seriously.
- If you think it’s all a giant conspiracy then take a time machine back to the year 1000 BC where you will die by the age of 35. Now come back to the present where thousands of people have jobs that ensure you live to 80.
- FluNet and FluID are data repositories.
- They helped out during Covid.
- There is a cutesy but informative 2-minute animation on how things are coordinated.

### Source

- World Health Organization (WHO)
  - Thanks for the map!
  - <https://www.who.int/initiatives/global-influenza-surveillance-and-response-system>
    - The map above is on this page. 🖱️ You can click on it and zoom in.
  - [https://www.who.int/multi-media/details/the-global-influenza-surveillance-and-response-system-\(gisrs\)](https://www.who.int/multi-media/details/the-global-influenza-surveillance-and-response-system-(gisrs))
    - Cutesy video.

# Pages 25 to 27 – Alaska road trip & reconstruction of the 1918 virus by the CDC

## Reconstruction of the 1918 Influenza virus

### *The Deadliest Flu: The Complete Story of the Discovery and Reconstruction of the 1918 Pandemic Virus*

- Summary
  - This is a super-cool article – all on one page you can scroll – on how the **1918 influenza virus** was recovered and reconstructed by the CDC.
  - There are **historical photos** of:
    - **Brevig Mission, Alaska.**
    - **Dr. Johan Hultin** and colleagues at the **permafrost gravesite.**
    - **Dr. Jeffery Taubenberger** and **Dr. Ann Reid** doing **genetics research.**
    - **Dr. Peter Palese** who made the **plasmids.**
    - **Dr. Terrence Tumpey** in a **BSL-3 lab.**
- Source
  - **CDC Archive**
    - <https://archive.cdc.gov/#/details?url=https://www.cdc.gov/flu/pandemic-resources/reconstruction-1918-virus.html>
- Authors
  - **Douglas Jordan**
  - **Terrence Tumpey**
  - **Barbara Jester**

### *Discovery and characterization of the 1918 pandemic influenza virus in historical context*

- Summary
  - **More history from the people directly involved with the resurrection of the virus.**
- Source
  - **Antiviral Therapy**
    - 12:581–591
    - 2007
    - <https://pubmed.ncbi.nlm.nih.gov/17944266/>
- Authors
  - **Jeffery K Taubenberger, MD PhD**
  - **Johan V Hultin, PhD**
  - **David M Morens, MD**
    - **National Institute of Allergy and Infectious Diseases, National Institutes of Health, Bethesda, MD, USA**





DC-3


- This airplane has 2 propellers.
- The 14 cylinders of the engine are arranged in a circle a.k.a. **radial engine**.

- [https://en.wikipedia.org/wiki/Douglas\\_DC-3](https://en.wikipedia.org/wiki/Douglas_DC-3)
- [https://en.wikipedia.org/wiki/Pratt\\_%26\\_Whitney\\_R-1830\\_Twin\\_Wasp](https://en.wikipedia.org/wiki/Pratt_%26_Whitney_R-1830_Twin_Wasp)

## Page 28 – Recap

### *The Deadliest Flu: The Complete Story of the Discovery and Reconstruction of the 1918 Pandemic Virus*

#### ○ Summary

- This paper was already mentioned on page 24.
- This paper is now archived so you can't tell how far along you are when scrolling. Whatever.
-  Scroll down about 4 pages. There are 2 photos of lung tissue.
  - The **top photo** (image **a**) is a mouse lung infected with a *standard influenza virus*. The lung tissue looks pretty normal.
  - The **bottom photo** (image **c**) is a mouse lung infected with the *reconstructed 1918 influenza virus*. The mouse's lungs are packed with white blood cells (**neutro-phils**) attempting to fight a bacterial superinfection. Honestly, I can't quite tell but they might be **lympho-cytes** whose job in life is to fight viruses. Someone smarter than me knows the answer.

#### • Verbatim

- The fully reconstructed 1918 virus was striking in terms of its ability to quickly replicate, i.e., make copies of itself and spread infection in the lungs of infected mice. For example, four days after infection, the amount of 1918 virus found in the lung tissue of infected mice was **39,000 times higher** than that produced by one of the comparison recombinant flu viruses.
- The 1918 virus was extremely virulent. **Image a)** shows mouse lung tissue infected with a human seasonal H1N1 flu virus. **Image c)** shows the impact of the 1918 virus in mouse lung tissue. The 1918 virus replicates quickly and causes severe disease in the lung tissues of mice. In 1918, the virus caused severe disease in the lungs of people infected, as well.

#### • Source

- **CDC Archive**
  - <https://archive.cdc.gov/#/details?url=https://www.cdc.gov/flu/pandemic-resources/reconstruction-1918-virus.html>

#### • Authors

- **Douglas Jordan**
- **Terrence Tumpey**
- **Barbara Jester**

**Page 29 – Points of clarity  
for people obsessed with  
details**

## 1968 Hong Kong flu

### 1968 Pandemic (H3N2 virus)

- Summary
  - **1968 Pandemic** is the official name used by the CDC. **Hong Kong Flu** is the casual name.
  - The first sentence is technical but the rest is readable.
- Source
  - CDC
    - <https://www.cdc.gov/flu/pandemic-resources/1968-pandemic.html>

### Hong Kong Flu

- Summary
  - **Hong Kong flu** is not the official name.
  - This reads nicely and will get you started.
- Source
  - Wikipedia
    - [https://en.wikipedia.org/wiki/Hong\\_Kong\\_flu](https://en.wikipedia.org/wiki/Hong_Kong_flu)

## Avian (Bird) Flu

### Information on Bird Flu

- Summary
  - The **Avian flu virus** prefers birds but can from time to time infect humans.
- Verbatim
  - Avian influenza refers to the disease caused by infection with avian (bird) influenza (flu) Type A viruses. These viruses occur naturally among wild aquatic birds worldwide and can infect domestic poultry and other bird and animal species. Avian flu viruses do not normally infect humans. However, sporadic human infections with avian flu viruses have occurred.
- Source
  - CDC
    - 14 June 2022
    - <https://www.cdc.gov/flu/avianflu/index.htm>

### Avian Influenza (Bird Flu)

- Summary
  - This article describes what happens when humans are ill with the **Avian influenza virus**. Is it wickedly confusing to call that **Bird Flu**? I vote, yes. I mean, doesn't 'Bird Flu' imply it's *birds* that are sick? Oh well, at least they admit it's a misleading term.
  - It's up to you, dear reader, to figure out if the authors mean an infection of birds or an infection of humans. But in this instance, it's clear it's humans because **Medscape** is a journal devoted to human disease.
- Verbatim
  - Avian influenza is a **slightly misleading** term, as influenza is among the natural infections found in birds. The term avian influenza used in this context refers to **zoonotic human infection** with an influenza strain that primarily affects birds.
- Translation

- **Zoonotic human infection** means this virus can jump from bird to human. That's what you get for living close to our feathered friends. See page 88 of *Hidden Zoo* for details.
- Source
  - Medscape
  - 3 October 2021.
  - <https://emedicine.medscape.com/article/2500029-overview>
- Author
  - **Nicholas John Bennett, MBBCh, PhD, FAAP**, MA(Cantab) Assistant Professor of Pediatrics, Co-Director of Antimicrobial Stewardship, Medical Director, Division of Pediatric Infectious Diseases and Immunology, Connecticut Children's Medical Center
- Co-authors
  - **Joseph Domachowske, MD** Professor of Pediatrics, Microbiology and Immunology, Department of Pediatrics, Division of Infectious Diseases, State University of New York Upstate Medical University
- Specialty Editor Board
  - **Francisco Talavera, PharmD, PhD** Adjunct Assistant Professor, University of Nebraska Medical Center College of Pharmacy; Editor-in-Chief, Medscape Drug Reference
- Chief Editor
  - **Michael Stuart Bronze, MD** David Ross Boyd Professor and Chairman, Department of Medicine, Stewart G Wolf Endowed Chair in Internal Medicine, Department of Medicine, University of Oklahoma Health Science Center; Master of the American College of Physicians; Fellow, Infectious Diseases Society of America; Fellow of the Royal College of Physicians, London

### Avian influenza

- Summary
  - Well, in this case, it's an article about the infection in birds. And what's the clue? The journal is the *Merck Manual - Vet Manual*. Plus, the author is a **vet (D.V.M. = Doctor of Veterinary Medicine)**.
  - **Merck** is a giant pharmaceutical company. There is a *Merck Manual* of human disease which is incredibly dense information all in one small but fattish book with tiny writing and parchment-like paper. It's a really cool book. It's very technical.
  - There is also the aforementioned book for animal diseases called the *Merck Manual – Veterinary Manual* (which I just call the *Merck Vet Manual*). It's a fabulous resource. It's quite technical but at the same time readable and understandable because it's very well written.
- Verbatim
  - Avian influenza (AI) is a viral infection of domestic poultry, and pet, zoo, and wild birds. In domestic poultry, AI viruses are typically of low pathogenicity (LP), causing subclinical infections, respiratory disease, or drops in egg production, but a few AI viruses are highly pathogenic (HP), causing severe systemic disease with multiple organ failure and high mortality.
- Source
  - **Merck Manual – Veterinary Manual**
    - Last modified October 2022
    - <https://www.merckvetmanual.com/poultry/avian-influenza/avian-influenza?query=avian%20influenza>
- Author
  - **Swayne, David E., DVM, PHD**. Southeast Poultry Research Laboratory.

## Swine (Pig) Flu

### Information on Swine/Variant Influenza

- Summary
  - If a **Pig flu virus** happens to infect a human it's called **variant flu virus**.

- Verbatim
  - When a flu virus that normally spreads in pigs but not people is found in a person, it is called a “variant flu virus.”
- Source
  - CDC
    - 30 June 2023
    - <https://www.cdc.gov/flu/swineflu/keyfacts-variant.htm>

### FLU CAN SPREAD BETWEEN PIGS AND PEOPLE

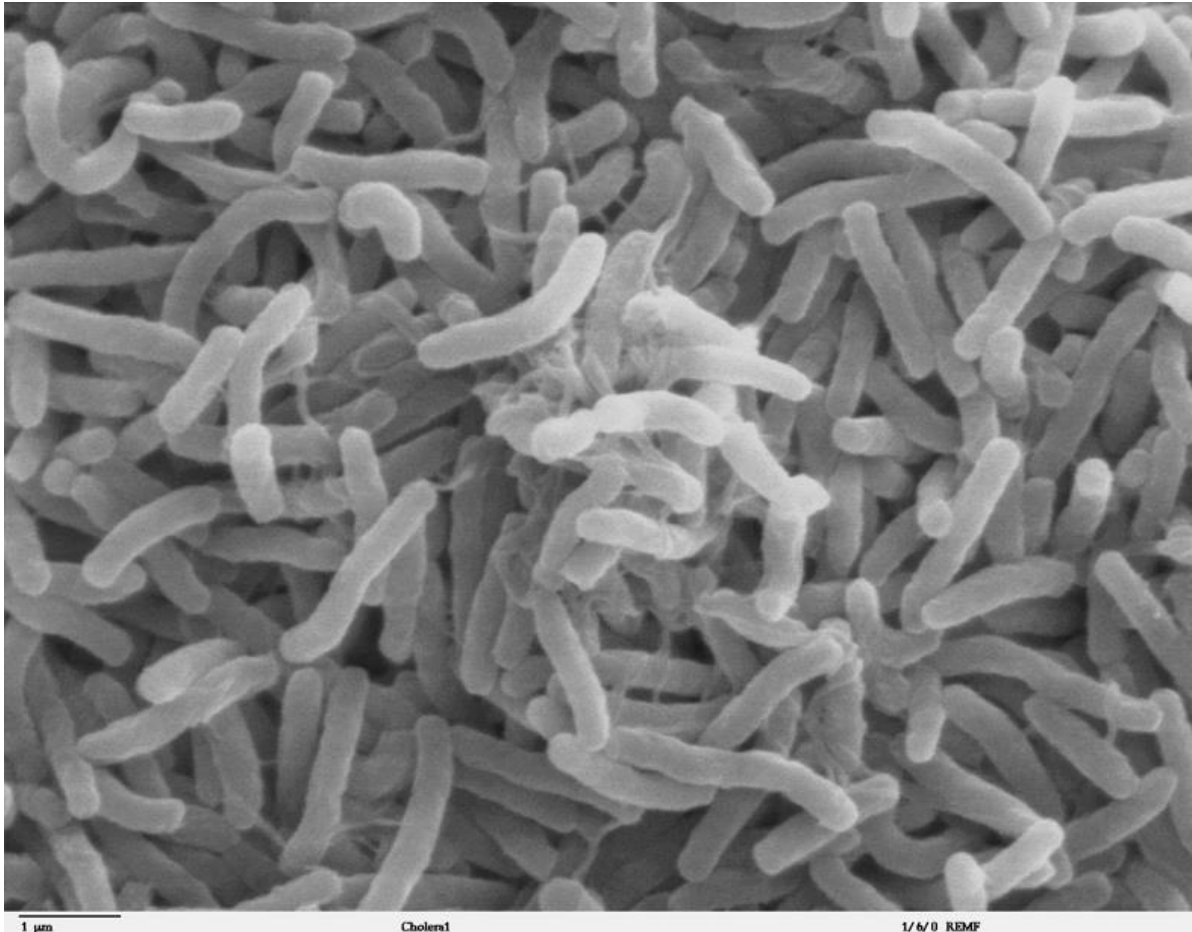
- Summary
  - This is an interesting infographic from the CDC and the US Department of Agriculture (USDA). I like the purple motif.
  - The dude in the purple hat kinda looks like Eminem and the farm girl in the purple plaid shirt kinda like Lana Del Rey ... but, um, I’m pretty sure they weren’t there.
- Source
  - CDC
  - USDA
  - <https://www.cdc.gov/flu/pdf/swineflu/transmission-between-pigs-people.pdf>

### Influenza A Virus in Swine

- Summary
  - Okay, the author is a vet and this is the *Merck Vet Manual* ... so this is about the illness in pigs.
  - What happens to the pig? Depression, anorexia (loss of appetite), fever, prostration (“pross tray shun”) (basically that means lying flat on the ground because of exhaustion), cough, shortness of breath, nasal discharge, and discharge from the eyes. No fun for the pig. Pig mortality 1 – 4%.
- Summary
  - Merck Manual – Veterinary Manual
    - October 2022
    - <https://www.merckvetmanual.com/respiratory-system/respiratory-diseases-of-pigs/influenza-a-virus-in-swine?redirectid=3839?ruleredirectid=30&query=swine%20influenza>
- Author
  - Montserrat Torremorell, DVM, PhD. College of Veterinary Medicine, University of Minnesota.

# Page 30 - Cholera #1 Death by Diarrhea

Cholera bacteria



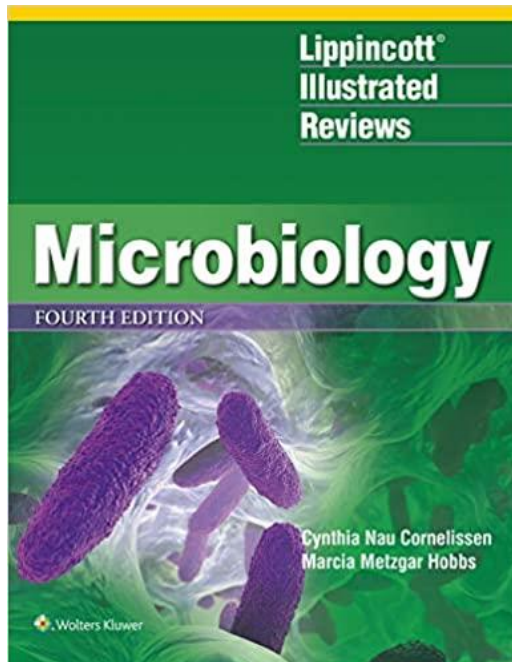
### *Vibrio cholera*

#### ○ Summary

- That's the **Cholera bacteria** a.k.a. *Vibrio cholera*.
- “Vib ree oh” “collar ah”
- It's the view from an electron microscope.
- See that obscure **scale bar** at the lower left? It's 1 micron ( $\mu\text{m}$ ) meaning 1/1000<sup>th</sup> of a milli-meter, meaning about 1/1000<sup>th</sup> of the width of this letter 'u.' Each **bacterium** (singular) is about 1  $\mu\text{m}$  long.
- This tiny bacteria kills you – well, more likely a 5-year old child in Africa – with the massive fluid loss due to the extreme diarrhea of Cholera.

#### • Source

- Wikipedia
  - [https://en.wikipedia.org/wiki/Vibrio\\_cholerae](https://en.wikipedia.org/wiki/Vibrio_cholerae)



### Lippincott's Illustrated Reviews: Microbiology, 4<sup>th</sup> Edition

- Summary
  - **Micro-biology** is the study of **micro-organisms** using a **micro-scope**. Sometimes the term **Medical Micro-biology** is used – the emphasis is on organisms that infect humans.
  - This book is really quite readable even if you've never taken a biology course in your life. You can get a really good understanding of the big picture of microbiology. Every single organism mentioned in *Hidden Zoo* is in the Lippincott book, and in significantly more detail.
  - This is not the book a specialist in infectious disease would use – it's too basic for them. But for the rest of us, it's a great book with ample detail.
- Time now for an important distinction:
  - **Microbiology**
    - **Microbiology describes the organisms.** How big are they? What do they look like? What nutrients do they need? Do they like sugar? Do they need oxygen? What environments are they found in, outside humans? What disease do they cause when inside humans?
  - **Infectious Disease**
    - **Infectious Disease (ID) doctors** figure out what organism is causing illness in a patient and then give the antibiotic that kills it. That's the basic picture.
    - See page 85 for details.
- Source
  - **LWW** (Lippincott Williams & Wilkins) (they are the book publisher)
    - 2019.
    - 448 pages.
    - Publisher website
      - <https://shop.lww.com/Lippincott--Illustrated-Reviews--Microbiology/p/9781496395856>
    - Amazon
      - [https://www.amazon.com/Lippincott-Illustrated-Reviews-Microbiology-dp-1496395859/dp/1496395859/ref=dp\\_ob\\_title\\_bk](https://www.amazon.com/Lippincott-Illustrated-Reviews-Microbiology-dp-1496395859/dp/1496395859/ref=dp_ob_title_bk)
- Authors
  - **Cynthia Nau Cornelissen PhD** (Editor)
  - **Marcia Metzgar Hobbs PhD** (Editor)

Cholera bacteria shape: rod versus curve

## A Periplasmic Polymer Curves *Vibrio cholerae* and Promotes Pathogenesis

- Summary
  - The curved shape of the *Cholera* bacteria aids in penetrating the wall of your intestines. This paper has ridiculous amounts of information on that process.
  - **The very first image ('Graphical Abstract')** is a drawing of the shape changing from rod to curved. The thing that looks like a tail is a **flagellum** ("flaj ell um") which has a whip-like movement that helps to propel the bacteria.
    - By the way, a human **sperm cell** also has a flagellum – that's why those sperm are such good swimmers.
  - **Figure 7 ('Models of Vibroid Curvature')** shows the bacteria *penetrating* the intestine and then *escaping*, meaning it exits in your diarrhea, ready to infect the next person who drinks untreated sewage water.
  - There are mathematical equations to calculate the growth rate.
- Source
  - Cell
    - **2017**
    - <https://www.sciencedirect.com/science/article/pii/S0092867416317354>
- Author
  - Thomas M. Bartlett <sup>1</sup>
  - Benjamin P. Bratton <sup>1 2</sup>
  - Amit Duvshani <sup>1</sup>
  - Amanda Miguel <sup>3</sup>
  - Ying Sheng <sup>4</sup>
  - Nicholas R. Martin <sup>1</sup>
  - Jeffrey P. Nguyen <sup>2</sup>
  - Alexandre Persat <sup>1 8</sup>
  - Samantha M. Desmarais <sup>3</sup>
  - Michael S. VanNieuwenhze <sup>5</sup>
  - Kerwyn Casey Huang <sup>3 6</sup>
  - Jun Zhu <sup>4 7</sup>
  - Joshua W. Shaevitz <sup>2</sup>
  - Zemer Gitai <sup>1 9</sup>
- Institution
  - What an interesting mix of expertise.
  - <sup>1</sup> **Department of Molecular Biology**, Princeton University, Princeton, NJ 08544, USA
  - <sup>2</sup> **Lewis-Sigler Institute for Integrative Genomics**, Princeton University, Princeton, NJ 08544, USA
  - <sup>3</sup> **Department of Bioengineering**, Stanford University, Stanford, CA 94305, USA
  - <sup>4</sup> **Department of Microbiology**, Nanjing Agricultural University, Nanjing 210014, China
  - <sup>5</sup> **Department of Chemistry**, Indiana University, Bloomington, Bloomington, IN 47405, USA
  - <sup>6</sup> **Department of Microbiology and Immunology**, Stanford University School of Medicine, Stanford, CA 94305, USA
  - <sup>7</sup> **Department of Microbiology**, Perelman School of Medicine, University of Pennsylvania, Philadelphia, PA 19104, USA

Just how many liters (or cups) of diarrhea are there per day?

### Summary

- The estimates for *Cholera* diarrhea range from 12 – 48 liters per day, which is 48 – 192 cups per day. The math is explained just below.

### Volume

- I have converted all data sources to liters and cups per day.
  - The metric system symbols are:



- **Liters** = L or l (that's a lower case L)
  - **milli-Liters** = mL or ml
- There are **4.2 cups** in **1 liter**. Let's just call it **4 cups** for easy math.
  - In other words, if you drink **4 cups** of **water**, that's **1 liter** of **fluid intake**.
  - And if **4 cups** of **diarrhea** comes out your bum, that's **1 liter** of **fluid loss**.

#### Diarrhea estimates for Cholera (from least to most):

##### **Cholera**

- Summary
  - **12 – 24 liters per day = 48 - 96 cups per day**
- Verbatim
  - In adults with severe cholera, the rate of diarrhoea may quickly reach 500-1000 mL/h, leading to severe dehydration.
- Source
  - The Lancet
    - The Lancet is a well-respected medical journal published in England.
    - **2004**
    - [https://www.thelancet.com/journals/lancet/article/PIIS0140-6736\(03\)15328-7/fulltext](https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(03)15328-7/fulltext)
    - This is only the abstract of the paper. I have the full paper, courtesy of the author. Thank you Dr. Sack!
- Author
  - **David Sack, MD** - Department of International Health, Johns Hopkins University Bloomberg School of Public Health, Baltimore, Maryland

##### **Cholera**

- Summary
  - **24 liters per day = 96 cups per day**
- Verbatim
  - Cholera-related diarrhea comes on suddenly and can quickly cause dangerous fluid loss – as much as a quart (about 1 liter) an hour.
- Source
  - **Mayo Clinic**
    - <https://www.mayoclinic.org/diseases-conditions/cholera/symptoms-causes/syc-20355287>
- Author
  - Mayo Clinic Staff

##### **Cholera**

- Summary
  - **24 liters per day = 96 cups per day**
- Verbatim
  - **Few diseases give a clinical presentation as arresting as that of cholera. Massive watery diarrhea, up to 1 liter per hour, can lead to hypotensive shock and death within hours of the first symptom ("cholera gravis").**
- Source
  - The Lancet
    - 2013
    - <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3761070/>
- Author
  - **Jason B. Harris**,<sup>1,2,\*</sup>
  - **Regina C. LaRocque**,<sup>1,3,\*</sup>
  - **Firdausi Qadri**,<sup>4,\*</sup>
    - This author is from **Bangladesh**, where there is lots of Cholera. The other authors are from **Boston**, where there is no Cholera. Just sayin'.

- Edward T. Ryan,<sup>1,3,5,\*</sup>
- Stephen B. Calderwood<sup>1,3,6,\*</sup>
- Institution
  - <sup>1</sup>Division of Infectious Diseases, [Massachusetts General Hospital](#), Boston, MA
  - <sup>2</sup>Department of Pediatrics, [Harvard Medical School](#), Boston, MA
  - <sup>3</sup>Department of Medicine, [Harvard Medical School](#), Boston, MA
  - <sup>4</sup>International Centre for Diarrhoeal Disease Research, [Dhaka Bangladesh](#)
  - <sup>5</sup>Department of Immunology and Infectious Diseases, [Harvard School of Public Health](#), Boston, MA
  - <sup>6</sup>Department of Microbiology and Immunobiology, [Harvard Medical School](#), Boston, MA
  - \*All authors contributed equally to this work

### Cholera

- Summary
  - 25 liters per day = 100 cups per day
- Verbatim
  - A patient can lose up to 25 litres of fluid per day.
- Source
  - [Médicin Sans Frontiers \(MSF\)](#) a.k.a. [Doctors Without Borders](#).
    - <https://www.msf.org/cholera>

### Cholera toxin – A foe & a friend

- Summary
  - 48 liters per day = 192 cups per day
- Verbatim
  - The combined effect produces vast fluid loss from the intestine, in extreme cases up to 2 liters per hour. (page 158, 2<sup>nd</sup> column, 1<sup>st</sup> paragraph)
- Source
  - Indian Journal of Medical Research
    - 2011
    - <https://web.archive.org/web/20130203143806/http://icmr.nic.in/ijmr/2011/february/0204.pdf>
    - This is reference no. 12 in Wikipedia. [https://en.wikipedia.org/wiki/Cholera\\_toxin](https://en.wikipedia.org/wiki/Cholera_toxin)
- Author
  - [Joaquín Sánchez](#)
    - Facultad de Medicina, UAEM, Av Universidad, Col. Chamilpa, Mexico
  - [Jan Holmgren](#)
    - University of Gothenburg Vaccine Research Institute (GUVAX) & Department of Microbiology and Immunology. The Sahlgrenska Academy at University of Gothenburg, Gothenburg, Sweden.

## Cholera Toxin (CTX)

### Cholera toxin – A foe & a friend

- Summary
  - This paper was described immediately above.
  - This is an uber-detailed paper on the cholera toxin.
  - The toxin is a 'foe' because it harms humans.
  - The toxin is a 'friend' to scientists because it is useful in the laboratory as a:
    - **prototype entero-toxin**

- An entero-toxin is a toxin released by bacteria. It ends up in the intestines. The Greek word '*enteron*' means gut. So an entero-toxin is a gut toxin.
  - Scientists use the cholera toxin to model the effects of such toxins.
  - The word '*toxin*' is used so broadly, especially on the internet where you can buy products that claim to detoxify you, that it can lose its meaning. However, it has specific definitions in medicine and biology.
- **experimental adjuvant**
  - An **adjuvant** ("ah joo vant") is added to a vaccine to increase effectiveness.
  - **Figure 1** shows the molecular structure of the toxin.
- Source
  - See previous entry.

### Sambhu Nath De

- This man, a micro-biologist from India, discovered the **Cholera toxin** in **1959**.
- [https://en.m.wikipedia.org/wiki/Sambhu\\_Nath\\_De](https://en.m.wikipedia.org/wiki/Sambhu_Nath_De)

## Cholera (the illness) – a global perspective

### Cholera

- Summary
  - This is the CDC home page on Cholera.
  - You can drown in information here. It's all well-written and understandable.
- Source
  - **CDC**
    - 30 October 2020
    - <https://www.cdc.gov/cholera/>

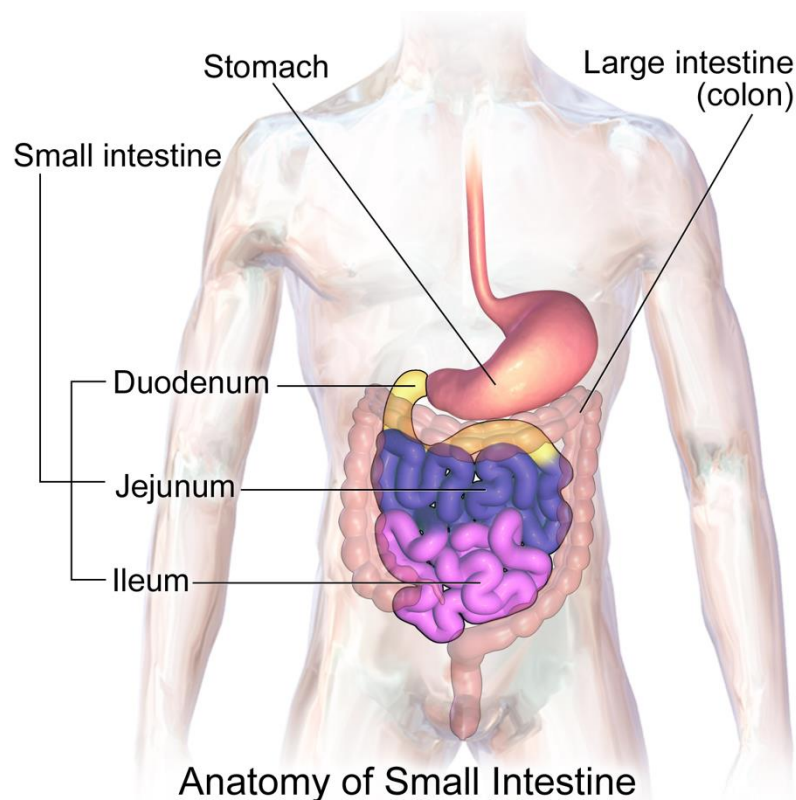
### Cholera in Africa

- Summary
  - There is a map of Cholera regions in **Sub-Saharan Africa (SSA)**.
  - It's not shaded so I guess it is not a **choropleth map**. (see page 2 of this bibliography).
- Source
  - **CDC**
    - 2 October 2020
    - <https://www.cdc.gov/cholera/africa/index.html>

### Cholera

- Summary
  - This was mentioned previously.
  - Tons of information. Very readable.
  - These **doctors** go to the most troubled regions in the world.
- Verbatim
  - It causes profuse diarrhea and vomiting which can lead to death by intense dehydration, sometimes within a matter of hours. Cholera is a serious risk in the aftermath of emergencies, like the cyclones that struck Mozambique in 2019, but can strike anywhere. The situation can be especially problematic in rainy seasons when houses and latrines flood and contaminated water collects in stagnant pools.
- Source
  - **Médecin Sans Frontiers (MSF) a.k.a. Doctors Without Borders**.
    - <https://www.doctorswithoutborders.ca/cholera>

## Bowel length - overview



Okay, the **small intestine** is small, as in **narrow**. The **large intestine** is large, as in **wide**. The terms 'small' and 'large' do not refer to length. So get that straight in your head before reading more.

- [https://en.wikipedia.org/wiki/Small\\_intestine](https://en.wikipedia.org/wiki/Small_intestine)

### Dead or alive?

- It's easy to measure the length of the intestines of a dead person. It's exceptionally difficult to measure the length in a living person because they don't just uncoil like a garden hose; they are clothed in something called the mesentery that keeps them in a fairly loopy arrangement.
- Secondly, the intestines of an alive person are ... drum roll please ... alive. That means the muscles in the wall of the intestines are actively contracting, propelling food along, so of course they will be shorter than if measured in a dead person in whom they can be quite easily stretched.
- Thirdly, when we open up the abdominal cavity of a person it's not just for fun. It's because they have a surgical problem, and quite often there is a kind of reactive scar tissue present called **adhesions** that glom onto the intestines. Now it's even harder to estimate length. In fact, these adhesions can glue things together so badly that they squish the small intestines and block them ... that's called a **Small Bowel Obstruction**. Sometimes it resolves on its own. But if it's recurrent (keeps happening), then a surgeon probably will have to cut out the bad bits ... that's called a **Small Bowel resection**.

### Thinking in metric

- **1 meter = 3 feet, 3 inches**. So 3 feet is close enough for a rough estimate.

- If you want precision, Google this: *1 meter to feet and inches*.

### Yardstick vs Meterstick

- See the drawing on page 52 of *Hidden Zoo*.

## Bowel length in a living person

### Conversation

- **Me (surgical assistant):** "How long is the small intestine?"
- **Surgeon:** "Three meters."
- **Me (surgical assistant):** "And how long is the large intestine?"
- **Surgeon:** "One meter."
- This shall be the final answer, as *she* handles the intestines in the operating room. If anyone knows, *she* does.
- That conversation took place in OR7 (Operating Room #7) at Surrey Memorial Hospital in Metro Vancouver in the summer of 2023.
- By the way, in a bibliography or footnote, ***pers comm*** means a *personal communication* between the author (me, in this case) and some expert (the surgeon).

### Conversation – three months later with a different surgeon

- **Me (surgical assistant):** "How long is the small intestine?"
- **Surgeon:** "Six to seven meters."
- **Me (surgical assistant):** "And how long is the large intestine?"
- **Surgeon:** "Two meters."
- Or shall this be final answer? ... as *he* handles the intestines in the operating room. If anyone knows, *he* does.

For my drawing I used 3 meters (approximately 10 feet) for the small intestine, and 1.5 meters (approximately 5 feet) for the large intestine. Total 15 feet.

## Bowel length in a dead person

### *Are Intestines Really 20 Feet Long??? Let's Measure Them!!*

- Summary
  - **GROSS** video of real intestines from a dead person.
- Source
  - **Institute of Human Anatomy**
    - This is a 15-minute **YouTube** video. Charming in its own way.
    - <https://www.youtube.com/watch?v=Mtgi8mls5e4>

### *Anatomical study of the length of the human intestine*

- Summary
  - The intestines from 200 cadavers were measured and the total length (small intestine plus large intestine) was **8 meters (26 feet)**. Plus or minus 1.3 meters (4 feet).
  - Remember, cadavers are not living. So the most accurate answer will come from the living.
- Verbatim

- Although preoperative assessment of the length of the intestine may be of interest to avoid postoperative consequences of large intestinal resection, measurements of the intestine are quite rare and results variable in the literature. This anatomical study aimed to assess the length of the different intestinal segments, their variation and their correlation with sex, age, weight and height. Two hundred non-fixed adult cadavers (100 men, 100 women) who willingly gave their bodies for scientific purposes were studied. **The post mortem average length of the whole intestine was 795.5+/-129 cm** and was significantly longer in men and in young subjects. It was correlated with the subject's weight but not height. Multivariate analysis demonstrated that the factor showing the strongest correlation with intestinal length was body weight. This latter parameter may be useful in the preoperative assessment of intestinal length.
- Translation
  - **Post-mortem** means after-death.
- Source
  - Surgical and Radiologic Anatomy
  - December 2002
  - <https://pubmed.ncbi.nlm.nih.gov/12497219/>
- Authors
  - G Hounnou, C Destrieux, J Desmé, P Bertrand, S Velut
  - Laboratoire d'Anatomie, Faculté de Médecine, 2 bis, boulevard Tonnelé, 37032 Tours cedex, France.

### Short Bowel Syndrome: Practical Approach to Management

- Verbatim
  - **Postmortem measurements of small bowel length are generally about a meter longer as the bowel is easily stretched.**
- Source
  - *Short Bowel Syndrome: Practical Approach to Management*
    - 2016
    - CRC Press
    - Page 31
    - ISBN 9781498720809
    - [https://books.google.ca/books?id=GBhjDAAAQBAJ&pg=PA31&redir\\_esc=y#v=onepage&q&f=false](https://books.google.ca/books?id=GBhjDAAAQBAJ&pg=PA31&redir_esc=y#v=onepage&q&f=false)
    - This is reference no. 3 in Wikipedia – Small Intestine. [https://en.wikipedia.org/wiki/Small\\_intestine](https://en.wikipedia.org/wiki/Small_intestine)
- Author
  - DiBaise, John K
  - Parrish, Carol Rees
  - Thompson, Jon S

### Small/Large Intestine Length Ratio



- Summary
  - I'm pretty sure this is from a cadaver (dead person).
- Verbatim
  - **In humans, the small intestine is about 6 meters or 20 feet long and the large intestine is about 1.5 meters or 5 feet long.**
- Source
  - The Center for Academic Research and Training in Anthropogeny (CARTA)
    - <https://carta.anthropogeny.org/moca/topics/smalllarge-intestine-length-ratio>

I was going to make a table to summarizing the results ... but it's Friday evening and I am going to watch the finals of a bouldering competition ... so you do it ... it will be more instructive!

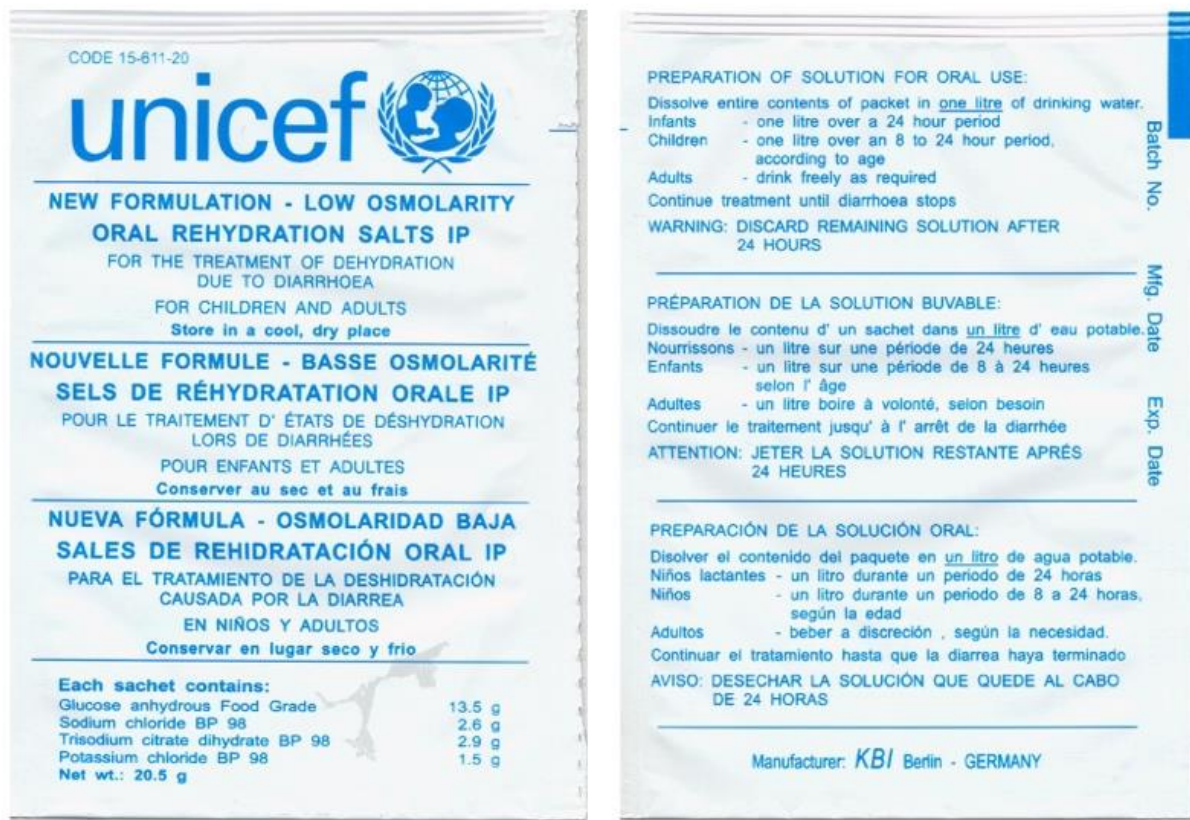
# Page 31 – Cholera #2 Soho

## Epidemics of Cholera

### List of epidemics

- Summary
  -  Go to the second table and click on the 'Disease' column. Then scroll down in that same column so you can see a chronological list of Cholera epidemics.
  -  If you are curious about a particular epidemic, say the 2001 epidemic of Cholera in Nigeria, then go sideways to the last (6<sup>th</sup>) column and click on the link to information about it.
  - You can't beat Wikipedia for tables that easily show the data however you like it.
- Source
  - [https://en.wikipedia.org/wiki/List\\_of\\_epidemics](https://en.wikipedia.org/wiki/List_of_epidemics)

## Treatment of Cholera



## UNICEF

- Summary
  - Those little white packages with blue writing contain **Oral Rehydration Salts (ORS)**.
  - They are provided by **UNICEF (United Nations Children's Fund)** to treat **Cholera**. Think, children in **Africa**.
- Source
  - <https://en.wikipedia.org/wiki/UNICEF>
    - The photo of the packages is from here.
    - There's also a photo of **Lionel Messi** with the UNICEF logo on his FC Barcelona jersey.

## Oral Rehydration Salts (ORS) - A New Reduced Osmolarity Formulation

- Summary
  - **What's in the package?**
    - glucose (sugar)
    - sodium chloride (NaCl)
    - potassium chloride (KCl)
    - citrate
  - It is called 'oral' because it goes in your mouth, that is, you swallow it.
  - It is **re-hydration** since you're suffering from severe **de-hydration**.
  - **Osmo-larity** ("oz mow" – mow rhymes with low – "la rit ee") is a unit of concentration in chemistry.
- Source
  - [unicef \(United Nations Children's Fund\)](#)
  - <http://www.rehydrate.org/ors/who-unicef-statement.html>



### Cholera

- Summary
  - Oral Cholera Vaccines (OCV) are described.
- Source
  - World Health Organization (WHO)
    - 30 March 2022
    - <https://www.who.int/news-room/fact-sheets/detail/cholera>

### Interactive guide to a Cholera treatment center

- Summary
  - This is a drawing of a Cholera treatment center showing stuff like observation tents, hospitalization tents, and recovery tents. 🖐️ You can click on the parts.
- Source
  - Médecin Sans Frontiers (MSF) a.k.a. Doctors Without Borders
    - Will you find these doctors in regions stricken with Cholera? Yes.
    - <https://www.msf.org/interactive-guide-msf-cholera-treatment-centre>
      - Hmm ... this links no longer works. Well, if you find it, let me know svp.

### Making Water Safe in an Emergency

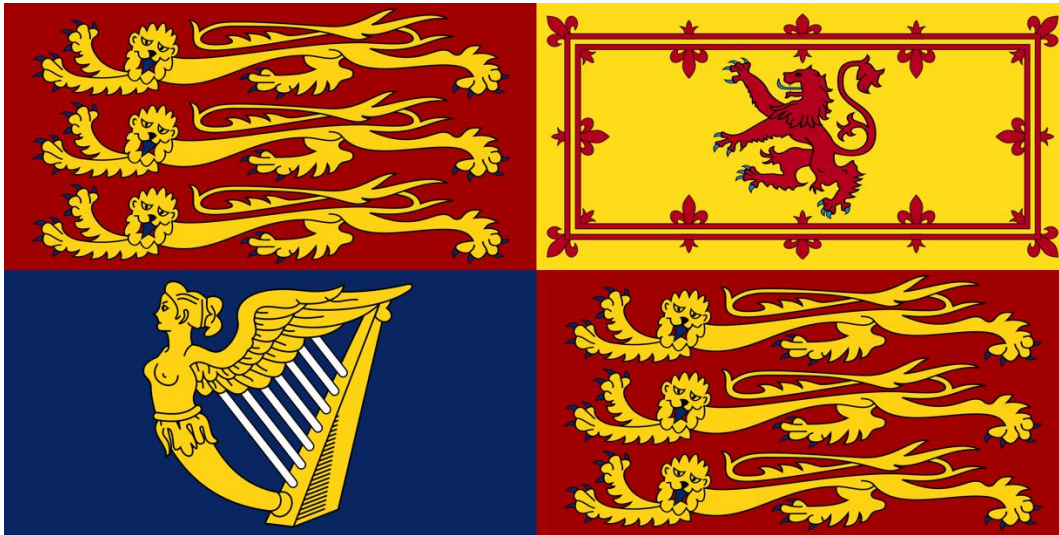
- These are **water safety guidelines** from the CDC.
- <https://www.cdc.gov/healthywater/emergency/making-water-safe.html>

## Flags of the UK



### Union Jack

- Summary
  - That's your standard flag of jolly old England.
  - It may be flown at half-mast if there is a tragedy.
- Source
  - Wikipedia
    - [https://en.wikipedia.org/wiki/Union\\_Jack](https://en.wikipedia.org/wiki/Union_Jack)



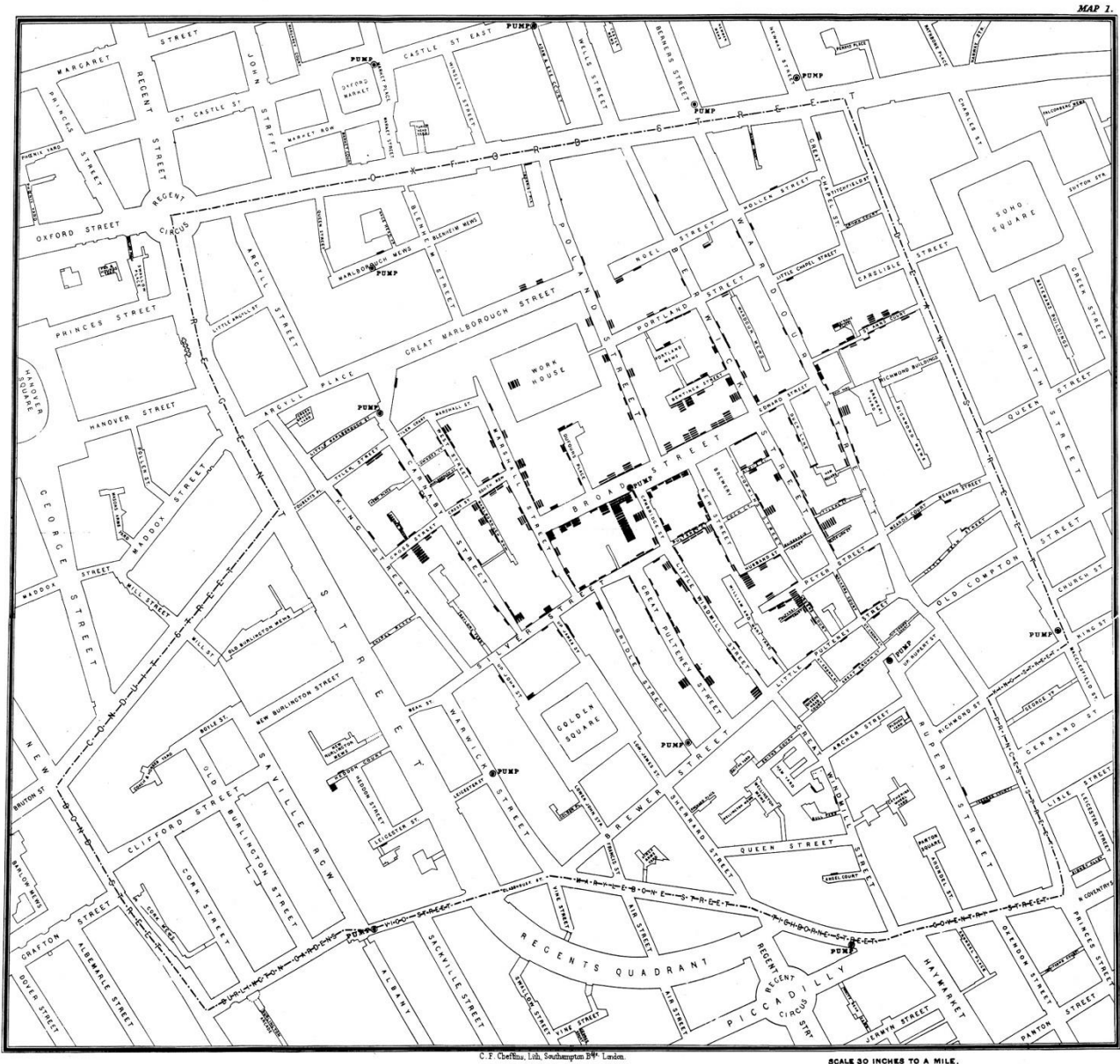
### Royal Standard of the United Kingdom

- Summary
  - This is flown at Buckingham Palace when the Queen (at the time I drew it) or King is at the palace.
  - It is never flown at half-mast.
  - This is the flag I drew but I could not fit in 7 lions and a topless angel.
- Source
  - [https://en.wikipedia.org/wiki/Royal\\_Standard\\_of\\_the\\_United\\_Kingdom](https://en.wikipedia.org/wiki/Royal_Standard_of_the_United_Kingdom)

### Flags

- Verbatim
  - When The Queen is in residence the Royal Standard is flown. Unlike the Union flag, the Royal Standard is never flown at half-mast.
- Source
  - Royal.uk
    - <https://www.royal.uk/flags>

**Maps**



### 1854 Broad Street cholera outbreak

- Summary
  - That's the original map of **Dr. John Snow** in 1854.
  - This map is 100% famous in **epidemiology** (the study of patterns of disease) because it literally shows the pattern of **Cholera** on the map.
  - If there is a single image that captures the essence of epidemiology, it is this map.
- Source
  - Wikipedia
    - [https://en.wikipedia.org/wiki/1854\\_Broad\\_Street\\_cholera\\_outbreak](https://en.wikipedia.org/wiki/1854_Broad_Street_cholera_outbreak)

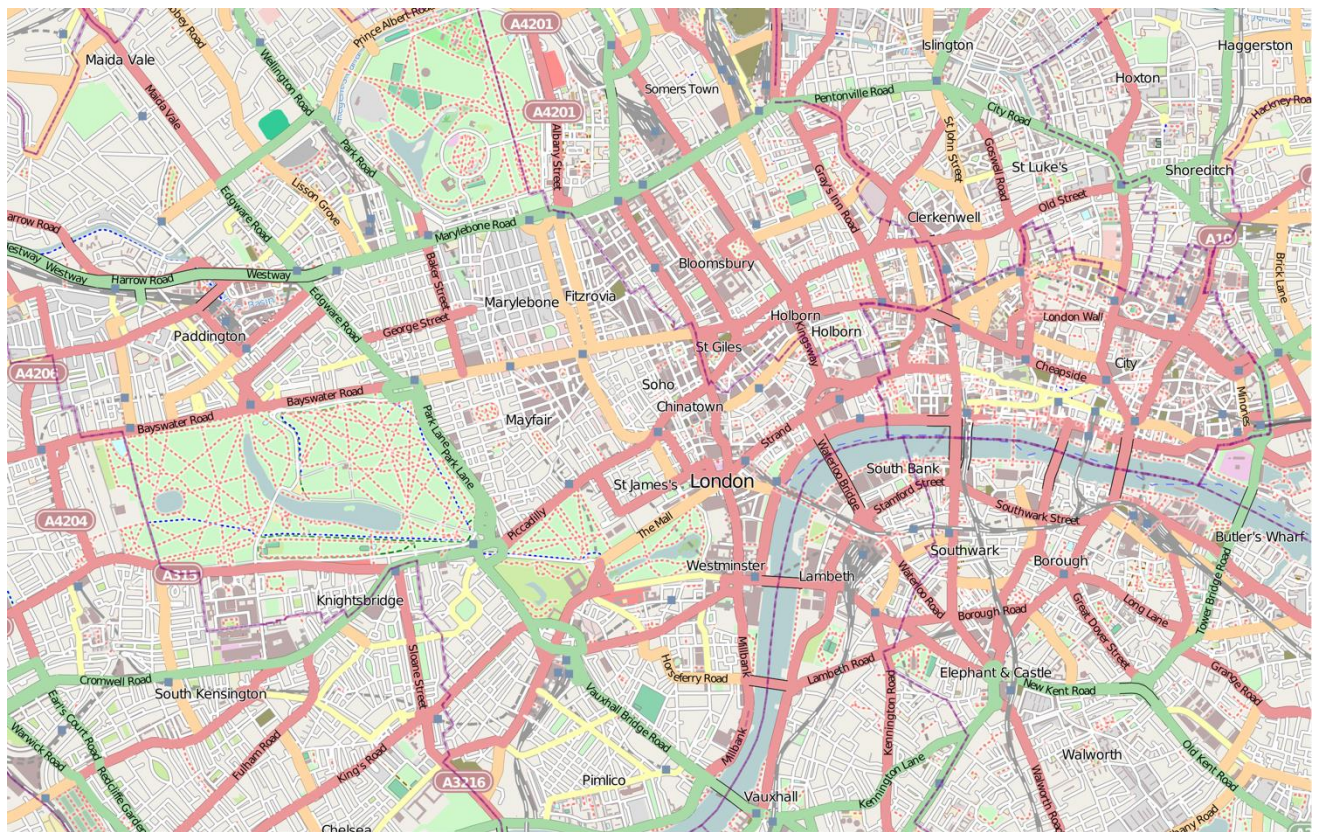
### John Snow's Cholera data in more formats

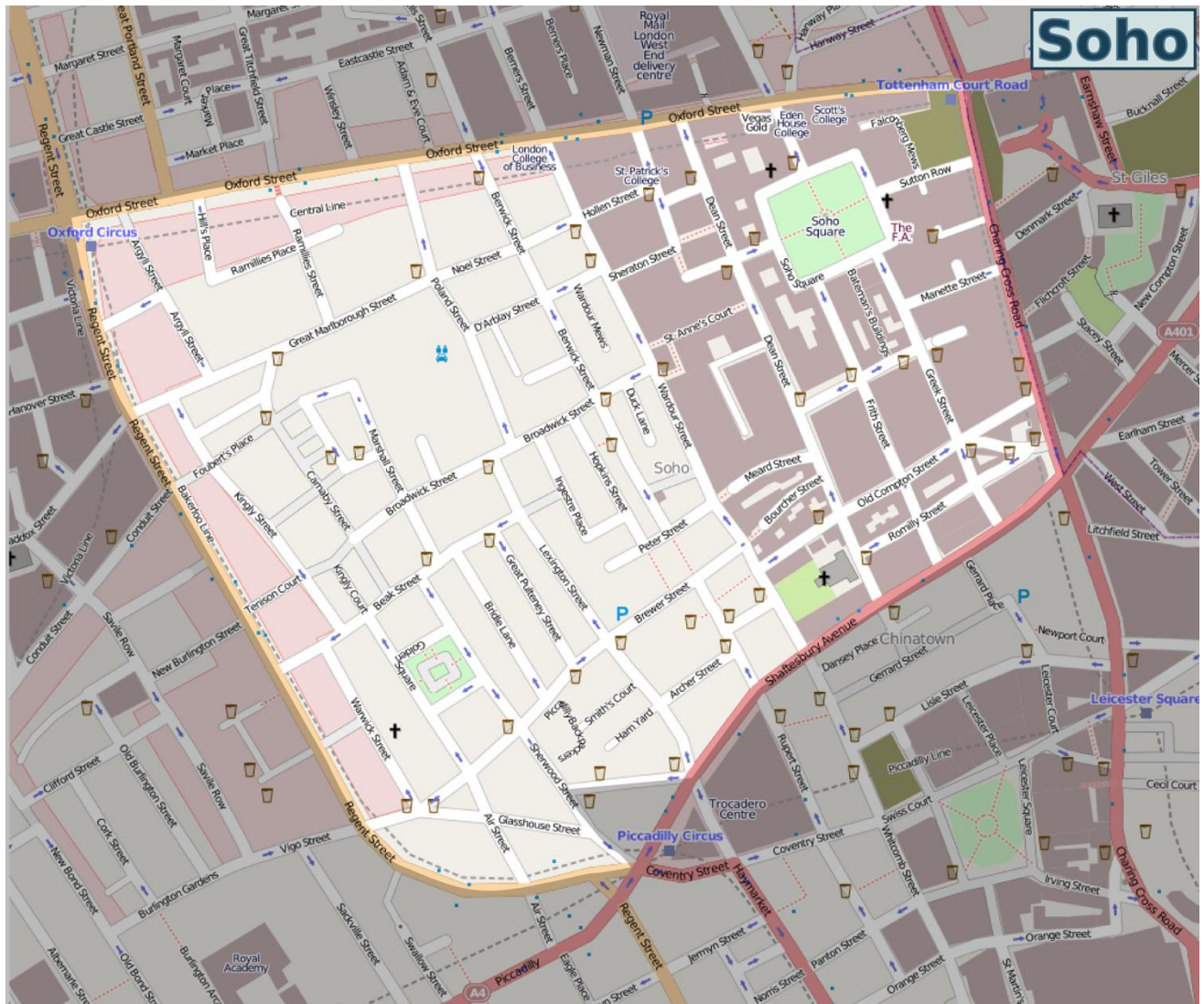
- Summary
  - This site digitizes the original map of Dr. Jon Snow and adds color for clarity.
- Source
  - **Robin's Blog**
    - 13 March 2013

- <https://blog.rtwilson.com/john-snows-cholera-data-in-more-formats/>

### John Snow and the 1854 Broad Street cholera outbreak

- **Summary**
  - In this 8-minute video, the Broad Street pump neighbourhood in London is explored.
- **Source**
  - **Harvard Online**
    - 19 April 2017
    - YouTube
    - <https://www.youtube.com/watch?v=INjrAXGRda4>



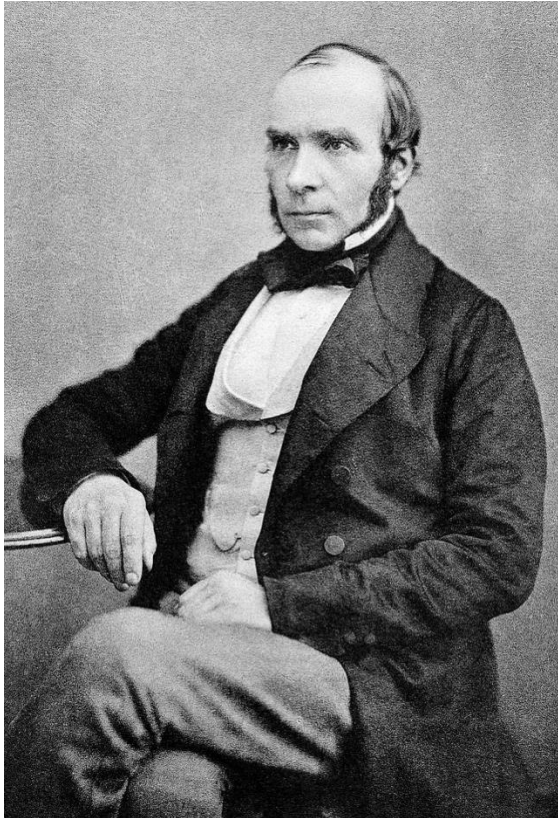


### Soho

- Summary
  - The top map is London. Soho is just a bit above where it says 'London' at dead center. The River Thames is also visible.
  - The bottom map is Soho. You culprit pump was at the intersection of Broadwick Street (formerly, Broad Street) and Lexington Street (formerly, Cambridge Street), in the center of the map.
- Source
  - Wikipedia
    - <https://en.wikipedia.org/wiki/Soho>

**Page 32 – Cholera #3 Jon Snow**

## John Snow & his sort-of-friends Jon, Florence, Filippo and Robert



### *John Snow*

- This is John Snow the doctor.
- The map is here, too.
- [https://en.wikipedia.org/wiki/John\\_Snow](https://en.wikipedia.org/wiki/John_Snow)

### *Jon Snow (Game of Thrones)*

- [Game of Thrones Wiki](#)
  - This is Jon Snow the warrior.
  - [https://gameofthrones.fandom.com/wiki/Jon\\_Snow](https://gameofthrones.fandom.com/wiki/Jon_Snow)

### *Game of Thrones*

- HBO. 8 seasons, 73 episodes.
- <https://www.hbo.com/game-of-thrones>



*Florence Nightingale*

- What an awesome photo. Her eyebrows are on the verge of a frown but her lips on the verge of a smile.
- [https://en.wikipedia.org/wiki/Florence\\_Nightingale](https://en.wikipedia.org/wiki/Florence_Nightingale)

### *Who First Discovered Cholera?*

- Summary
  - A short history lesson.
  - 1854 – There is a **Cholera** outbreak in **Florence**, Italy. **Filipo Pacini** discovers the bacteria **Vibrio cholera** and writes a paper, "*Microscopical observations and pathological deductions on cholera*" ... but it is completely ignored and **Dr. John Snow** in **Soho** has very likely never heard of the work either.
  - 1884 – **Robert Koch** independently discovers **Vibrio cholera** (and also the bacteria **Mycobacterium tuberculosis** that causes **Tuberculosis**) and gets the **Nobel Prize**.
- Source
  - **UCLA Department of Epidemiology – Fielding School of Public Health**
    - <https://www.ph.ucla.edu/epi/snow/firstdiscoveredcholera.html>
    - Safari says this site is no longer safe. Okey dokey.

## COVID-19 Dashboard

### *COVID-19 Dashboard*

- Summary
  - The **COVID-19 Dashboard** was a website that graphically displayed the spread of **COVID** cases globally. Think of it as John Snow's cholera map writ large for the entire planet.
- Source
  - **Center for Systems Science and Engineering** at **Johns Hopkins University**.
    - <https://coronavirus.jhu.edu/map.html>

### *Professor Lauren Gardner Discusses How the COVID-19 Dashboard is Built and Maintained*

- Summary
  - In this 10 minute video **Dr. Lauren Gardner** explains the 'dashboard' she designed.
- Source

- **Johns Hopkins University**
  - 13 March 2020
  - YouTube
  - <https://www.youtube.com/watch?v=0JR9ghz2eMw>

*'Every Day Is a New Surprise.' Inside the Effort to Produce the World's Most Popular Coronavirus Tracker*

- Summary
  - **Lauren Gardner, PhD**
  - Education all at [University of Texas at Austin](#)
    - 2006 – B.S.Arch.E. in **architectural engineering**
    - 2008 – M.S.E. in **civil engineering**
    - 2011 – **PhD in transport engineering**
  - Work
    - Pandemic avoidance re:
      - Shipping lanes
      - Air traffic routes
- Source
  - Pulitzer Center
    - 7 April 2020
    - <https://pulitzercenter.org/reporting/every-day-new-surprise-inside-effort-produce-worlds-most-popular-coronavirus-tracker>
- Author
  - Jocelyn Kaiser

## Page 33 – Yearbook Recap

*'Virus' vs. 'Bacteria' - The key differences between two common pathogens*

- Summary
  - I like how the dictionary put it.
- Verbatim
  - **Bacteria are giants when compared to viruses.**
- Source
  - Merriam Webster dictionary
    - <https://www.merriam-webster.com/words-at-play/virus-vs-bacteria-difference>

## Page 34 – 1424 Pathogens That Don't Like Us



# Humans are infected by 1424 species of micro-organism

1424

- I was reminded by **Dr. Tony Chow**, an **Infectious Disease (ID) specialist**, that this number of 1424 should neither be considered definitive nor finite. Estimates vary, plus new species are discovered.

## TOTAL NUMBER OF SPECIES

- 538 species bacteria
- 219 species viruses
- 57 species amoebas (the technical umbrella term is 'Protozoa')
- 287 species worms
- 6 species prions
- 317 species fungi
- 1424 species TOTAL

## SUMMARY

- **Microbiology by Numbers**
  - **nature reviews microbiology**
  - 12 August 2011
  - There is supplementary information (just below) at the end of this paper.
  - <https://www.nature.com/articles/nrmicro2644>
- **Supplementary information S1: #microbiologybynumbers**
  - **Verbatim**
    - ~ 1400 species of human pathogen, 208 viruses or prions [this is the only value I did not use], 538 bacteria, 317 fungi, 57 protozoa, and 287 helminths.
    - (This sentence is 4<sup>th</sup> from the end in the bulleted list on the page.)
  - [https://static-content.springer.com/esm/art%3A10.1038%2Fnmicro2644/MediaObjects/41579\\_2011\\_BFnmicro2644\\_MOESM1\\_ESM.pdf](https://static-content.springer.com/esm/art%3A10.1038%2Fnmicro2644/MediaObjects/41579_2011_BFnmicro2644_MOESM1_ESM.pdf)
    - **Use this link.**

## DETAILS

- Bacteria
  - Source 1: **nature reviews microbiology** (above)
    - 538 species pathogenic to humans.
  - Source 2: Wikipedia
    - 59 species do most of the damage
      - Of the 59 species listed in the table with their clinical characteristics, 11 species (or 19%) are known to be capable of natural genetic transformation.
      - In the illustrated guide on page 34 I rounded 59 up to 60 where I stated "about 60 species that do most of the damage."
      - [https://en.wikipedia.org/wiki/Pathogenic\\_bacteria](https://en.wikipedia.org/wiki/Pathogenic_bacteria)
- Viruses
  - Source 1: **nature reviews microbiology** (above)
    - 208 species pathogenic to humans.
      - But this number is hard to discern because it says, 'viruses or prions'.
      - Can subtract the 6 prion diseases.
      - Thus: 208 – 6 = 202 virus species.
  - Source 2: Mark Woolhouse
    - **Human viruses: discovery and emergence**
    - Verbatim
      - There are 219 virus species that are known to be able to infect humans.

- Philosophical Transactions of the Royal Society B: Biological
  - 19 October 2012
  - [Mark Woolhouse](#), Centre for Immunity, Infection and Evolution, University of Edinburgh, Ashworth Laboratories, Kings Buildings, West Mains Road, Edinburgh EH9 3JT, UK
  - <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3427559/>
- Source 3: [ViralZone](#)
  - [Human viruses and associated pathologies](#)
  - This is a list of 129 (yes, 129) viruses that are pathogenic to humans. So that's a short list.
    - <https://viralzone.expasy.org/678>
- Worms
  - Source 1: nature reviews microbiology (above)
    - 287 species pathogenic to humans.
    - The technical term for parasitic worms is **helminths** ("hell minths").
- Protozoa
  - Source 1: nature reviews microbiology (above)
    - 57 species pathogenic to humans.
    - **Protozoa** is the umbrella term that includes amoebas and other single cell (uni-cellular) critters. But remember, they are NOT bacteria.
  - Source 2:
    - [History of Human Parasitology](#)
    - [Verbatim](#)
      - Humans are hosts to nearly 300 species of parasitic worms and over 70 species of protozoa, some derived from our primate ancestors and some acquired from the animals we have domesticated or come in contact with during our relatively short history on Earth.
    - American Society for Microbiology
    - 1 October 2002
    - [F. E. G. Cox](#)
    - <https://doi.org/10.1128%2FCMR.15.4.595-612.2002>
- Prions
  - Source 1: [Johns Hopkins Medicine](#)
    - [Prion Diseases](#)
    - No date, no author.
    - 6 described in their list. I will use this value.
    - <https://www.hopkinsmedicine.org/health/conditions-and-diseases/prion-diseases>
  - Source 2: Wikipedia
    - They list 10 but really it's 6 as 1-5 are [Creutzfeldt Jacob Disease \(CJD\)](#). This starts to get hair splitty.
    - <https://en.wikipedia.org/wiki/Prion>
  - Source 3: Virology Journal
    - [An overview of human prion diseases](#)
    - They have a table of [animal prions](#) and [human prions](#). Go mental.
    - Virology Journal
    - 24 December 2011
    - [Muhammad Imran](#) and [Saqib Mahmood](#). Department of Human Genetics and Molecular Biology, University of Health Sciences (UHS), Lahore, Pakistan
    - <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3296552/>
- Fungi
  - Source 1: nature reviews microbiology (above)
    - 317 species pathogenic to humans.
  - Source 2: Wikipedia
    - [Pathogenic fungus](#)
      - 1,500,000 species of fungi.
        - 300 species pathogenic to humans.

- 8000 species pathogenic to plants.
  - [https://en.wikipedia.org/wiki/Pathogenic\\_fungus](https://en.wikipedia.org/wiki/Pathogenic_fungus)
- *Stop neglecting fungi*
  - This is reference no. 1 in Wikipedia.
  - nature microbiology
    - 25 July 2017
    - <https://doi.org/10.1038%2Fnmicrobiol.2017.120>
  - Verbatim
    - There are an estimated 1.5 million fungal species, of which over 8,000 are known to cause disease in plants and 300 to be pathogenic to humans.
    - *Candida*, *Aspergillus*, *Pneumocystis* and *Cryptococcus* spp. are the most common cause of serious disease in humans, and five diseases – wheat stem rust, rice blast, corn smut, soybean rust and potato late blight – are the most devastating for crop production. Infections primarily occur in immunocompromised patients, such as those undergoing chemotherapy or infected with HIV, and many are acquired in hospitals.

# Page 35 – Epidemiology Triangle

## Epidemiologic triangle and tetrahedron

### Summary by me

- The **Disease Triangle** a.k.a. **Epidemiologic Triangle** is made of 3 things:
  - **Host** – that's you.
  - **Agent** – that's the nasty organism, for example the *Yellow Fever virus*.
  - **Environment** – this is where the host and agent meet. It might be the swamps of Panama.
- The **Disease Tetrahedron** a.k.a. **Epidemiologic Tetrahedron** adds 1 more thing:
  - **Vector** – this is usually an insect (like a mosquito) that transmits the agent (virus) to you (host). It also lives in the environment. It gets inserted into the middle of the triangle.

### Who uses these Disease triangles and tetrahedrons?

- **Medical doctors, research scientists, epidemiologists, dentists, vets and botanists** (specifically, **plant pathologists** who study plant diseases), to name a few.

### *Principles of Epidemiology in Public Health Practice: Lesson 1: Introduction to Epidemiology: Section 8: Concepts of Disease Occurrence*

- Summary
  - This is the **CDC** teaching course mentioned on page 2 of this bibliography.

- **Figure 1.16** on page 1-52 shows an Epidemiologic Triangle.
- Verbatim
  - A number of models of disease causation of been proposed. Among the simplest of these is the epidemiologic triad or triangle, the traditional model for infectious disease. The triad consists of an external **agent**, susceptible **host**, and an **environment** that brings the host and agent together.
- Source
  - **CDC**
    - You can download the pdf.
    - <https://stacks.cdc.gov/view/cdc/6914>

### What is the epidemiologic triangle?

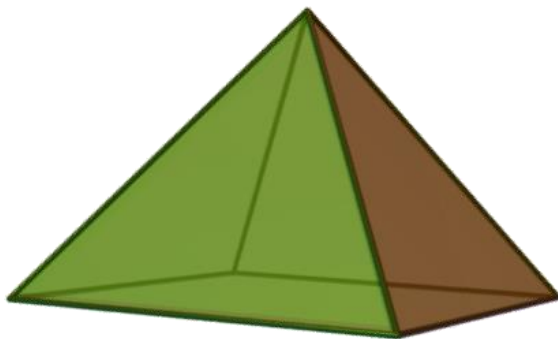
- Summary
  - This was the answer on Quora by Dr Tim Sly.
- Verbatim
  - You are probably referring to the epidemiological "triad", comprising the host (human), the agent (bacteria, virus, fungus, parasite), and the environment (e.g. water or food or air). If you are observant, you will see a fourth component - the vector, forming a **tetrahedron**. This would be the mosquito (in malaria or dengue), or flea (in plague), and so on. Real-world disease transmission and aetiology is a bit more complex, but this model still serves well. Remove one of the components, and the disease is stopped.
- Source
  - Quora
    - Dr. Timothy Sly DPH, PhD, Professor Emeritus (Epidemiology), School of Public Health, Toronto Metropolitan University, Toronto
      - I hold a master's degree in Epidemiology from the Faculty of Medicine at the University of Western Ontario, and a PhD in Risk Studies from Teesside University in the United Kingdom.
      - <https://www.quora.com/What-is-the-epidemiologic-triangle>
        - Scroll down just a bit to find this.

Geometry trivia ...



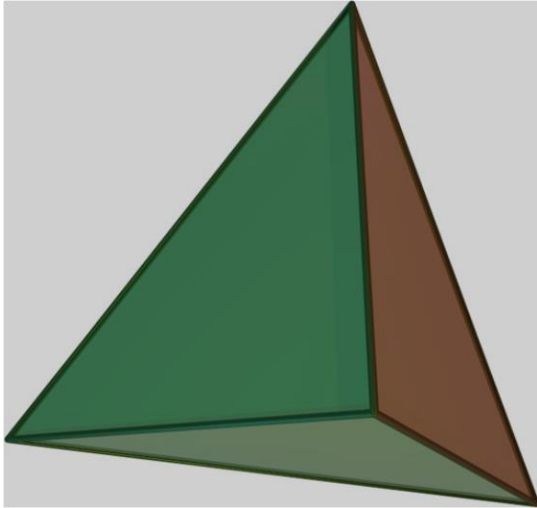
### Great Pyramid of Giza

- Summary
  - A pyramid like the one in Egypt has 5 'faces'. Get that in your head. Five. Five. Five. Five. Five.
    - The four identical faces you can see as you walk around the pyramid have a triangle shape.
    - The 5<sup>th</sup> face is the square on the ground; you could only see it if you could make the pyramid rise into the air like in a science fiction movie.
  - The Pyramids in Egypt are 'square pyramids' because the base is a square.
  - Guess how the builders made them level?
    - They drew a giant square on the ground → pounded posts at the 4 corners of the square → flooded the area with water → attached string between the posts, right at water level → drained the water away → now you have a level field to build on.
    - At least that's what I read when I visited.
- Source
  - [https://en.wikipedia.org/wiki/Great\\_Pyramid\\_of\\_Giza](https://en.wikipedia.org/wiki/Great_Pyramid_of_Giza)



### Square pyramid

- That's a square pyramid. That's what the pyramid in Egypt is. Five. Five. Five. Five. Five.
- [https://en.wikipedia.org/wiki/Square\\_pyramid](https://en.wikipedia.org/wiki/Square_pyramid)



### Tetrahedron

- Summary
  - A **tetra-hedron** (“teh tra hee dron”) has 4 faces. Do you agree there are four faces? Four. Four. Four. Four.
  - *Tetra* means 4. That’s why dogs are also known as tetra-pods = 4 legs.
  - It’s a 3-dimensional shape. However, this geometry term has been distorted by epidemiologists into a 2-dimensional drawing on a flat piece of paper. Whatever.
- Source
  - <https://en.wikipedia.org/wiki/Tetrahedron>
    - I rotated their tetrahedron so it points upright.

# Page 36 – Civilization is Terrible 4U

Page 36 is based on what I read in the phenomenal book, *Guns, Germs, and Steel*. See page 108 of the bibliography.

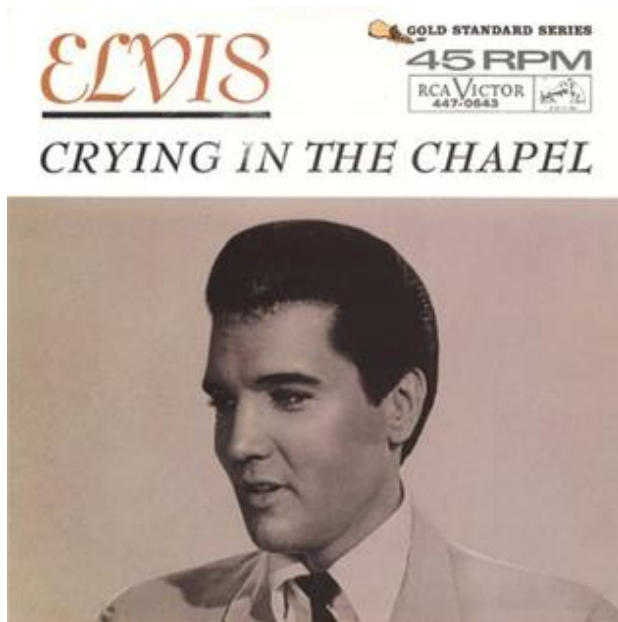
*Natural Selection: Uncovering Mechanisms of Evolutionary Adaptation to Infectious Disease - The evolutionary link between sickle-cell trait and malaria resistance showed that humans can and do adapt. But are the “bugs” that make us sick evolving as well?*

- Summary
  - The organism that causes **Malaria** has been present in humans for 100,000 years. Wow.
  - This organism is a single cell. It is called *Plasmodium* (“plaz moh dee um”). It is transmitted by female mosquitoes.

- See page 69-70 of *Hidden Zoo* for more on Malaria.
- Verbatim
  - Research indicates that the malaria-causing parasite *Plasmodium falciparum* has occurred in human populations for approximately **100,000 years**, with a large population expansion in the last 10,000 years as human populations began to move into settlements (Hartl, 2004)
- Source
  - nature education
    - 2008
    - <https://www.nature.com/scitable/topicpage/natural-selection-uncovering-mechanisms-of-evolutionary-adaptation-34539/>
- Author
  - Pardis C. Sabeti M.D., D.Phil. (Harvard University, Cambridge, MA)

# Page 37 – Karaoke Virus. For real?

Elvis Presley



*Crying in the Chapel*

- [https://en.wikipedia.org/wiki/Crying\\_in\\_the\\_Chapel](https://en.wikipedia.org/wiki/Crying_in_the_Chapel)

$R_0$  (R naught)

Some background

Pronunciation

- “R not” ... this is the common way to say it.
- “R zero” ... less often people say this.

Synonyms

- $R_0$
- Rnaught
- Rnought
- Reproduction number
- Basic reproduction number
- Basic reproduction rate

Spelling: both of these are valid spelling

- naught
- nought

Word origin

- Naught is the British term for zero.
- So for 0.5, the Brits would say, “Naught point five.” To which I would respond, “If it’s not point five, then what is it?” Haha.

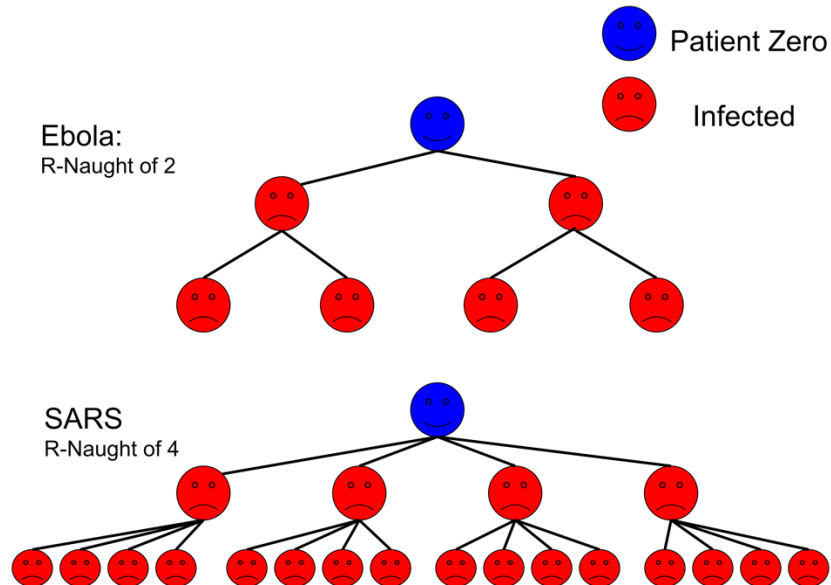
What does  $R_0$  mean, mathematically?

- It’s a math symbol. It’s an R followed by a subscript zero.  $R_0$
- In case you’re new to this:
  - sub-script goes below:  $R_0$      $CO_2$      $H_2O$
  - super-script goes above:  $10^2$      $e = mc^2$      $Mg^{2+}$  (Magnesium has a charge of +2)

Get it?

- Sub means below, as in *sub-marine*, as in below the water.
- Super means above, as in *I feel super duper today*. As in, *super-star*.





### Basic reproduction number

- Here's what  $R_0$  means in epidemiology:
  - $R_0$  ("R not") is a fancy way of saying, *How many people did you infect?*
    - $R_0 = 0$  = You infected 0 (zero) people. This is the **best case scenario**.
    - $R_0 = 1$  = You infected 1 person.
    - $R_0 = 2$  = You infected 2 persons.
    - $R_0 = 3$  = You infected 3 persons.
    - $R_0 = 4$  = You infected 4 persons.
- Okay, now look at that image with red and blue faces
  - Ebola
    - It's the top set of faces.
    - "Patient Zero" in blue is the very first person to get infected with **Ebola**. He infected 2 people. And those people each infected 2 people. So  $R_0$  is 2.
    - The spread of infection is like so:  $1 \rightarrow 2 \rightarrow 4 \rightarrow 8 \rightarrow 16 \rightarrow 32 \rightarrow$  and so on.
  - SARS
    - It's the bottom set of faces.
    - "Patient Zero" in blue is the very first person to get infected with **SARS**. He infected 4 people. And those people each infected 4 people. So  $R_0$  is 4.
    - The spread of infection is faster now.  $1 \rightarrow 4 \rightarrow 16 \rightarrow 64 \rightarrow 256 \rightarrow$  and so on.
- Is  $R_0$  confusing?
  - Yes. Saying, "R zero equals two" is incredibly confusing. How can zero equal two? I get it that's not the intention of the meaning but it's still confusing.
- Source
  - [https://en.wikipedia.org/wiki/Basic\\_reproduction\\_number](https://en.wikipedia.org/wiki/Basic_reproduction_number)

### Notes on $R_0$

- Summary
  - This math is over my head.
- The math, summarized
  - $R_0 = \text{Reproduction number}$ 
    - Reproduction number is the number of secondary infections produced by a single typical infection in a rarefied population.
  - $R_0 = \tau \times c \times d = \text{Transmissibility} \times \text{Rate of Contact} \times \text{Duration}$ 
    - Dimensionless
    - Given:

- $\tau$  = Transmissibility = probability the infection spreads from person A to person B
- $c$  = rate of contact
- $d$  = duration of being infective
- Application
  - $R_0$  is used to figure out how many people to vaccinate.
- Malaria
  - There is some crazy math that models the spread of **Malaria**.
- Source
  - This is a pdf from Stanford University.
    - 1 May 2007
    - <https://web.stanford.edu/~jhj1/teachingdocs/Jones-on-R0.pdf>
- Author
  - James Holland Jones, Department of Anthropological Sciences, Stanford University

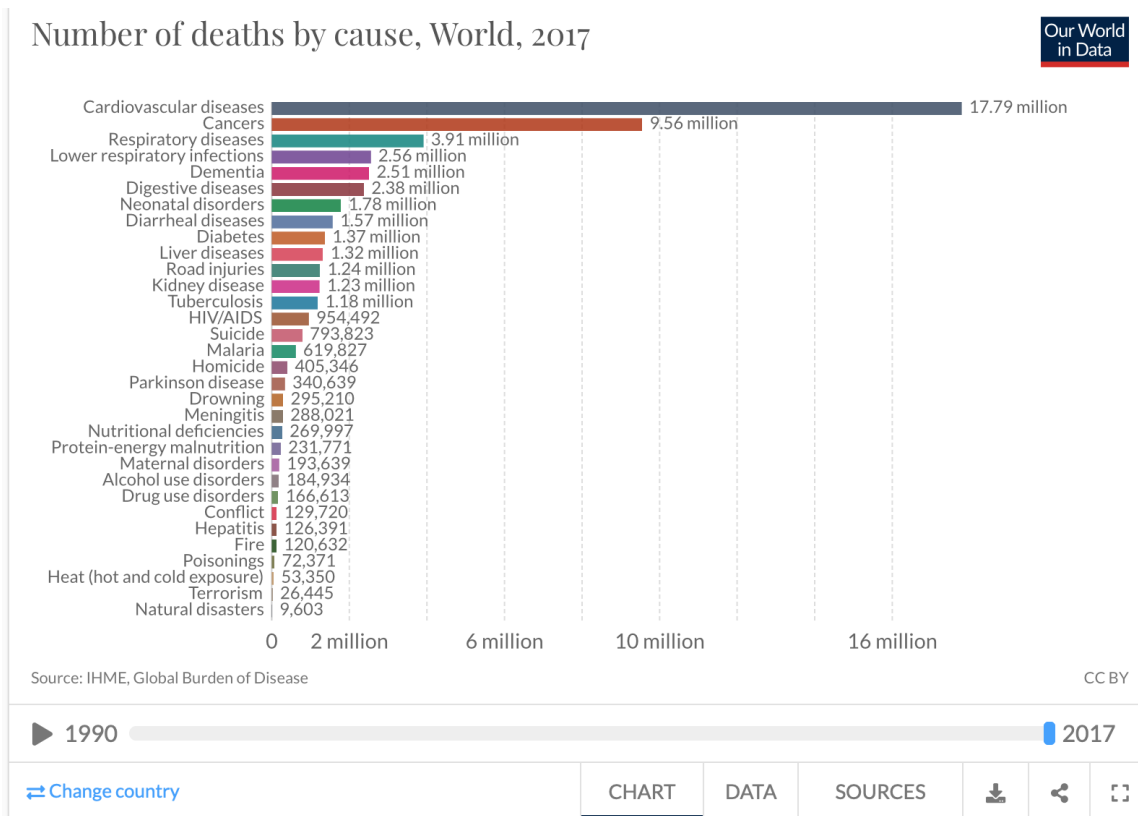
*Reproduction number (R) and growth rate (r) of the COVID-19 epidemic in the UK: methods of estimation, data sources, causes of heterogeneity, and use as a guide in policy formulation*

- Summary
  - Insane detail on the  $R_0$  for **COVID-19** in the United Kingdom.
  - Page 7 is devoted to a definition of  $R_0$ .
  - Page 8 has an interesting flow chart that shows the stages that you personally will progress through: **Susceptible** → **Infected but not Infectious** → **Infected and Infectious** → **Recovered and Immune**. You have to read that 2 or 3 times for it to make sense.
- Source
  - Royal Society
    - 24 August 2020. It was important at this early stage of the covid pandemic to do mathematical modeling.
    - <https://royalsociety.org/-/media/policy/projects/set-c/set-covid-19-R-estimates.pdf>

# Page 38 – Cemetery of Humanity


Causes of Death – Source #1

Our World in Data



## Causes of death

### Summary

- This is a fantastic website, well written, concise and with excellent graphs.
-  Above is an interactive graph from **Our World in Data**. Hover the cursor over the graph (on the website, not here) and lots of data pops up. This is the map I converted into my Shady Acres Cemetery. Thank you, Our World in Data!
- My favorite graph is **Deaths by Animal**. The #1 killer of humans is mosquitoes. The #2 killer of humans is humans. Yes, they include 'humans' as an animal that attacks humans. If we try harder at being savage, we can beat mosquitoes and be at the top of the list. This graph disappeared, boo hoo, where did you go?

Animal	Human deaths (in 2016)
Mosquito	→ 780,000 human deaths
Human	→ 546,000 human deaths
Scorpion	→ 3,500 human deaths
Crocodile	→ 1000 human deaths

- Another cool graph is, *Death rate from venomous animal contact, 2019*.
- There used to be a graph addressing the question, "Does the news reflect what we die from?" but it seems to have disappeared since I started this bibliography. If you find it please let me know.


### Source

- Our World in Data**
  - <https://ourworldindata.org/causes-of-death>
    - The graph shown above is a **histogram** (it has bars to show quantity) – it's about ¾ down the web page.
  - <https://ourworldindata.org/grapher/death-rate-from-venomous-animal>
    - This is deaths due to venomous creatures.
  - <https://ourworldindata.org/causes-of-death#deaths-by-animal>
    - This is not working any longer.

## Causes of Death – Source #2

### Global Health Data Exchange (GHDx)

#### GBD Results Tool

- Summary
  - Global Health Data Exchange (GHDx) is the source of data for Our World in Data.
  - They have extremely detailed data that you can tailor to your search.
  - There are categories you can search such as Cause, Location, Age, Sex.
  - Here is a sample search to look at the data for **Malaria**.
    -  On the left side of the page, go to the Cause' box pulldown menu → type in 'Malaria' → declick 'All causes' (the default setting) → now you can see loads of data in the right side of the page.
- Source
  - Global Health Data Exchange (GHDx)
    - 2019
    - <http://ghdx.healthdata.org/gbd-results-tool>

## Smoking as an “underlying” risk factor that increases the risk of a poor outcome with a coronavirus infection

#### #99 – Peter Hotez, M.D., Ph.D.: Continuing the conversation on COVID-19

- Summary
  - Smoking increases the number of ACE2 Receptors that the coronavirus can bind to.
  - The ACE2 Receptor is the 'doorbell' that the virus rings in order to get inside a cell. So basically, smoking puts more doorbells on the house and you're more likely to open the door. Kinda sorta. See pages 145-150 for details.
- Source
  - Peter Attia MD podcast
    - Peter Attia interviews Peter Hotez MD, PhD in this 1 hour 6 minute podcast.
    - <https://peterattiamd.com/peterhotez2/>

## Cancer

Benign tumors versus malignant tumors (cancer) are described on page 12 of this bibliography.

# Page 39 – Tombstones That Glitter

## 1918 Influenza Pandemic: gender

### *Sex- and age-based differences in mortality during the 1918 influenza pandemic on the island of Newfoundland*

- Verbatim
  - Differences in sex-based mortality varied across regions; they were not significant for the aggregate population.
- Translation
  - That's slightly wordy. They mean that there could be more deaths in one particular gender in a particular geographic region. But looking at the 'aggregate' – which is everyone who died everywhere – that males and females died in equal numbers. They were looking at the island of Newfoundland in Canada.
- Source
  - American Journal of Human Biology
    - 2018 November 29
    - <https://onlinelibrary.wiley.com/doi/abs/10.1002/ajhb.23198>
- Author
  - Taylor Paskoff
  - Lisa Sattenspiel

## 1918 Influenza Pandemic: tri-modal distribution of death

### *1918 Pandemic (H1N1 virus)*

- Verbatim
  - Mortality was high in people younger than 5 years old, 20-40 years old, and 65 years and older.
  - The high mortality in healthy people, including those in the 20-40 year age group, was a unique feature of this pandemic.
- Source
  - CDC
    - 20 March 2019
    - <https://www.cdc.gov/flu/pandemic-resources/1918-pandemic-h1n1.html>

## 1918 Influenza pandemic: other factors

### *The 1918 Influenza Epidemic's Effects on Sex Differentials in Mortality in the United States*

- Summary
  - This paper explains how people with pre-existing **Tuberculosis (TB) bacteria** in their lungs were more likely to die from the **1918 Influenza virus**.
  - They also dive into the subtleties of gender versus death.
- Source
  - Population and Development Review
    - 10 September 2009
    - <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2740912/>
- Author
  - Andrew Noymer
  - Michel Garenne

## Malaria deaths in children

## Malaria

- Summary
  - 57% of Malaria deaths are in children less than 5 years old.
- Source
  - Our World in Data
    - February 2022
    - <https://ourworldindata.org/malaria>
- Authors
  - Max Roser, PhD – Founder and director of Our World in Data.
  - Hannah Ritchie, PhD – Head of Research at Our World In Data.

## Australia's investment in eradicating malaria

- Summary
  - Who gets Malaria in Australia? Travelers who have returned from malaria regions *in other countries*. For example, someone from Australia travels to Uganda, gets malaria there, then returns to Australia.
  - Point being, there is nuance to data. If you read that someone in Australia has Malaria don't make the assumption they got it *in* Australia. This applies to almost every fact in medicine ... there is always nuance.
- Verbatim
  - Malaria has historically been endemic in Australia but was declared eradicated from the country in 1981. Although it is no longer endemic, approximately 700-800 cases occur each year in Australia in travellers who have been infected elsewhere.
- Translation
  - **Endemic** means a disease is continuously present in a region. Malaria *used to be* endemic in Australia.
- Source
  - National Health and Medical Research Council (NHMRC) of Australia.
    - 23 April 2021
    - <https://www.nhmrc.gov.au/about-us/news-centre/australias-investment-eradicating-malaria>

## How I Died Today

See death certificates on page 41.

# Page 40 - Passport Control



That's a **Komodo dragon** stalking a deer. Is he wearing a GoPro?

- [https://en.wikipedia.org/wiki/Komodo\\_dragon](https://en.wikipedia.org/wiki/Komodo_dragon)



What a specimen!

- [https://en.wikipedia.org/wiki/Komodo\\_\(island\)](https://en.wikipedia.org/wiki/Komodo_(island))



That's southeast Asia.

- [https://en.wikipedia.org/wiki/Southeast\\_Asia](https://en.wikipedia.org/wiki/Southeast_Asia)



## SOUTHEAST ASIA



Okay, see Indonesia? It's all beige colored. Now find Port Headland on the north coast of Australia and follow the line of longitude upwards ... do you see the triangle formed Sumba, Sumbawa, and Flores? Komodo Island is the little unnamed island between the three islands.

- [https://en.wikipedia.org/wiki/Southeast\\_Asia](https://en.wikipedia.org/wiki/Southeast_Asia)



The red dot is Komodo Island.

- Now that you know where they live, don't be a douchebag by supporting animal trafficking. Let them live in peace, eating deer.
- [https://en.wikipedia.org/wiki/Komodo\\_\(island\)](https://en.wikipedia.org/wiki/Komodo_(island))

## Page 41 – Death Certificate

### Death Certificates

*Medical Examiner's and Coroners' Handbook on Death Registration and Fetal Death Reporting*

- Summary
  - This is a 128-page pdf from the CDC, giving guidance to medical examiners and coroners on how to fill out a death certificate. Plus details on how to report the death of a fetus (think, baby inside the womb a.k.a. uterus).
  - Page 21 has definitions of: natural, accident, suicide, homicide, Could not be determined, and Pending investigation.
- Source

- CDC
  - 2003
  - It's a 128-page pdf.
  - [https://www.cdc.gov/nchs/data/misc/hb\\_me.pdf](https://www.cdc.gov/nchs/data/misc/hb_me.pdf)

### Physicians' Handbook on Medical Certification of Death

- Summary

- This is a 56-page pdf from the CDC, giving guidance to medical doctors on how to fill out a death certificate.
- There are 13 cases of death. Fairly typical grisly doctor stuff. It's written in technical medical language but you can kind of follow along.

- Cases

Case #1: **Pancreatitis**

- "Pan kree ah tight iss"
- Your **pancreas** ("pan kree us") lives under your stomach. It makes insulin whose job in life is to allow sugar inside cells. The insulin is secreted into the blood – that way it gets everywhere in the body.
- And the pancreas makes digestive juices that get secreted into the small intestine.
- This person's pancreas was inflamed so badly the person died. There are quite a few causes of pancreatitis.

Case #2: **Pulmonary Embolism**

- "Pull mon air ee"
- "Em ball iz um"
- **Pulmonary** is a fancy word for lungs.
- 'Pulmonary embolism' means a **blood clot** went to the lungs .. and in this case it was big enough to fatally disrupt the blood from being oxygenated.

Case #3: **Heart attack** a.k.a. **Myo-cardial Infarction**

- "My oh card ee ul"
- "In fark shun"
- The **coronary arteries** that supply the heart were narrowed so not enough blood was supplied to the heart (which is a muscle). The heart stopped beating.

Case #4: **Pulmonary Embolism**

- Another blood clot to the lungs.

Case #5: **Pseudomonas aeruginosa sepsis**

- "Sue dough moan us"
- "air oo jin oh sa"
- "sep siss"
- **Pseudomonas aeruginosa** is a bacteria. It was growing in the blood (think, millions of them). Death was by blood poisoning (a.k.a. sepsis).

Case #6: **Pneumocystis carinii pneumonia**

- "New moh siss tiss"
- "car in ee eye"
- **Pneumo-cystis carinii** is a weird organism that used to be considered a protozoan (think, single-celled amoeba) but is actually a fungus.
- This patient had **HIV/AIDS**, so the immune system got clobbered. Then the fungus caused pneumonia, resulting in death.
  - The CDC has loads of information.
  - <https://www.cdc.gov/fungal/diseases/pneumocystis-pneumonia/index.html>

Case #7: **Acute exacerbation of obstructive airway disease**

- The patient was a heavy smoker which results in lung damage called **Chronic Obstructive Pulmonary Disease (COPD)**.
- But things got suddenly worse which is called an '**acute exacerbation**' ("ex ass er bay shun").

#### Case #8: **Acute renal failure**

- "ree nul"
- **Acute** means sudden.
- **Renal failure** means kidney failure.
- This woman had severe **diabetes** and she ended up in a type of **coma** that can happen with **diabetes**. She was severely dehydrated and that can be associated with kidney failure. Take note, just because you're thirsty doesn't mean you get kidney failure. This is a well-known diabetes scenario that was described in this case.

#### Case #9: **Rupture of left ventricle**

- This man had a **heart attack**. When there is a heart attack there is death of heart muscle; usually at a precise location. Make a fist – that's your heart. It's all muscle but has 4 hollow chambers. Sometimes with a heart attack, the region of dead muscle can become so weak that it can rupture which is what happened in this case. **The lower left chamber of the heart called the left ventricle ruptured. It is the powerhouse chamber, so if it ruptures, that's bad news.**

#### Case #10: **Escherichia coli Meningitis**

- "Esher ish ee ah"
- "kow" – kow rhymes with low – "lie"
- "Men inj eye tiss"
- **This premature baby died of meningitis – an infection of the lining of the brain.**
- The bacteria that caused it was *Escherichia coli*, better known as *E. coli* because no one can spell *Escherichia* except those brainiac kids in spelling bees.

#### Case #11: **Hemorrhagic Shock**

- "Hee mow raj ick"
- **This is quite a sad case.** These are all true stories in this handbook.
- The key word to understand is **placenta** ("plah cent ah") which is the interface between mother and baby. (See page 84 of *Hidden Zoo* for lots of detail on the placenta).
- A **30-year old woman** at the 36-week mark of pregnancy suffered from a **placental abruption** ("plah cent ul" "abrup shun"). That means the placenta **abruptly** peels away from the uterus (womb) and bleeding results. This condition can be **mild / moderate / severe**. In this case it was severe and **the mother bled to death – that's hemo-rrhagic shock.**
- **The baby also died. There was a separate death certificate for the baby.**

#### Case #12: **Undetermined Natural Causes**

- **This 92-year old man died of old age, basically. But you can't call it old age on the death certificate!**

#### Case #13: **Congestive Heart Failure (CHF)**

- The key word here is '**congestive**.' You know when your nose is stuffed up? That's nasal congestion. This can happen with the heart, kinda sorta.
- What's the flow of blood through the 4 chambers of the heart?
  - Blood returning from body → **Right Atrium** → **Right Ventricle** → **lungs** (so the blood gets oxygenated) → back to the heart → **Left Atrium** → **Left Ventricle** → body. It's a loop.
  - In shorthand:
    - **RA → RV → lungs → LA → LV**
  - **When the Left Ventricle (LV) fails, the blood backs up into the lungs. That's the congestion. Makes it hard to breathe. That's Congestive Heart Failure (CHF).**

Instead of the nose being congested, it's the lungs. And the failing heart is the cause of the problem.

- CHF is a very complicated topic. We spend oodles of time learning about it in medical school and internship (a.k.a. residency). Every medical doctor, regardless of specialty, has to possess an understanding of CHF.
- Here's more information on CHF from [Johns Hopkins Medicine](#) which is also a great source of information. The first paragraph of this article explains CHF nicely.
  - [Johns Hopkins University](#) is in [Baltimore, Maryland](#).
  - <https://www.hopkinsmedicine.org/health/conditions-and-diseases/congestive-heart-failure-prevention-treatment-and-research>
- Source
  - **CDC**
    - 2003
    - It's a 56-page pdf.
    - The Mobile app has the same cases.
    - [https://www.cdc.gov/nchs/data/misc/hb\\_cod.pdf](https://www.cdc.gov/nchs/data/misc/hb_cod.pdf)

## Death Certificates – coronavirus

### **Certifying Deaths Due to Coronavirus Disease (COVID-19)**

- Summary
  - This is a 3-minute **CDC** video with instructions on how to fill out the **death certificate** when **coronavirus** is the cause.
- Source
  - CDC
    - 4 May 2020
    - <https://www.youtube.com/watch?v=oL3VMwieAms>

### **GUIDANCE FOR CERTIFYING COVID-19 DEATHS**

- Summary
  - This is a **State of Hawaii** 1-page summary on how to fill out the **death certificate** when **coronavirus** is the cause. Fairly similar idea to the CDC video above.
- Source
  - Hawaii.gov: Department of Health: Vital Records
    - 2022
    - <https://health.hawaii.gov/vitalrecords/guidance-for-certifying-covid-19-deaths/>

### **GUIDANCE FOR CERTIFYING COVID-19 DEATHS**

- Summary
  - This is a **State of Montana** summary on how to fill out the **death certificate** when **coronavirus** is the cause. Similar to the Hawaii site but more examples.
- Source
  - Montana.gov
    - No date
    - <https://dphhs.mt.gov/vitalrecords/certificationofcovid-19>

Death Certificate – gangster Al Capone  
... in case you were wondering



That's the gangster Al Capone.

**CERTIFICATE OF DEATH**  
FLORIDA

State Board of Health  
Bureau of Vital Statistics

State File No. \_\_\_\_\_  
Registrar's No. \_\_\_\_\_

**1. PLACE OF DEATH:**

(a) County Dade District No. 11-01

(b) Precinct \_\_\_\_\_ Precinct No. \_\_\_\_\_

(c) City or Town Miami Beach City or Town No. \_\_\_\_\_  
(Write name, not number)

(d) Name of hospital or institution 93 Palm Island  
(If in hospital or institution, write street number or location)

(e) Length of stay: In hospital or institution \_\_\_\_\_  
At place of death 19 years  
(Specify whether years, months or days)

**2. USUAL RESIDENCE OF DECEASED**

(a) State Florida (b) County Dade

(c) City or Town Miami Beach  
(If outside city or town limits, write RURAL)

(d) Street No. 93 Palm Island (If rural, give location)

(e) Citizen of Foreign country? no yes or no  
If yes, name country \_\_\_\_\_

**3. FULL NAME OF DECEASED** ALPHONSE CAPONE

3 (a) If veteran, name war \_\_\_\_\_ 3 (b) Social Security No. \_\_\_\_\_

4. Sex male 5. Color or race white

6. Single, married, widowed or divorced married

6 (a) If married, widowed or divorced, husband of (or) wife of Mary Capone

6 (b) Age of husband or wife, if alive 50 years

7. Birth date of deceased January 17 1899  
(month) (day) (year)

8. Age: Years 48 Months - Days 8 If less than one day  
hrs. \_\_\_\_\_ min. \_\_\_\_\_

9. Birthplace Brooklyn New York  
(City, town or county) (State or foreign country)

10. Usual occupation Retired

11. Industry or business \_\_\_\_\_

12. Name Gabriele Capone

13. Birthplace Italy

14. Maiden name Teresa Raiola

15. Birthplace Italy

16. Informant's Signature /s/ Ralph J. Capone

16 (a) Address 93 Palm Island, Miami Beach, FL

17. Burial, cremation or removal? Removal

17 (a) Date Jan. 30, 1947 (b) Place Chicago, Ill.

18. Funeral Director's Signature /s/ W. L. Philbrick

18 (a) Address Miami Beach, Florida

19. Filed Jan. 28 1947 C. W. Tomlinson  
Sub Local Registrar

**MEDICAL CERTIFICATION**

20. Date of Death: Month Jan. Day 25  
Year 1947 Hour 7 Minute 25 P. M.

21. I hereby certify that I attended the deceased from June 1940 to Jan. 25 1947; that I last saw him, alive on Jan. 25 1947 and that death occurred on the date and hour stated above.

Immediate cause of death Bronchopneumonia Duration 48 hrs.

Due to Apoplexy 4 days

Due to \_\_\_\_\_

Other conditions (Include pregnancy within 3 months of death) \_\_\_\_\_

Major findings: of operations \_\_\_\_\_  
(Give date of operation) \_\_\_\_\_  
of autopsy \_\_\_\_\_

Underline the cause to which death should be charged statistically.

22. If death was due to external causes, fill in the following:  
(a) (Probably) Accident, suicide, homicide (specify) \_\_\_\_\_  
Date of occurrence \_\_\_\_\_  
(c) Where did injury occur? \_\_\_\_\_  
(City or town) (County) (State)

(d) Did injury occur in or about home, on farm, in industrial place, in public place? \_\_\_\_\_  
(Specify type of place)

While at work? \_\_\_\_\_ (e) Means of injury \_\_\_\_\_


23. Signature /s/ Kenneth Phillips M. D.  
(a) Address 1150 S. W. 22nd St. Date Signed 1/26/47

MARGIN RESERVED FOR BINDING  
Write plainly with unfading black ink—this is a permanent record. Every item of information should be carefully supplied.

THIS IS A TRUE AND CORRECT COPY OF THE ORIGINAL RECORD.

V. S. No. 4

**Al Capone**

- **Summary**
  - The death certificate of the gangster Al Capone is ¾ down this Wikipedia page, just before the references.
  -  Click on the death certificate to read the (verbatim) findings:
    - Immediate cause of death: **Bronchopneumonia**
    - Due to: **Apoplexy**
  - I saw Al Capone's jail cell at Alcatraz Island, San Francisco. Very cool. Go visit!
- **Translation:**
  - **Broncho-pneumonia**
    - "Bronk oh"
    - This is pneumonia. The major airways (**bronchus** singular, "brong kuss") (**bronchi** plural, "brong eye") are affected also.
    - The 'i' in *bronchi* gets turned into an 'o' to make *broncho*. That's medical grammar, so awesome at being confusing.
  - **Apoplexy**
    - "App oh plex ee"
    - This is an old-school term for a Stroke. Sometimes when you get a Stroke you can no longer control your throat muscles and can inhale your stomach secretions and end up with pneumonia. That's what seemingly happened to Al Capone.

- Source
  - [https://en.wikipedia.org/wiki/Al\\_Capone](https://en.wikipedia.org/wiki/Al_Capone)

## Death Certificate – an unfortunate pilot killed in a plane crash ... in case you were wondering

Certificate of Death		Certificate No. 25366
1. NAME OF DECEASED <b>EDDIE SCHNEIDER</b>		Date of Death: <b>December 23, 1940</b>
PERSONAL PARTICULARS <i>(To be filled in by Medical Examiner.)</i>		MEDICAL CERTIFICATE OF DEATH <i>(To be filled in by Medical Examiner. See over.)</i>
2. USUAL RESIDENCE: (a) State <b>N.Y.</b> (b) Co. <b>Queens</b> (c) Town or City <b>Brooklyn</b> <b>32-50 - 93d Street, Jackson Heights St.</b> (d) No. _____ (e) Length of residence or stay in City of New York immediately prior to death <b>Life</b>		16. PLACE OF DEATH: (a) NEW YORK CITY: (b) Borough <b>Brooklyn</b> (c) Name of Hospital or Institution <b>Flatbush Avenue &amp; Deep Creek</b> (d) If elsewhere than in hospital or own residence, specify character of place of death, as: hotel, office, store, street, taxicab, etc.
3. SINGLE, MARRIED, WIDOWED, OR DIVORCED (write the word) <b>Married</b>		17. DATE AND HOUR OF DEATH <b>December 23d 1940 P.M.</b>
4. WIFE or HUSBAND of <b>Gretchen</b>		18. SEX <b>Male</b> 19. Color or Race <b>White</b> 20. Approximate Age <b>29</b>
5. DATE OF BIRTH OF DECEASED <b>October 20th 1911</b>		21. I hereby certify (a) that in accordance with Sections 878-2.0 and 878-3.0 of the Administrative Code for the City of New York, I went to, and took charge of the dead body at <b>Kings County Morgue</b>
6. AGE <b>29</b> yrs. mon. day. hrs. or min.		22. I further certify (a) that I examined the body and investigated the circumstances of this death, and (b) that I examined the body and investigated the circumstances of this death, and I further certify from the investigation, (complete autopsy)* (partial autopsy)* (incision) and examination (c) that, in my opinion, death occurred on the date and at the hour stated above and resulted from (natural causes)* (accident)* (suicide)* (homicide)* (undetermined circumstances, pending further investigation)*, and (d) that the causes of death were: <b>Crushed Chest &amp; Abdomen; Hemothorax &amp; Hemoperitoneum: - in aeroplane crash.</b>
7. OCCUPATION A Trade, profession, or particular kind of work, as spinner, sawyer, book-binder, etc. B Industry or business in which work was done, as silk mill, saw-mill, bank, etc. <b>Aeroplane Pilot</b>		11. NAME OF FATHER OF DECEASED <b>Emil</b>
8. BIRTHPLACE OF DECEASED (State or country) <b>U. S.</b> How long in U. S. (if of foreign birth)		12. BIRTHPLACE OF FATHER (State or country) <b>Germany</b>
10. IF DECEASED WAS VETERAN, NAME WAR		13. MAIDEN NAME OF MOTHER OF DECEASED <b>Inga Petersen</b>
11. NAME OF FATHER OF DECEASED <b>Emil</b>		14. BIRTHPLACE OF MOTHER (State or country) <b>Norway</b>
12. BIRTHPLACE OF FATHER (State or country) <b>Germany</b>		15. SIGNATURE OF INFORMANT <b>GRETCHEN SCHNEIDER</b> M. E. Case No. <b>4418</b>
13. MAIDEN NAME OF MOTHER OF DECEASED <b>Inga Petersen</b>		Signed <b>Reuben Baduy</b> (Medical Examiner) <b>Thomas R. Sample</b> (Chief Medical Examiner)
14. BIRTHPLACE OF MOTHER (State or country) <b>Norway</b>		16. ADDRESS <b>32-50-93<sup>RD</sup> St. Jackson Hgts</b>
15. SIGNATURE OF INFORMANT <b>GRETCHEN SCHNEIDER</b> M. E. Case No. <b>4418</b>		17. RELATIONSHIP TO DECEASED <b>WIFE</b>
16. ADDRESS <b>32-50-93<sup>RD</sup> St. Jackson Hgts</b>		18. DATE OF BURIAL OR CREMATION <b>Dec 27, 1940</b>
17. RELATIONSHIP TO DECEASED <b>WIFE</b>		19. PERMIT NUMBER <b>2383</b>
18. DATE OF BURIAL OR CREMATION <b>Dec 27, 1940</b>		20. FUNERAL DIRECTOR <b>New York Funeral Service</b> ADDRESS <b>148 E. 74<sup>th</sup> St</b>
19. PERMIT NUMBER <b>2383</b>		21. BUREAU OF RECORDS
20. FUNERAL DIRECTOR <b>New York Funeral Service</b> ADDRESS <b>148 E. 74<sup>th</sup> St</b>		22. DEPARTMENT OF HEALTH
21. BUREAU OF RECORDS		23. CITY OF NEW YORK

### Death certificate

- Summary
  - This is the death certificate of a pilot who died in a plane crash.
- Details
  - The pilot is **Eddie Schneider** who is 29 years old and has set previous speed records in the United States.
  - It is 23 December 1940 at 1:25 pm.
  - Eddie is flying at **600 feet Above Ground Level (AGL)** → the tail of his plane is struck by another plane → Eddie's plane goes into a spin → plane crashes → Eddie dies.
- The death certificate reads:
  - Crushed chest & abdomen; Hemothorax & hemoperitoneum: - in aeroplane crash.
- Translation



- **Crushed chest**
  - When your chest is suddenly and violently crushed that is bad. The major blood vessels may detach from the heart. This is not the same as being crushed by a python, which is a slow process. And when a jack fails and the vehicle crushes your chest, that could be sudden or slow – depends on how fast and how much weight falls on your chest.
- **Crushed abdomen**
  - Not good. Probably massive bleeding.
- **Hemo-thorax**
  - “Hee mow” “Thor axe”
  - That means there is blood in the chest cavity.
- **Hemo-peritoneum**
  - “Hee mow” “pear it on nee um”
  - The abdominal organs are wrapped in a kind of biological Saran Wrap called the peritoneum. The presence of blood inside this (which there isn’t supposed to be) is called hemo-peritoneum.
- Source
  - [https://en.wikipedia.org/wiki/Death\\_certificate](https://en.wikipedia.org/wiki/Death_certificate)
  - [https://en.wikipedia.org/wiki/Eddie\\_August\\_Schneider](https://en.wikipedia.org/wiki/Eddie_August_Schneider)

# Page 42 – Homicide & Suicide

## Asphyxia

### What is Asphyxia?

- Summary
  - “ass fix ee ah”
  - Simple and readable article on asphyxia.
  - There are definitions of:
    - **Choking**
    - **Aspiration**
    - **Suffocation (smothering)**
    - **Strangulation**
    - **Drug Overdose (OD)**
    - **Birth asphyxia**
    - **Seizure**
    - **Chemical asphyxia**
    - **Carbon Monoxide poisoning**
    - **Cyanide poisoning**
    - **Hydrogen Sulphide poisoning**
- Source
  - WebMD
    - **2021**
    - <https://www.webmd.com/first-aid/asphyxia-overview>
- Source
  - Rachel Reiff Ellis

### Pathology of Asphyxial Death

- Summary
  - Technical details on asphyxia.
  - Grisly photos on the Terminology page.
- Verbatim
  - "Asphyxia" is a term derived from Greek that literally translates as "stopping of the pulse."
- Source
  - Medscape
    - 2016 January 24
    - <https://emedicine.medscape.com/article/1988699-overview>
- Authors
  - Michael A Graham, MD, pathologist, Medical Examiner
  - Marianna Sandomirsky, MD, pathologist, Medical Examiner
- Chief Editor
  - J Scott Denton, MD, pathologist, coroner

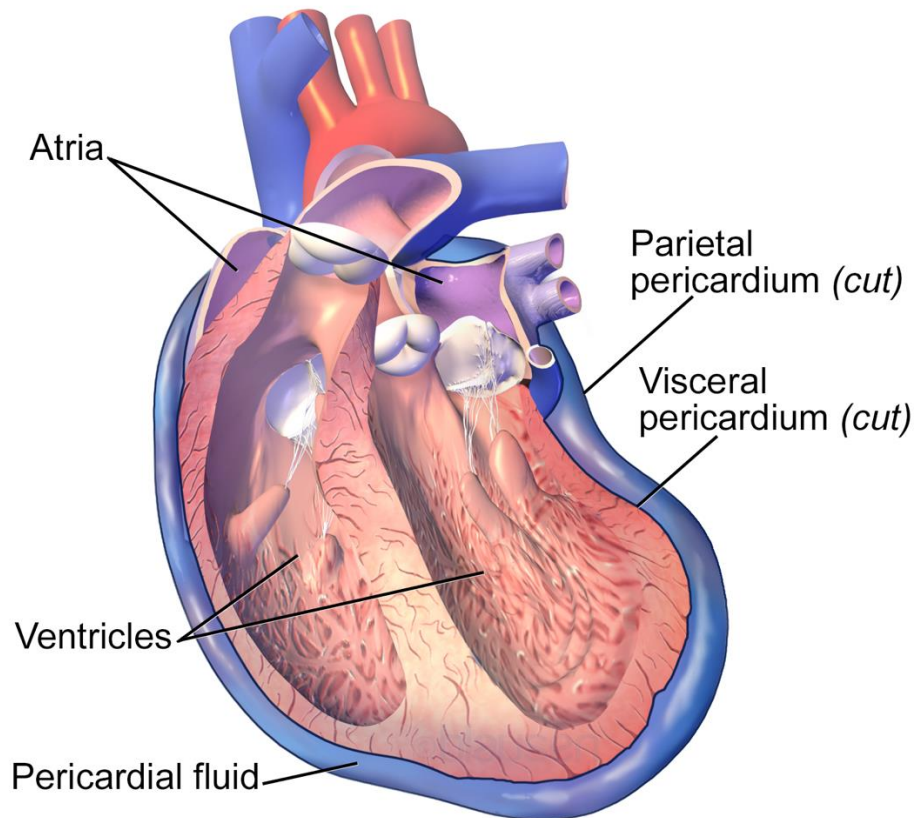
### Asphyxia

- There are links to sub-types of asphyxia.
- <https://en.wikipedia.org/wiki/Asphyxia>

# Page 43 – Death by Python

See [Asphyxia](#) on page 41 of the bibliography

How does a Python kill you?



## Pericardial Sac

That's your heart. Just remember that for now.

- <https://en.wikipedia.org/wiki/Pericardium>

### Snake constriction rapidly induces circulatory arrest in rats

- Summary
  - Scientists offered unconscious rats to hungry pythons and measured a whole wack of scientific parameters in the soon-to-be-dead rats.
  - Okay ... no doubt about it ... this is fascinating ... but you need to learn some **anatomy** (the parts) and some **physiology** (how the parts work).
- Anatomy & Physiology
  - **Pericardium**
    - “pair ee card ee um”  
or
    - “pair ih card ee um”
    - The pericardium is the slippery sac the heart sits inside. It's the blue sac in the diagram above.
    - Except it's a little more complex than this. Imagine you put the heart into a plastic bag. Now put that plastic bag inside another one. The two bags are the **pericardium** a.k.a. **pericardial sac**. Furthermore, the two bags are so close together that there is only a 'potential space' between them. Or at the very least, only a tiny volume of fluid in that space – that's very important. In the diagram above:
      - The inner bag is the **visceral pericardium** (“viss er ul”).
      - The outer bag is the **parietal pericardium** (“pa rye et ul”).
      - Don't obsess on the names, just remember it's two bags.
  - **Tamponade**
    - “tam pon odd” .. but more like “tam pon ahd”

- This is a bad thing.
  - If fluid gets into that potential space between the two sacs, the heart cannot expand. This can kill you or a rat.
- Pressures
  - Now it's gonna get more technical, so put your thinking cap on.
  - **Pressure**
    - If you make a fist and push your knuckles into the palm of your hand, that's pressure you're feeling. Pressure is force per unit area.
    - This is measured in milli-meters (mm) of mercury ... which is confusing because what does that have to do with your fist? In fact, we measure pressure by how much the earth's atmosphere pushes on things. And the way this is measured in a lab is how high the mercury in a glass tube rises. Specifically, how many milli-meters does it rise. So that's why the units of pressure are 'millimeters of mercury.'
  - **Diastolic pressure**
    - "die ass tall ick"
    - This is the blood pressure when the heart *relaxes*.
  - **Pericardial pressure**
    - This is pressure inside the pericardial sac. If this pressure is even a tiny bit higher than diastolic pressure inside the heart, the heart cannot expand. This is the mechanism of tamponade. Even 3 mm higher can cause tamponade.
  - When the python squeezes the rat, there is a massive rise (150 mm) in pericardial pressure. The heart cannot expand at all. This is extreme **tamponade**. The rat dies of '**circulatory arrest**' since the blood can no longer circulate.
- Asphyxia?
  - Now ... in terms of **asphyxia** ... the old school of thought was that the python prevented the lungs from expanding ... and this is probably true since the chest is being compressed. And this fits the definition of asphyxia, which is kind of broad. But importantly, the scientific study showed that the tamponade occurred very rapidly. So asphyxia probably has a lesser role to play. You are free to ruminate on these differences when a python is squeezing you to death.
  - There were lots of other parameters measured.
    - Heart rate decreased by half.
    - Blood pressure in the periphery decreased by half.
    - Blood pressure in the chest increased 6-fold.
    - Potassium levels in the blood increased.
  - I skipped some details, like exactly how that pericardial pressure rises so rapidly (other than the obvious python exerting pressure) ... and that's because I don't really know. I think it's because the pressure inside the chest cavity (Central Venous Pressure) rises rapidly. But what I'm not sure about is if the volume of fluid in the pericardial sac actually increases. I kind of don't think so. Someone knows ... let me know svp.
- Verbatim
  - As **legless predators**, snakes are unique in their ability to immobilize and kill their prey through the process of constriction, and yet how this pressure incapacitates and ultimately kills the prey remains unknown.
    - Okay, if nothing else, the term "legless predator" is ominous and strange.
- Source
  - Journal of Experimental Biology
    - 1 July 2015
    - <https://journals.biologists.com/jeb/article/218/14/2279/14389/Snake-constriction-rapidly-induces-circulatory>
- Authors
  - Scott M. Bobac
  - Katelyn J. McCann
  - Kevin A. Wood
  - Patrick M. McNeal
  - Emmett L. Blankenship
  - Charles F. Zwemer

- Institution
  - Dickinson College, Department of Biology, Carlisle, Pennsylvania, USA
  - All Pets Emergency and Referral Clinic, Aphairetta, Georgia, USA

# Page 44 – Strangling, Carbon Monoxide Poisoning & Cyanide. Generally speaking, a bad day

See [Asphyxia](#) on page 41.

## Strangulation

### *2019 Crime in the United States – Expanded Homicide Data Table 9*

- Summary
  - When in doubt, ask the FBI.
  - There were 13,927 murders in the USA in 2019, and 64 were by **strangulation**.
- Source
  - **FBI**
    - <https://ucr.fbi.gov/crime-in-the-u.s/2019/crime-in-the-u.s.-2019/topic-pages/tables/expanded-homicide-data-table-9.xls>

### *'I thought I was about to die': Management of non-fatal strangulation in general practice*

- Summary
  - No doubt about it, this is morbidly fascinating.
  - Table 1 gets into the nitty gritty of what actually gets squeezed shut – was it a vein, artery, or airway? The fancy terms are:
    - **Venous occlusion**
    - **Arterial occlusion**
    - **Airway occlusion**
  - **Occlusion** (“awk clue zhun”) means flow – either blood or air – through a tube is blocked.
- Verbatim
  - Pressure to the neck can be via one or two hands applying the pressure (**manual strangulation**), by applying pressure using a forearm from behind (**chokehold strangulation**), or using a **ligature** or object. Pressure can be gradually exerted, sudden, or on-off in nature, particularly during a prolonged struggle or dynamic assault. Research from the 1940s on institutionalised ‘volunteers’ demonstrated a consistent sequence of events during strangulation.<sup>24</sup> Generally, **loss of consciousness occurred around 6.8 seconds** (range 4-10 seconds), possible **anoxic seizure** by

14 seconds (range 11–17 seconds) and, occasionally, **urinary incontinence** from 15 seconds and then **faecal incontinence** from 30 seconds.<sup>24</sup> There was often a period of post-strangulation confusion, often without awareness of their loss of consciousness.

- Translation
  - **Ligature** means something like a rope or wire.
  - **Anoxic seizure** means a seizure caused by a complete lack of oxygen.
  - **Urinary incontinence** means loss of control of the bladder, in other words, pee your pants.
  - **Faecal incontinence** means loss of control of the bowels, in other words, poop your pants.
    - *Faecal* is the British (or Australian) spelling.
    - *Fecal* is the American spelling.
- Source
  - Australian Journal of General Practice
    - <https://www1.racgp.org.au/ajgp/2022/november/management-of-non-fatal-strangulation>

## Carbon monoxide poisoning

See *All Things Blood* on page 715 of the bibliography.

## Cyanide



- **Cyanide** is a Carbon (C) atom triple bonded to a Nitrogen (N) atom. Does that help you?
- <https://en.wikipedia.org/wiki/Cyanide>



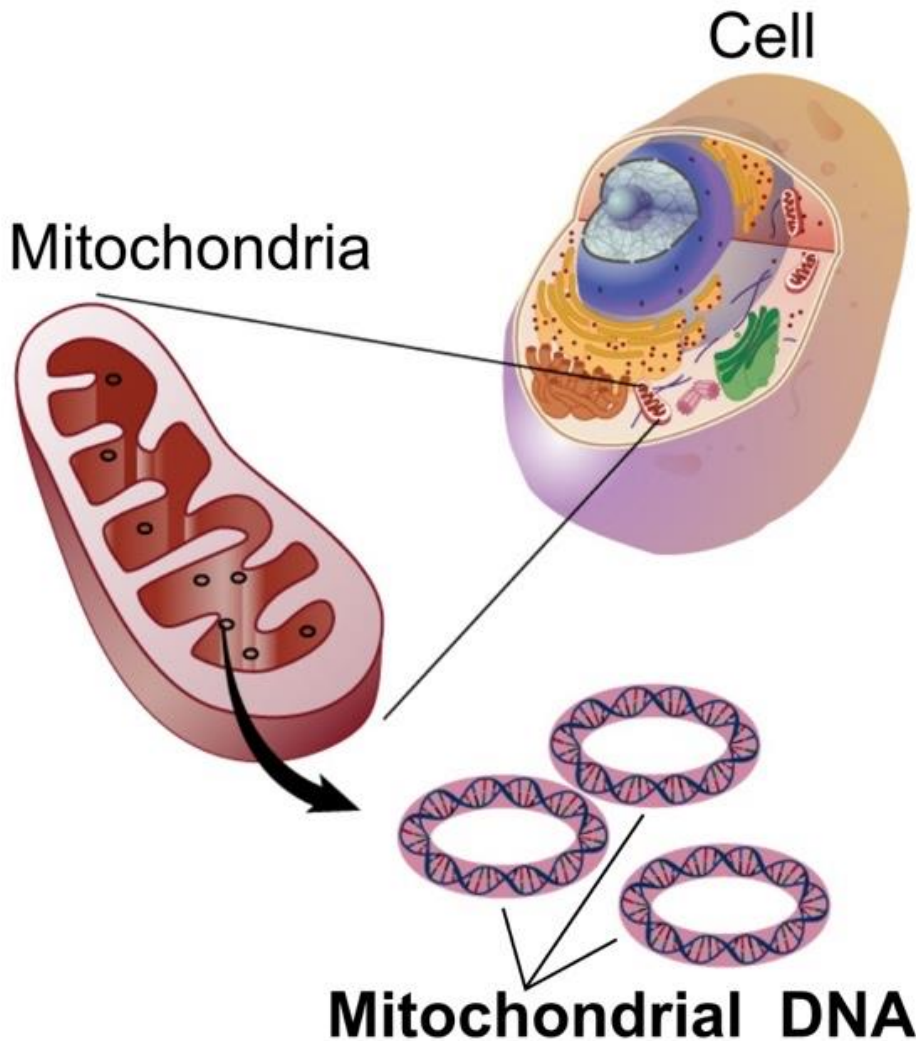
What color are those robin eggs? **Cyan**. The lips turn this color with **Cyanide** poisoning.

- <https://en.wikipedia.org/wiki/Cyan>

### Cyanide: Exposure, Decontamination, Treatment

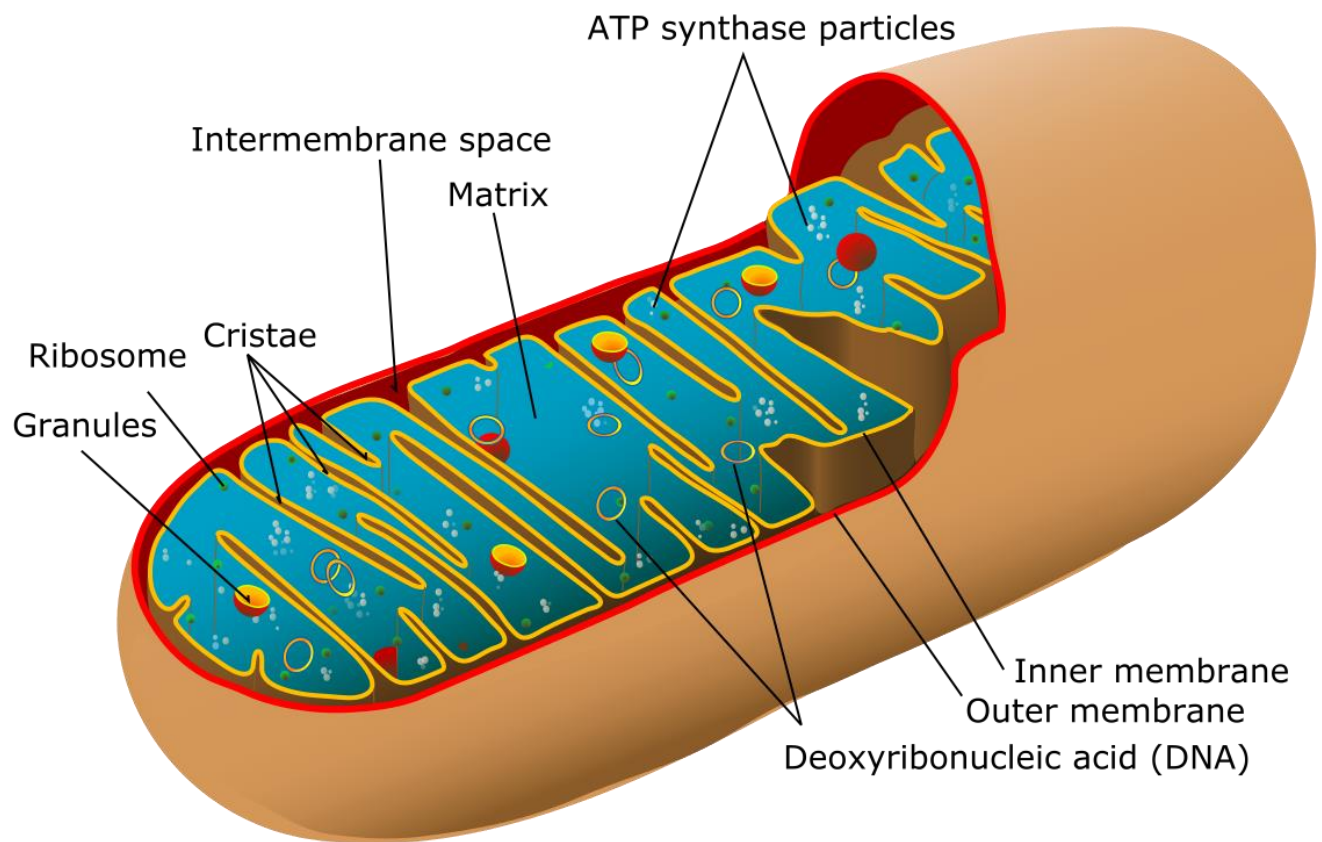
- Summary
  - **This is all rather practical advice on cyanide poisoning.** It takes about 3 minutes to read.

- CDC
  - 7 February 2023
  - <https://www.cdc.gov/chemicalemergencies/factsheets/cyanide.html#:~:text=Symptoms%20from%20cyanide%20poisoning%20can,High%20or%20low%20blood%20pressure>



See that weird thing that got zoomed up in size? That's a **mitochondria** – it's one of those words that ends up being either singular or plural. The technical singular is **mitochondrion** ("might oh kon dree on"). Most definitely don't lose sleep over this. And don't lose sleep over the **mitochondrial DNA** – it's not important here.

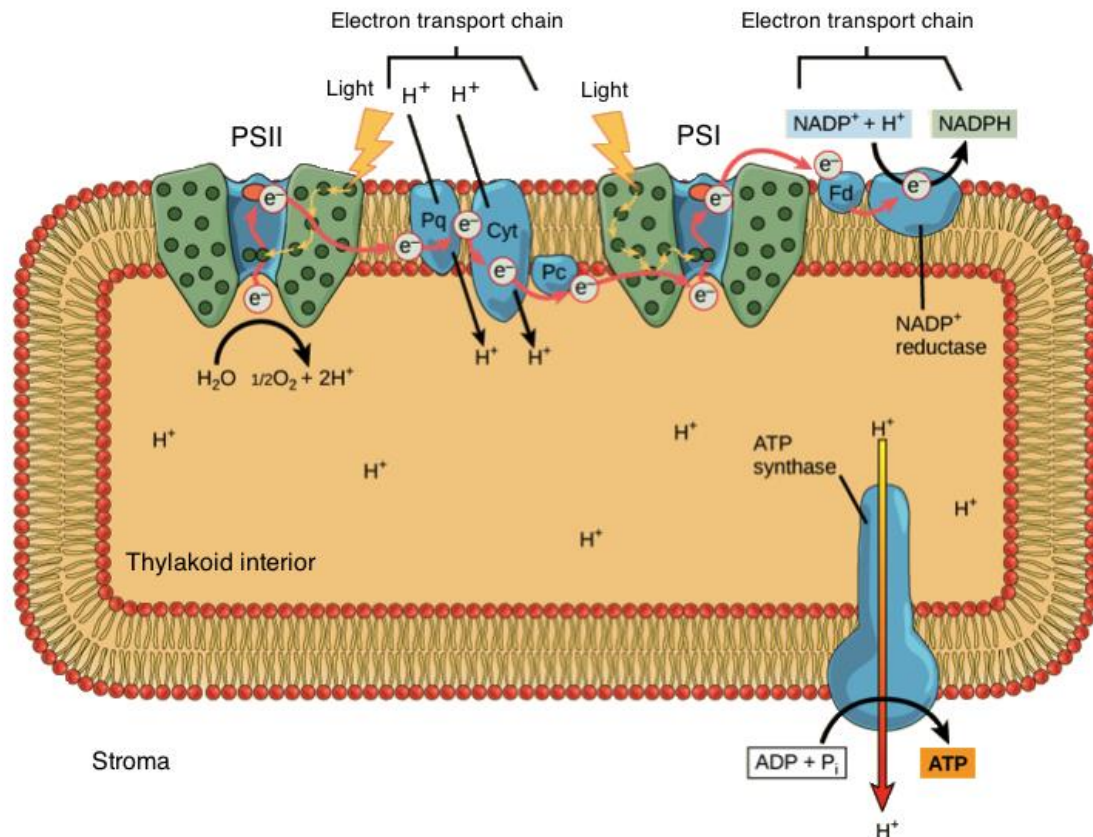
- Please pay attention to this normal sequence of operations:
  - When you eat food containing sugar (**glucose**) ... it ends up in your stomach ... then your intestines extract the glucose ... then the glucose gets sent all over the body in the blood ... the glucose eventually ends up inside a cell ... and gets broken down via 10 chemical steps to something called **pyruvate** ("pie roo vate") ... the pyruvate ends up inside the mitochondria ... and it gets turned into energy.
- **Cyanide poisons the mitochondria.** Put another way, cyanide stops energy metabolism.
- [https://en.wikipedia.org/wiki/Mitochondrial\\_DNA](https://en.wikipedia.org/wiki/Mitochondrial_DNA)



That's a **mitochondria**.

- See the **Matrix**? That's where the pyruvate ends up.
- See that thing called the **Inner membrane**? Located on this is a fantastically complex set of chemical structures called the **electron transport chain (etc)**.
- Source
  - [https://en.m.wikipedia.org/wiki/File:Animal\\_mitochondrion\\_diagram\\_en\\_%28edit%29.svg](https://en.m.wikipedia.org/wiki/File:Animal_mitochondrion_diagram_en_%28edit%29.svg)
    - Mariana Ruiz Villarreal [LadyofHats](#) who states: the diagram i made myself using adobe illustrator.





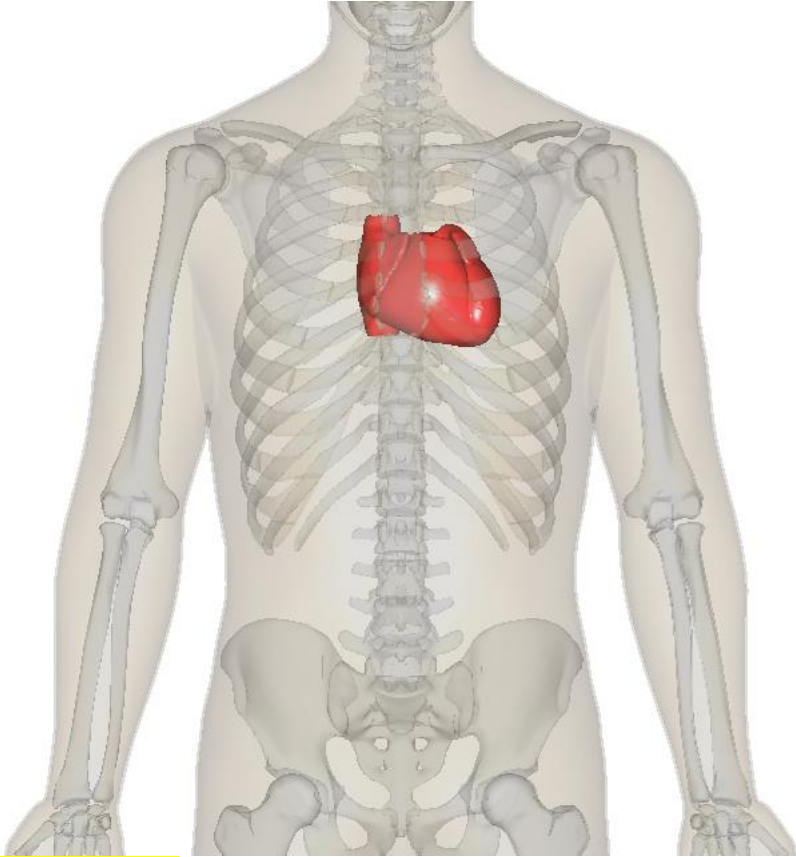
That's a drawing of a mitochondria with only the inner membrane.

- See what is labelled as the **Electron transport chain**?
- See the blue blob labelled **Cyt**? That means **Cytochrome c oxidase** – it's an enzyme (a chemical speeder upper). Getting downright technical, cyanide inhibits *cytochrome c oxidase*. The electrons cannot flow. Energy cannot be produced. This is also known as **chemical asphyxia**.
- That was an entire semester reduced to a paragraph and falls far short of the complexity.
- [https://en.m.wikipedia.org/wiki/Electron\\_transport\\_chain](https://en.m.wikipedia.org/wiki/Electron_transport_chain)

# Page 45 – How Corona-virus Got Its Name

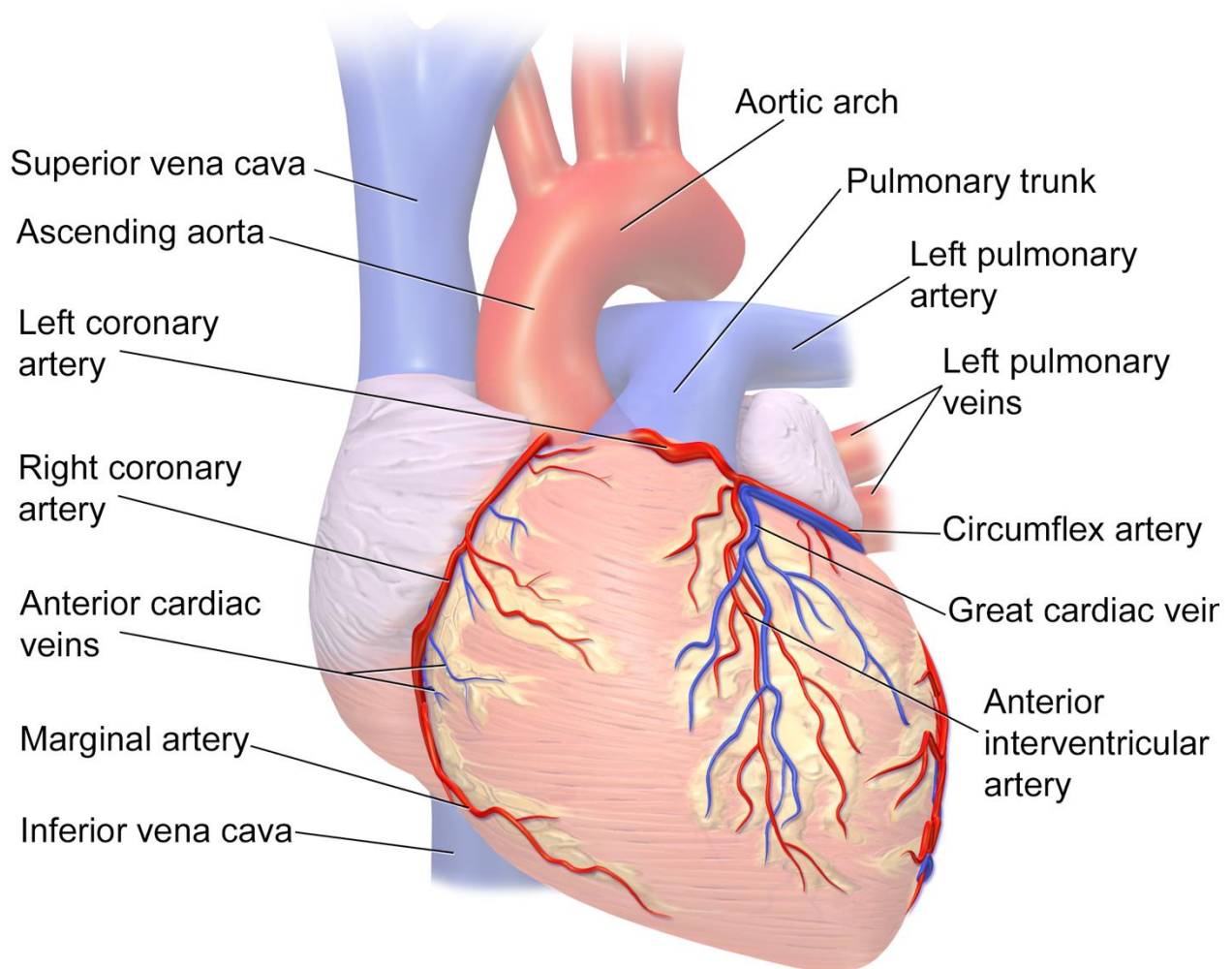
See Asphyxia on page 41.

Coronary arteries



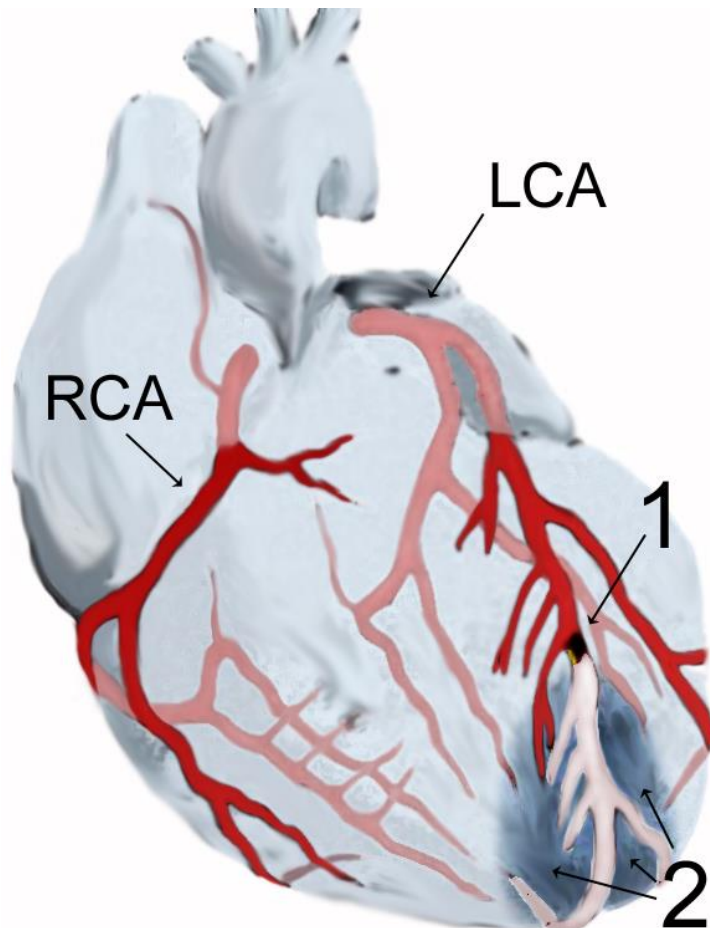
**That's your heart.**

- The heart is a **pump** but it also needs blood itself because it's a **muscle**. Blood carries the oxygen and sugar (glucose) that the muscle needs to contract.
- <https://en.wikipedia.org/wiki/Heart>



That's your heart.

- The big curving red tube is the **aorta** carrying blood out of the heart. It is the diameter of a garden hose and is the largest artery in the body. It is insanely cool to feel the aorta of a living person during cardiac surgery. It has a definite feel of pressure to it. It's a bit like pushing into a wiener dog balloon that is decently inflated. Kinda sorta.
- See the **Right coronary artery**? It arises at the very bottom of the aorta at the **aortic root** (not labelled). It is the blood supply to the right ½ of the heart.
- See the **Left coronary artery**? It also arises at the aortic root. It is the blood supply to the left ½ of the heart.
- <https://en.wikipedia.org/wiki/Heart>



### That's a **Heart Attack**.

- The RCA (**Right Coronary Artery**) is okay.
- **The LCA (Left Coronary Artery) has a blockage where the black spot is** – the arrow labelled **1** is pointing at it. Downstream from the blockage, the heart muscle tissue dies, which is the dark gray region where the three arrows from **2** are pointing.
- [https://en.wikipedia.org/wiki/Right\\_coronary\\_artery](https://en.wikipedia.org/wiki/Right_coronary_artery)

### Coronary arteries

- Summary
  - **This is a simple diagram of the blood supply of the heart.** It shows:
    - **Right Coronary Artery (RCA)**
      - Notice how it descends on the front (anterior) surface of the heart then wraps around the back (posterior). During its whole course, small branches of the artery (not shown) penetrate the heart and supply the muscle.
    - **Left Coronary Artery (LCA)**
    - **Circumflex Artery**
      - It's a branch of the LCA. It heads to the back surface of the heart.
- Source
  - **The Texas Heart Institute**
    - No date, no author.
    - <https://www.texasheart.org/heart-health/heart-information-center/topics/the-coronary-arteries/>

### Coronary Artery Anatomy (3D Anatomy Tutorial)

- Summary
  - This is a 5-minute video on the coronary arteries that supply the heart. It's in 3D.
  - This makes more sense if you first look at the article above by the [Texas Heart Institute](#).
- Source
  - [Geeky Medics](#)
  - 17 May 2019
  - <https://www.youtube.com/watch?v=xuIFY3onWPQ>

### Coronary artery disease

- Summary
  - [Cardiologist Stephen Kopecky, M.D.](#) gives a 5-minute video all about the **Coronary Artery Disease**, which is essentially narrowing of the coronary arteries → leading to reduced blood supply to the heart.
- Source
  - [Mayo Clinic](#)
    - YouTube video is embedded. 11 Feb 2022
  - <https://www.mayoclinic.org/diseases-conditions/coronary-artery-disease/symptoms-causes/syc-20350613>

## Corona of sun

### What is the Sun's Corona?

- There is a [NASA](#) photo and details on the corona.
- 22 July 2021
- <https://spaceplace.nasa.gov/sun-corona/en/>

### Stellar corona

- Loads of images.
- [https://en.wikipedia.org/wiki/Stellar\\_corona](https://en.wikipedia.org/wiki/Stellar_corona)

## Coronavirus name

### A Novel Coronavirus from Patients with Pneumonia in China

- Summary
  - The authors describe the virus as having the appearance of the solar corona.
  - This paper was already mentioned on Page 1 of the bibliography.
- Verbatim
  - Virus particles had quite distinctive spikes, about 9 to 12 nm, and gave virions the appearance of a solar corona.
- Translation
  - **nm** means nano-meter. Recall that the coronavirus is about 100 nm in diameter. So the spikes at 9 to 12 in size are about 1/10<sup>th</sup> the size of the virus.
- Source
  - New England Journal of Medicine
    - 24 Jan 2020
    - <https://www.nejm.org/doi/full/10.1056/NEJMoa2001017>
- Authors
  - [Zhu et al](#), specifically:

- Na **Zhu**, Ph.D., Dingyu **Zhang**, M.D., Wenling **Wang**, Ph.D., Xingwang **Li**, M.D., Bo **Yang**, M.S., Jingdong **Song**, Ph.D., Xiang **Zhao**, Ph.D., Baoying **Huang**, Ph.D., Weifeng **Shi**, Ph.D., Roujian **Lu**, M.D., Peihua **Niu**, Ph.D., Faxian **Zhan**, Ph.D., Xuejun **Ma**, Ph.D., Dayan **Wang**, Ph.D., Wenbo **Xu**, M.D., Guizhen **Wu**, M.D., George F. **Gao**, D.Phil., and Wenjie **Tan**, M.D., Ph.D.
- They are part of the China Novel Coronavirus Investigating and Research Team

## Page 46 – A Complicated Coronavirus Death

See Asphyxia on page 41.

See the Coronary Artery information on page 45.

## Page 47 – Death by Old Age is Not Allowed

See the Death Certificate details on page 40.

### Signs and Symptoms

#### Signs and Symptoms

- Summary
  - This is a classic description by a medical doctor in 1968.
- Verbatim
  - Most physicians, if asked to distinguish between signs and symptoms, would reply in a fashion something like this:
  - A **symptom** is a manifestation of disease apparent to the patient himself, while a **sign** is a manifestation of disease that the physician perceives.
  - The sign is objective evidence of disease; a symptom, subjective.
  - Symptoms represent the complaints of the patient, and if severe, they drive him to the doctor's office. If not severe, they may come to light only after suitable questions. The patient perceives, for example, subjective pains and discomforts [Doctor, I have a bad headache], or disturbances of function [Doctor, I can't move my arm the way I used to], or some simple appearance [Doctor, I have had this rash for the past ten days and I'm worried about it].
- Source
  - Journal of the American Medical Association (JAMA)
    - JAMA ("Ja ma") is a pretty famous journal in Medicine.
    - 28 October 1968
  - <https://jamanetwork.com/journals/jama/article-abstract/341611>
- Author
  - Lester S. King, MD


# Page 48 – CFR & Nuns with Shotguns

## Case Fatality Rate (CFR)

### Case Fatality Ratios

- Summary

- The simple math for calculating the Case Fatality Rate is at the very top.
- There are examples of the **Case Fatality Rate** due to eating food that has been infected by various types of bacteria.

-  Click on Table 13: In the United States in 2015 there were 77 deaths (from what could loosely be called '**food poisoning**') in a total of 20,107 cases.

$$\frac{77 \text{ deaths}}{20,107 \text{ cases}} = 0.0038 \text{ (that's a fraction)}$$

Now multiply the fraction by 100 to get a %.

$$0.0038 \times 100 = 0.38\% \text{ (that's a percent)} = \text{That's the Case Fatality Rate.}$$

- This data is from a CDC division called the Foodborne Diseases Active Surveillance Network (FoodNet).
- By the way, in the Table you'll see a bacteria named *Yersinia*. Is that the Plague bacteria, *Yersinia pestis*? No. It's a cousin called *Yersinia enterocolitica* which causes diarrhea.

- Source

- CDC
  - 8 March 2016
  - <https://www.cdc.gov/foodnet/reports/data/case-fatality.html>

### Principles of Epidemiology in Public Health Practice: Lesson 3: Measure of Risk: Section 3: Mortality Frequency Measures

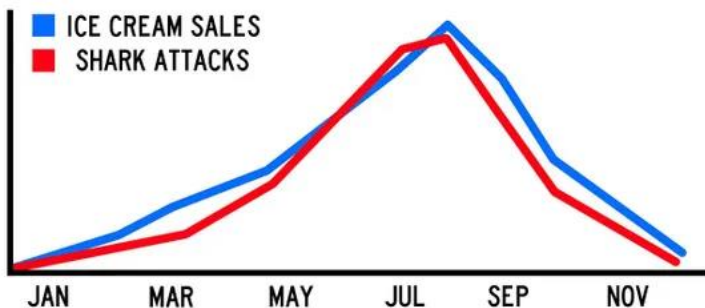
- Summary

- This is a CDC course.
- **Case Fatality Rate** is ½ way down the page.
- There are loads of Mortality definitions:
  - **Crude Death Rate**
  - **Cause-specific Death Rate**
  - **Neo-natal Mortality Rate**
    - These are deaths *before, during, and shortly after* delivery of the baby. It's a window in time.
    - Neo means new. Natal means birth.
  - **Infant Mortality Rate**
  - **Maternal Mortality Rate**

- **Case Fatality Rate**
- And more.
- There are many examples and Q&A exercises.
- This webpage showcases how **epidemiologists** at the **CDC** thoroughly analyse data. But this stuff takes time – usually **years**. And the more time there is, the more data that is analysed. Then the patterns emerge.
- Source
  - CDC
    - 18 May 2012
    - <https://www.cdc.gov/csels/dsepd/ss1978/lesson3/section3.html>

## Correlation

### CORRELATION IS NOT CAUSATION!



Both ice cream sales and shark attacks increase when the weather is hot and sunny, but they are not caused by each other (they are caused by good weather, with lots of people at the beach, both eating ice cream and having a swim in the sea)

#### Correlation Definitions, Examples & Interpretation

- Summary
  - That **fabulous graph** above of **sharks** and **ice cream** is in this article.
  - These are excellent, concise, simple definitions with easy examples. They don't kill you with jargon.
- Source
  - Simply Psychology
    - 2020
    - <https://www.simplypsychology.org/correlation.html>
    - By the way, the link at the top left of this page to **Theories** opens up to all sorts of coolness on psychology.
- Source
  - Dr. Saul Mcleod, PhD psychology

#### Correlation and Causality

- Summary
  - This is a 10 minute video by **Salman Khan** all about the nuances of **cause** and **correlation**. He's a fabulous teacher and is funny and a bit quirky. He has a Master of Science (MSc) in engineering from the Massachusetts Institute of Technology (MIT) and a Master of Business Administration (MBA) from Harvard University.



- Source
  - Khan Academy
    - There are vast amounts of high-quality information on the Khan Academy website, covering everything from math to biology to astronomy to finance. They start simple and build up to complex.
    - If you are useless at helping your kid with their homework because you have no idea how to multiply fractions ( $\frac{1}{2} \times \frac{3}{4} = ??$ ), send them to this free site.
    - <https://www.khanacademy.org/math/probability/xa88397b6:scatterplots/estimating-trend-lines/v/correlation-and-causality>

Who first coined the phrase "correlation does not imply causation"?

- Some decent guesses here.
- Stack Exchange
  - 2021
  - <https://stats.stackexchange.com/questions/551312/who-first-coined-the-phrase-correlation-does-not-imply-causation>

## Nuns with Shotguns

The shotgun is from a Manga doll I bought in Amsterdam. Full disclosure 'n all that.

# Page 49 – Risk Factors – Doctors are Krazy about them

## Risk Factors

People with Certain Medical Conditions

- Summary
  - This is the CDC page on **COVID Risk Factors (RF)**. It's pretty thorough and readable.
- Suggestion
  - If you're curious about the risk factors on anything, then Google this:
    - *CDC risk factors [ name of disease or illness ]*
    - e.g., *CDC risk factors Breast Cancer*
    - e.g., *CDC risk factors drowning*
  - If there is no hit for the CDC, then Google this:
    - *risk factors [ name of disease or illness ]*
- Source
  - CDC
    - 19 October 2022

- <https://www.cdc.gov/coronavirus/2019-ncov/need-extra-precautions/people-with-medical-conditions.html>

## Body Mass Index (BMI)

### Mayo Clinic BMI and waist circumference calculator

- Verbatim
  - Body mass index (BMI) uses weight and height to estimate body fat.
- Formula
  - **Body Mass Index (BMI) = weight / height<sup>2</sup>**
    - Yes, your weight divided by your height squared.
    - This formula is based on the metric system, meaning weight in kilograms and height in centimeters.
    - You may notice in my formula the number 703. It's a correction factor for converting Imperial units (pounds and inches) to metric (kg and centimeters). This is a non-issue if you use an automated calculator.
- Summary
  - This website has a calculator to figure out your Body Mass Index (BMI) using either pounds and inches, or kilograms and centimeters. Plus it asks for your age.
- Examples
  - If you are 5 feet tall and weigh 85 pounds you are probably underweight. Not enough fat. Your BMI is 17.
  - If you are 5 feet tall and weight 300 pounds you are probably overweight. Too much fat. Your BMI is 59.
  - If the BMI is greater than 30, that's starts to be a concern for **Obesity**.
  - If the BMI is less than 17, that's starts to be a concern for **Anorexia** (the **eating disorder**). A BMI of 15 would be severe Anorexia.
- Source
  - Mayo Clinic
    - <https://www.mayoclinic.org/diseases-conditions/obesity/in-depth/bmi-calculator/itt-20084938>

### Adult BMI Calculator

- Summary
  - There is the CDC version of the calculator, and there are loads of links on BMI.
- Source
  - CDC
    - 2 September 2022
    - [https://www.cdc.gov/healthyweight/assessing/bmi/adult\\_bmi/english\\_bmi\\_calculator/bmi\\_calculator.html](https://www.cdc.gov/healthyweight/assessing/bmi/adult_bmi/english_bmi_calculator/bmi_calculator.html)

**Page 50 – Zombie Day at the  
CDC**

## Definitions

The **ONLINE ETYMOLOGY DICTIONARY** has simple definitions if you like work origins a.k.a. **etymology**.

- **En-demic**
  - "particular to a people or locality," 1650s (*endemic*), with **-ic** + **Greek *endemos*** "native, dwelling in (a place), of or belonging to a people," from *en* "in" (see **en-** (2)) + *dēmos* "people; district" (see **demotic**). From 1660s as a noun.
  - <https://www.etymonline.com/search?q=endemic>
- **Epi-demic**
  - c. 1600, "common to or affecting a whole people," originally and usually, though not etymologically, in reference to diseases, from French *épidémique*, from *épidémie* "an epidemic disease," from Medieval Latin *epidemia*, from **Greek *epidēmia*** "a stay in a place; prevalence of an epidemic disease" (especially the plague), from *epi* "among, upon" (see **epi-**) + *dēmos* "people, district" (see **demotic**). Also see **-ic**.
  - <https://www.etymonline.com/search?q=epidemic>
- **Pan-demic**
  - of diseases, "incident to a whole people or region," 1660s, from Late Latin *pandemus*, from **Greek *pandemos*** "pertaining to all people; public, common," from *pan-* "all" (see **pan-**) + *dēmos* "people" (see **demotic**). Modeled on **epidemic**; OED reports that it is "Distinguished from *epidemic*, which may connote limitation to a smaller area." The noun, "a pandemic disease," is recorded by 1853, from the adjective. Related: *Pandemia*.
    - OED means Oxford English Dictionary.
  - <https://www.etymonline.com/search?q=pandemic>
- **Pan-gea (Pangaea)**
  - "supercontinent of the late Paleozoic era," 1924, from **Greek *pan-*** "all" (see **pan-**) + ***gaia*** "earth" (see **Gaia**). First attested in German, 1920, in Alfred Wegener's "*Die Entstehung der Kontinente und Ozeane*" (but according to OED the word is not found in 1914 first edition).
  - <https://www.etymonline.com/search?q=pangea>
- **Pan-thalassa**
  - "universal sea," such as that which surrounded **Pangaea**, 1893 (Suess), from **Greek *pan-*** "all" (see **pan-**) + ***thalassa*** "sea" (see **thalasso-**).
  - <https://www.etymonline.com/search?q=panthalassa>
- **Pan-theon**
  - early 15c., *Panteon* "the Pantheon in Rome," from Latin *Pantheon*, name of a temple dedicated to all the gods built in Rome c. 25 B.C.E. by Agrippa (since 609 C.E. made into the Christian church of Santa Maria Rotonda), from Greek *Pantheon* (*hieron*) "(shrine) of all the gods," from *pantheon*, neuter of *pantheios*, from ***pan-*** "all" (see **pan-**) + *theios* "of or for the gods," from ***theos*** "god" (from PIE root **\*dhes-**, forming words for religious concepts). In reference to any group of exalted persons from 1590s.
  - <https://www.etymonline.com/search?q=pantheon>




### CDC address

- **Centers for Disease Control and Prevention, 1600 Clifton Road, Atlanta, GA 30329 USA**
- <https://www.cdc.gov/contact/index.htm>

### Historical Perspectives History of CDC

- Summary
  - **The CDC has gone through a few name changes.**
  - **Center for Disease Control** 1970
  - **Centers for Disease Control** 1981
  - **Centers for Disease Control and Prevention** 1992
- Verbatim
  - As the scope of CDC's activities expanded far beyond communicable diseases, its name had to be changed. In 1970 it became the **Center** for Disease Control, and in 1981, after extensive reorganization, Center became **Centers**. The words "and **Prevention**" were added in 1992, but, by law, the well-known three-letter acronym was retained. In health emergencies CDC means an answer to SOS calls from anywhere in the world, such as the recent one from Zaire where Ebola fever raged.
- Source
  - **CDC**
    - 09 / 19 / 98 = 19 September 1998
    - <https://www.cdc.gov/mmwr/preview/mmwrhtml/00042732.htm>


### CDC Organization

- Summary
  - **The CDC has many Centers.**
  -  Click on a link to investigate.
- [Center for Forecasting and Outbreak Analytics \(CFA\)](#)
- [Global Health Center \(GHC\)](#)
- [National Center on Birth Defects and Developmental Disabilities \(NCBDDD\)](#)
- [National Center for Chronic Disease Prevention and Health Promotion \(NCCDPHP\)](#)
- [National Center for Emerging and Zoonotic Infectious Diseases \(NCEZID\)](#)
- [National Center for Environmental Health \(NCEH\)/ Agency for Toxic Substances and Disease Registry \(ATSDR\)](#)
- [National Center for Health Statistics \(NCHS\)](#)
- [National Center for HIV, Viral Hepatitis, STD, and TB Prevention \(NCHHSTP\)](#)
- [National Center for Immunization and Respiratory Diseases \(NCIRD\)](#)
- [National Center for Injury Prevention and Control \(NCIPC\)](#)
- [National Center for State, Tribal, Local, and Territorial Public Health Infrastructure and Workforce \(NCSTLPHIW\)](#)
- [National Institute for Occupational Safety and Health \(NIOSH\)](#)
- Source
  - CDC
    - <https://www.cdc.gov/about/organization/cio.htm>

# Page 51 – <sup>50</sup><sub>50</sub> – Scale, as in the relative size of things

## Scale

### *The Scale of the Universe 2*

- Summary
  - This is the COOLEST scale site.
  -  Scroll to increase or decrease in scale to see everything from quark to virus to elephant to galaxies.
- Source
  - Cary Huang
  - No date
  - <https://htwins.net/scale2/>

### *Lippincott's Illustrated Reviews: Microbiology*

- Summary
  - This is a basic textbook on **bacteria** and **viruses**.
  - I give details of this book on page 30.
- Source
  - You can buy it on amazon.
    - Richard A. Harvey PhD, Cynthia Nau Cornelissen PhD
    - <https://www.amazon.com/Lippincott-Illustrated-Reviews-Microbiology/dp/1608317331>

## Red blood cell size

### *Wheater's Functional Histology: A Text and Colour Atlas*

- See page 143.

## Blood cell deformation

### Background

- **Blood cells** travel in the blood.
- **Blood vessels** are tubes.
  - The **smallest** tube is the **capillary**. Plural, **capillaries**.
- Small things are measured in **microns** ( $\mu\text{m}$  is the metric symbol).

### Pay attention to diameter!

#### Structure

**Capillary** (smallest blood vessel. It's a tube.)

#### Diameter ( $\mu\text{m}$ )

4 – 10 microns\*

Red Blood Cell (RBC)	7 microns
Neutro-phil (WBC)	14 microns
▪ “New trow fill”	
▪ The neutro-phil is 1 of the 5 types of White Blood Cell (WBC).	

\* Different sources give different values for capillary diameter. It’s basically 4 to 10  $\mu\text{m}$ .

### Question

- If blood cells are **wider** than the smallest tube, how do they pass through?
- Restated, if a Red Blood Cell is 7  $\mu\text{m}$  wide how does it pass through a tube (the capillary) that is only 4  $\mu\text{m}$  wide?
- Restated, if a White Blood Cell is 14  $\mu\text{m}$  wide how does it pass through a tube (the capillary) that is only 4  $\mu\text{m}$  wide?

### Short answer

- The blood cells are **squishy**. They **deform** in shape, as if you were squishing cookie dough in your hand.

### Long answer

- I sent an email to a **blood specialist** a.k.a. **hematologist** (“heem ah tall oh jist”), whose name I will leave anonymous.

Dear Dr Blood,

I hope you can answer a simple question I have about blood flow.

How does a neutrophil (diameter 14  $\mu\text{m}$ ) not get stuck passing through capillaries (7  $\mu\text{m}$ )? I don’t mean how does it pass through the endothelium, enroute to an infection. I mean, how does it actually flow through a capillary? I know the RBC deforms and its size matches the capillary. But I am stuck on the mechanics of how an object whose diameter exceeds the diameter of a tube can pass through it.

Sincerely,

Al Jones, MD CCFP

Dear Al,

In addition to their ability to **tether**, **roll**, **crawl** and **extravasate**, **neutrophils** are also **deformable**, though less so than **RBCS**.

In the inflammatory state, neutrophils become stiffer and less deformable, further increasing their transit time. This is most evident in the pulmonary capillary bed.

Best,

Dr. Blood

### More background since that email exchange was in doctorspeak

- **White Blood Cells (WBC’s)** deform to pass through the tube. This much you already know.
- White Blood Cells are also able to **pass through** the wall of the capillary (the smallest tube). Yes, **right through it**. That’s how they get to the bacteria in your infected finger ... and kill them.
- The White Blood Cells, amazingly, perform an act called **pavementing** where they **flatten** onto the inner lining of the capillary. Then they **deform** in shape to **squeeze through** the tiny, tiny, tiny spaces between the cells that make the inner lining. That blood vessel lining is called the **endo-thelium** (“en dough thee lee um”).
- Get it? WBC **travel** in the blood and then **exit** the blood to fight infections. What an awesome design. That’s your immune system.

- The **pulmonary capillary bed** is the massive network of tiny blood vessels in the lungs.
- Now you know some histology!

For more information on blood, see the section at the end of the bibliography called All Things Blood.

## Virus size

### Viremia

- Summary
  - When viruses are present in the blood, that's called **Viremia** ("vy" – rhymes with sky – "reem ee ah").
  - Look how tiny they are, even compared to a blood vessel that's only as wide as your plucked hair ... which tells you how small they are compared to a blood vessel as wide as a pencil.
  - See page 98 Chickenpox virus for an example of viremia.
- Verbatim
  - Viremia: The presence of a virus in the blood.
- Source
  - CDC > Vaccines & Immunizations > Glossary
    - <https://www.cdc.gov/vaccines/terms/glossary.html#v>

# Page 52 – Chop Up Those Credit Cards

## Credit card thickness

### *This Is Why All Credit Cards Are the Same Size*

- Summary
  - This explains credit card size. It is easy to read.
- Summary
  - Reader's Digest
    - 25 March 2022
    - <https://www.rd.com/article/credit-cards-size/>
- Author
  - Morgan Cutolo

### *How to Measure Millimeters*

- Verbatim
  - Grab a normal credit card. Most credit cards (and other types of plastic cards) have a thickness of 30 mil, which comes out to around 0.76 millimeters (0.762 mm, to be exact).
- Source

- **wikiHow**
  - 1 November 2019.
  - <https://www.wikihow.com/Measure-Millimeters>
    - The statement is about ½ way down at 'Method 3.'

## Credit card standards

Credit card standards are set by:

- **International Organization for Standardization (ISO)**
  - 1947 – Founded in **Geneva, Switzerland**.
  - If I understood this correctly, they decided the English abbreviation should be **ISO** because *isos* means *equal* in Greek. Of course, that is very confusing since the intuitive abbreviation would be **IOS**. They set the standard for confusing.
  - **Organisation Internationale de Normalisation (OIN)** in French. Okay that one makes sense.
  - <https://www.iso.org/home.html>
  - [https://en.wikipedia.org/wiki/International\\_Organization\\_for\\_Standardization](https://en.wikipedia.org/wiki/International_Organization_for_Standardization)
- **International Electrotechnical Commission (IEC)**
  - 1906 – Founded in **London** by **British engineers** and **American engineers**.
  - <https://iec.ch/homepage>
  - [https://en.wikipedia.org/wiki/International\\_Electrotechnical\\_Commission](https://en.wikipedia.org/wiki/International_Electrotechnical_Commission)

Official standard

- The official standard is called **ISO/IEC 7810**.
- This is a joint effort of the **ISO** and **IEC**.
- [https://en.wikipedia.org/wiki/ISO/IEC\\_7810](https://en.wikipedia.org/wiki/ISO/IEC_7810)

## Millipede

### *The first true millipede—1306 legs long*

- **Summary**
  - I said 750 legs. Turns out it's 1306 legs as of December 16, 2021.
  - Figure 1 has photos of the legs.
- **Verbatim**
  - The name "millipede" translates to a thousand feet (from *mille* "thousand" and *pes* "foot"). However, no millipede has ever been described with more than 750 legs. We discovered a new record-setting species of millipede with 1,306 legs, *Eumillipes persephone*, from Western Australia. This diminutive animal (0.95 mm wide, 95.7 mm long) has 330 segments, a cone-shaped head with enormous antennae, and a beak for feeding.
  - "You mill ih pees" "per sef ah nee"
- **Source**
  - nature: scientific reports
    - 16 December 2021
    - <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8677783/>
- **Author**
  - **Paul Marek** and others.



## Scale bar

### *Morphometry of SARS-CoV and SARS-CoV-2 particles in ultrathin plastic sections of infected Vero cell cultures*

- Summary
  - **Figure 1** shows the Coronavirus with a 100 nano-meter (nm) **scale bar at the lower right.**
  - This paper is mentioned again on page 116 regarding the 'Vero cell' used by the Wuhan Institute of Virology.
- Source
  - nature Scientific Reports
  - **10 Feb 2021**
  - Michael Laue, Anne Kauter, Tobias Hoffmann, Lars Möller, Janine Michel, Andreas Nitsche
    - Advanced Light and Electron Microscopy, Centre for Biological Threats and Special Pathogens 4 (ZBS 4), Robert Koch Institute, Berlin, Germany
  - <https://www.nature.com/articles/s41598-021-82852-7>

## Bits and bytes

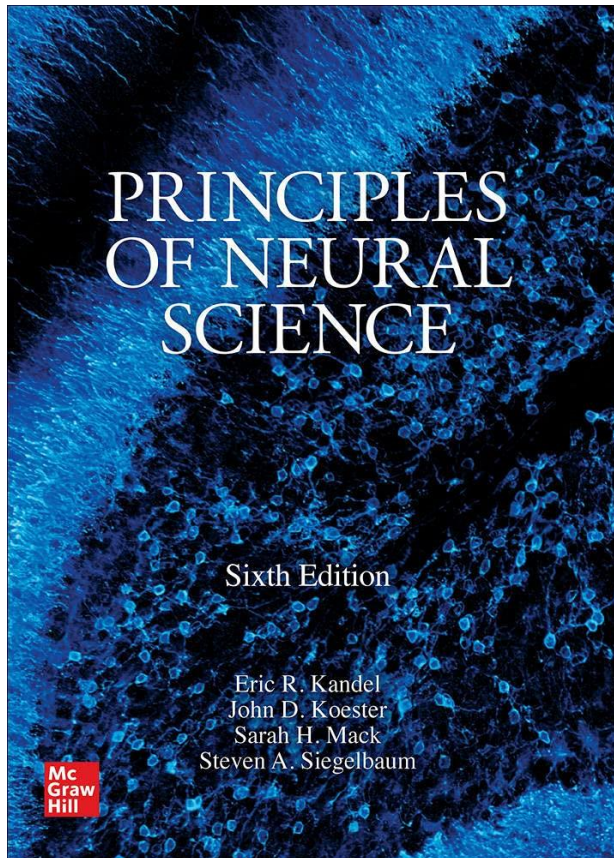
### *Bits and Bytes*

- Source
  - Stanford University
  - No date, no author.
  - <https://web.stanford.edu/class/cs101/bits-bytes.html>
- Summary
  - This is a short and sweet summary of bits and bytes.

## Francis turbine & Three Gorges Dam

See page 6 – China Lockdown

## Brain cell firing rate



*Principles of Neural Science, 6<sup>th</sup> Edition*

- Summary
  - *Principles of Neural Science* is the bible of **neuro-science**. It is a truly magnificent book. Yes, it's 1696 pages.
  - 🖐️ You can **Look inside** on amazon.com and check out the 64 chapters in the table of contents. You'll already start to get a sense of the organization of the brain. **This book is very readable**. It's really nicely written. I think anyone can read it. And you can easily buy a used edition (mine is the 3<sup>rd</sup> edition) for cheaper and still be up to speed.
  - This is not a clinical book to diagnose disease, though it definitely explains afflictions of the brain like **Stroke** and **Parkinson's Disease**. Its focus is on the parts of the brain and how they work. It has a fantastic (and technical) chapter on **sleep** and **dreaming**.
  - What is the conclusion you reach by reading this book (or even just 10% of it)? *My brain is a Ferrari*.
- Source
  - **McGraw Hill**
  - **2021**
  - 1696 pages
  - Amazon.com
    - You can **Look inside**.
    - [https://www.amazon.com/Principles-Neural-Science-Sixth-Kandel/dp/1259642232?ref=mp\\_dp\\_a2a\\_ns\\_d\\_rs\\_dp\\_0&pd\\_rd\\_w=Ut9Kz&pf\\_rd\\_p=121fb73d-5568-4d55-b28e-1cbd44672b1e&pf\\_rd\\_r=6V9Z6S2BAE9DF85P6DQG&pd\\_rd\\_r=d70b3627-6198-4f73-8d51-8de5eec81e1e&pd\\_rd\\_wg=UJwwf](https://www.amazon.com/Principles-Neural-Science-Sixth-Kandel/dp/1259642232?ref=mp_dp_a2a_ns_d_rs_dp_0&pd_rd_w=Ut9Kz&pf_rd_p=121fb73d-5568-4d55-b28e-1cbd44672b1e&pf_rd_r=6V9Z6S2BAE9DF85P6DQG&pd_rd_r=d70b3627-6198-4f73-8d51-8de5eec81e1e&pd_rd_wg=UJwwf)
  - Wikipedia – Principles of Neural Science.
    - [https://en.wikipedia.org/wiki/Principles\\_of\\_Neural\\_Science](https://en.wikipedia.org/wiki/Principles_of_Neural_Science)
- Authors
  - **Eric R. Kandel** – He got the Nobel Prize in Physiology and Medicine.
  - **John D. Koester**

- Sarah H. Mack
- Steven A. Siegelbaum

# Page 54 – Family Tree

*Krakatoa: The Day the World Exploded: August 27, 1883.* Simon Winchester. Harper Perennial; 1st Harper Perennial Ed. Publ. 2005 edition (July 5, 2005).

- [https://www.amazon.com/Krakatoa-World-Exploded-August-1883/dp/0060838590/ref=sr\\_1\\_1?Adv-Srch-Books-Submit.x=0&Adv-Srch-Books-Submit.y=0&qid=1668190473&refinements=p\\_28%3A+1883%5CcKrakatoa%3A+The+Day+the+Worl+d+Exploded%3A+August+27&s=books&sr=1-1&unfiltered=1](https://www.amazon.com/Krakatoa-World-Exploded-August-1883/dp/0060838590/ref=sr_1_1?Adv-Srch-Books-Submit.x=0&Adv-Srch-Books-Submit.y=0&qid=1668190473&refinements=p_28%3A+1883%5CcKrakatoa%3A+The+Day+the+Worl+d+Exploded%3A+August+27&s=books&sr=1-1&unfiltered=1)
- Summary
- This is a book all about the Krakatoa explosion in 1883.
- Sometimes called the 'crack heard around the world' because it was so loud.
- You can **Look inside**.

## 1883 eruption of Krakatoa

- Source
  - There are some cool photos of the eruption of the volcano.
- Source
  - [https://en.wikipedia.org/wiki/1883\\_eruption\\_of\\_Krakatoa](https://en.wikipedia.org/wiki/1883_eruption_of_Krakatoa)

## HEMOGLOBIN AND MYOGLOBIN BIOCHEMISTRY.

- Summary
  - This is a really good 6 minute video describing the difference between **hemo-globin** and **myo-globin**.
- Source
  - **Neural Academy: YouTube**
    - 14 February 2019
    - <https://www.youtube.com/watch?v=Qv-KExGKAYw>

## Chlorophyll vs Hemoglobin

- Summary
  - This is a 30 second animation showing how **chlorophyll** and **hemo-globin** exactly overlap.
  - They describe chlorophyll as '**plant blood**' which is a cool concept.
- Source
  - **KENVIC:YouTube**
  - 17 December 2019
  - <https://www.youtube.com/watch?v=UR4flhiE3yk>

# Page 56 – The 5 Kingdoms of Life



## Google Earth

### Space out with Google Earth on mobile

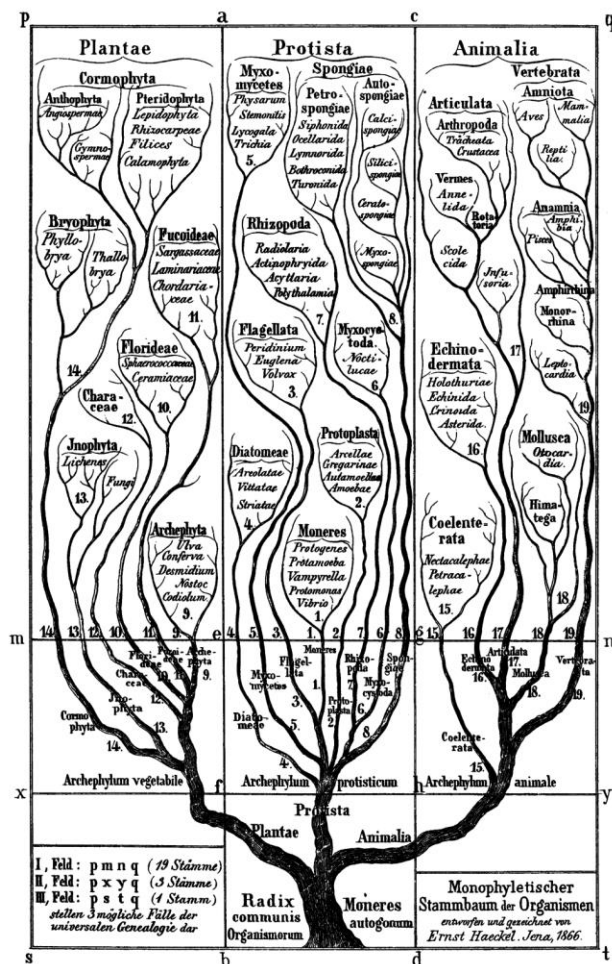
- Summary
  - The maximum altitude of Google Earth is 30,000 miles.
- Verbatim
  - As smartphones and tablets have become more powerful, we've been able to bring the quality of Earth's web and Pro versions to most smartphones. You can now see a view of the stars as you zoom out from Earth on your phone. Rotate the globe and you'll see images of the beautiful Milky Way, collected from the European Southern Observatory, depicting the stars as they'd appear to a space explorer at a point some 30,000 miles above the planet.
- Source
  - Jonathan Cohen: Software Engineer, Google Earth
    - 30 January 2020
    - <https://www.blog.google/products/earth/stars-in-google-earth-mobile/>

## Kingdoms of Life

### Kingdom (biology)

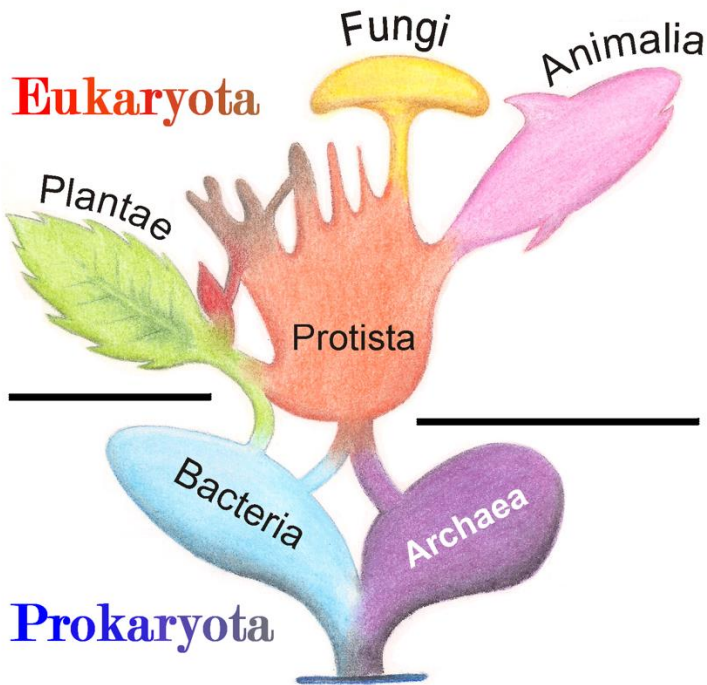
- Summary
  - A **Kingdom** is a huge group of similar *Life* forms. Just how many Kingdoms are there? Depending on how things are classified, at least 2, and up to 8.
  - N = 1 Kingdom
    - There isn't a classification with only 1 Kingdom.
  - N = 2 Kingdoms
    - Using the naked eye  , the simplest and most intuitive way to classify *Life* is into **Plants** and **Animals**. That's 2 Kingdoms.
  - N = 3 Kingdoms
    - When the microscope  was invented, tiny *Life* made of only 1 cell was seen for the first time. They were called **Protista** ("pro tist ah") – basically **amoebas** in a pond. Now there were 3 Kingdoms.
    - For simplicity in this guide, I wrote **Kingdom of Amoebas** but you won't find that in a textbook. The official name is **Kingdom Protista**.
    - Getting technical, the **amoebas** are a sub-group within the Kingdom Protista. Details on **page 85** of *Hidden Zoo*.
  - N = 4 Kingdoms

- Then it was noticed that some microscopic organisms do not have a nucleus. Those are **bacteria**. So now 4 Kingdoms.
- N = 5 Kingdoms
  - **Robert Harding Whittaker** was a **plant ecologist** (he studied communities of plants) and decided that **fungi** (mushrooms, mold, and yeast) were different from plants. Now **5** kingdoms. **This is what I used in my drawing on page 56. I like his classification the most. It's simple.**
- N = 6 Kingdoms
  - Then the scientist **Carl Woese** went all technical on us and said that bacteria could be split into two groups. So that makes for 6 Kingdoms.
- N = 7 Kingdoms and 8 Kingdoms
  - There are also classifications that create 7 Kingdoms and 8 Kingdoms. Fill your boots.
- Source
  - [https://en.wikipedia.org/wiki/Kingdom\\_\(biology\)](https://en.wikipedia.org/wiki/Kingdom_(biology))



3 Kingdoms of Life proposed in 1866.

- See the single thick trunk? That's all *Life*.
- See the 3 major branches? Those are **Plants**, **Protista** (single cell), and **Animals**.
- [https://en.wikipedia.org/wiki/Kingdom\\_\(biology\)](https://en.wikipedia.org/wiki/Kingdom_(biology))



## 6 Kingdoms of Life

Let's look at this drawing from top (more advanced) to bottom (simplest).

- **Above** the **black dividing line** are 4 kingdoms:
  - **Plantae**
    - That's Latin.
    - Take the word **Plant** and tack on 'ae' → **Plantae**.
    - So this is **Kingdom Plantae**.
    - Simpler to just call it the **Plant Kingdom**? Yes. Thank you, English.
  - **Fungi**
    - This is **Kingdom Fungi**.
    - Think, **mushrooms**, **bread mold**, **Athlete's Foot** and **Yeast Infections**.
  - **Animalia**
    - That's Latin.
    - Take the word **Animal** and tack on 'ia' → **Animalia**.
    - So this is **Kingdom Animalia**.
    - Simpler to just call it the **Animal Kingdom**? Yes.
    - This is you, me, **dogs**, **cats**, **dolphins**, **leeches**, **mosquitoes**, **T. rex** and lots of other things on the Discovery Channel.
  - **Protista**
    - No, it's not a protest.
    - **Protista** are **single-celled** organisms. Yes, just 1 cell. That's it.
    - Do they have a **nucleus**? Yes. Their **DNA** is packed inside the nucleus.
    - The Protista includes **amoebas** so I call this the **Kingdom of Amoebas** for simplicity. But the correct, official name is **Kingdom Protista**.
- **Below** the **black dividing line** are 2 kingdoms.
  - In the **5-Kingdom** classification, if the **Kingdom of Bacteria** is further divided into **Bacteria** and **Archaea** ("ark a ee ah") then there are **6 Kingdoms** like shown in this diagram.
  - **Kingdom Bacteria**
    - This is basically all the bacteria in this illustrated guide.
    - Are they 1 cell? Yes. Do they have a **nucleus**? No.
    - Is their **DNA** arranged in a circle called a **plasmid**? Yes.

- When you have a **toothache** or a **pimple** or **Strep throat** are bacteria causing the infection? Yes.
- Even though 10 bacteria might be found together in a cluster, they are not a 10-cell organism. They are simply 10 single cells that happen to find each other good company.
- Could you spend your entire life studying bacteria? Yes.
- **Kingdom Archaea**
  - Does archaea have too many vowels? Yes. Blame Latin for that.
  - The archaea have slightly different **metabolic pathways** than bacteria. That means how they break down food or make compounds is a bit different. But they look very similar under a microscope.

More terminology to make your life difficult:

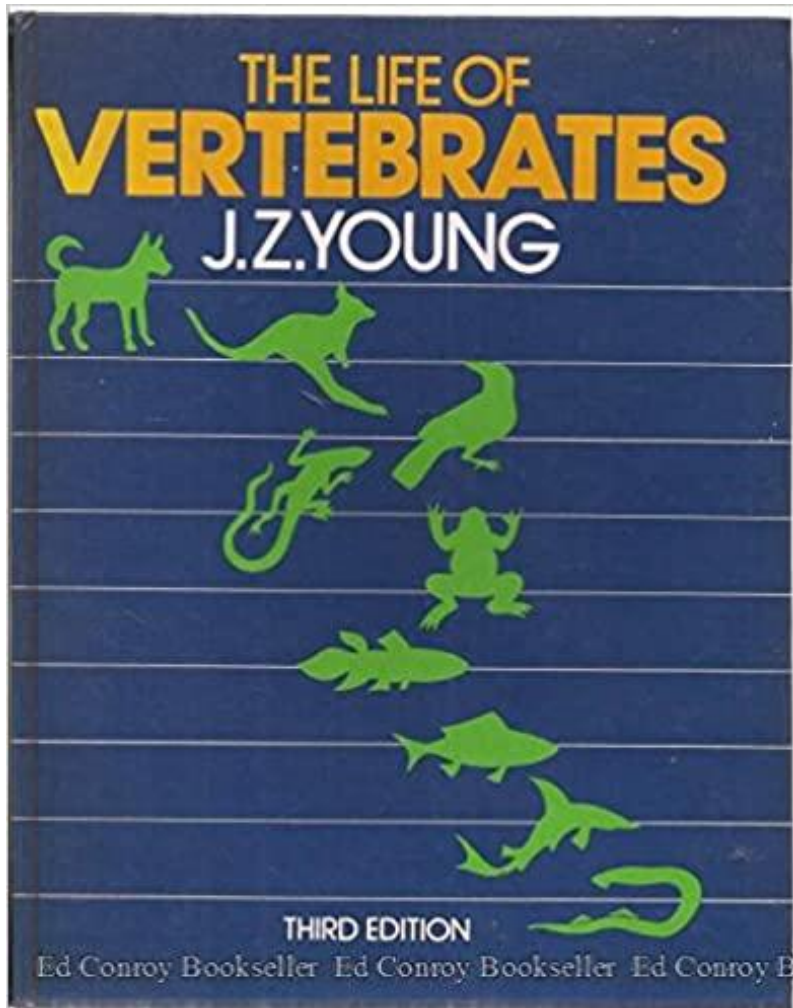
- **Eu-karyota** are advanced *Life* forms (above the line). They all have a nucleus. **Eu** means true. **Kary** means nucleus. So they have a 'true nucleus.'
- 
- **Pro-karyota** are basic *Life* forms (below the line). They lack a nucleus.

Do you see any viruses mentioned?

- No. They are not really considered *Life* so they don't make it into the Kingdoms.
- Oh, wait, you can make the argument they are *Life* since they have a genetic code just like you and me.

Source

- [https://en.wikipedia.org/wiki/Kingdom\\_\(biology\)](https://en.wikipedia.org/wiki/Kingdom_(biology))



### *The Life of Vertebrates*

- Summary
  - Getting downright technical, 'zoology' is the study of the **Animal Kingdom**. However, during my zoology degree we also spent time studying the other kingdoms like Bacteria, Amoebas, Fungi, and Plants.
  - *The Life of Vertebrates* was my one of my textbooks. It focused solely on the vertebrates in the Animal Kingdom.
  - Your spine is made of bones called **vertebrae** ("vert ah bray") that are stacked on top of each other. You are a **vertebrate** ("vert ah bret"). So are dogs, kangaroos, whales, birds, lizards, frogs and fish.
  - **Sharks** don't have a spine made of bone. It's **cartilage** which is softer than bone but still provides structure. Nevertheless, sharks are considered vertebrates.
  - Get it?
    - Cartilage (**soft**) + calcium → bone (**hard**).
    - Getting technical, a crystal called hydroxy-apatite ("high drox ee" "app ah tight") is also added. So really, it's like this:
      - Cartilage (**soft**) + calcium + hydroxy-apatite crystals → bone (**hard**).
      - Don't lose sleep over it.
  - **Earthworms and other squishy things have no vertebrae. They are invertebrates.** Different textbook. Different course called **invertebrate zoology**.
- Source
  - **Oxford University Press**; 3rd edition
    - 1981
    - 700 Pages



- <https://www.amazon.com/Life-Vertebrates-J-Z-Young/dp/0198571720>
- Author
  - **John Zachary Young** – he was a **zoologist** from England.
- Eric Chudler PhD neuroscience
  - “The principles now being discovered at work in the brain may provide, in the future, machines even more powerful than those we can at present foresee.” --J.Z. Young, in *Doubt and Certainty in Science. A Biologist's Reflections on the Brain*, 1960.

### List of animal phyla

- Summary
  - Remember, the classification within a Kingdom is like so:
    - **Kingdom: Phylum: Class: Order: Family: Genus: species**
  - **Phylum** is singular. (“fy lum”)
  - **Phyla** is plural. (“fy la”)
  - This article a simple description of the characteristics of each Phylum in the Animal Kingdom.
  - **There is an alphabetical table of the 35 Phyla in the Animal Kingdom.**
- Source
  - [https://simple.wikipedia.org/wiki/List\\_of\\_animal\\_phyla](https://simple.wikipedia.org/wiki/List_of_animal_phyla)

## Extra detail

### What's up with algae?

- If they're **uni**-cellular they're in the **Kingdom of Protista** (think, **amoebas**).
- If they're **multi**-cellular they're in the **Kingdom of Plants**.
- That's the basic picture.

### What are the criteria to be considered a plant?

- This is the answer according to **Encyclopedia Britannica**. These are notes I made in the past.
  1. You have to be **multi-cellular**. Hence, made of many cells – think, **millions** or **billions**.
  2. You have to be a **eu-karyote** (“you carry oat”) which means the nucleus (where the DNA lives) is wrapped by a membrane called the **nuclear envelope**.
    - The Greek word **eu** means **good** though in biology and medicine it tends to mean **true**.
    - So a eu-karyote has a true nucleus. We humans are also eu-karyotes – our cells all have a nucleus wrapped in a nuclear envelope.
  3. **Photosynthesis**, meaning you capture sunlight.
  4. Unlimited growth at localized regions ... don't know what that means.
  5. **Cellulose** in the cell walls, thus rigid. Cellulose is a kind of sugar that humans cannot digest whereas termites can.
  6. No means of locomotion, thus basically stationary.
  7. No nervous system. Plants do not feel pain, play chess, or know who Boba Fett is.
  8. Alternation of haploid and diploid generations. Check out those switched on **Green Brothers** on YouTube to get the skinny on this.

### How are fungi different from plants?

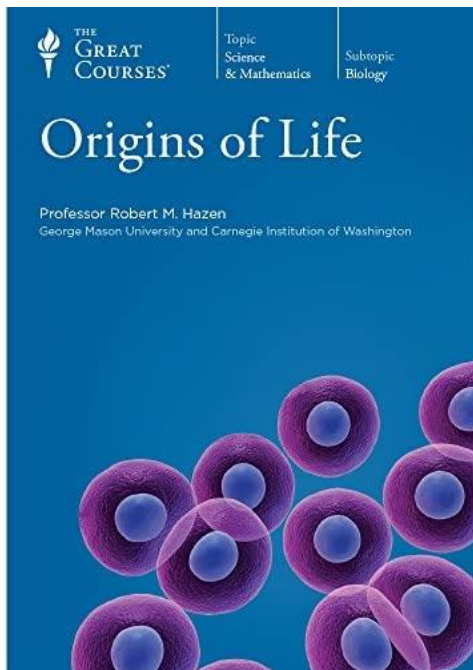
1. No **photosynthesis**. They cannot harness sunlight like plants.
2. Plants **make** their own organic molecules. Fungi must **absorb** them.
3. The cell wall of fungi contains **chitin**, not cellulose. But it is also a type of sugar. Chitin is also found in the exo-skeleton of insects and lobsters. Turns out sugar is rather important.

# Page 56 – What is Life?

## What is Life?

### Defining Life

- Summary
  - This is a thought-provoking and easy to read article. The author involves popular culture like *Star Trek*.
- Verbatim
  - “Two rabbits – a male and female – are alive but either one alone is dead.”
    - This was said at a meeting of scientists discussing the definition of life.
- Verbatim
  - “Life is a self-sustained chemical system capable of undergoing Darwinian evolution.”
    - When in doubt, ask **NASA**.
    - This comment is attributed to **Gerald Joyce** who was part of an **exo-biology** panel at NASA.
    - This is how **Joyce** is cited in *Astrobiology*
      - **Joyce G.F.**, **Deamer D.W.**, **Fleischaker G.** *Origins of Life: The Central Concepts*. Jones and Bartlett; Boston: **1994**. Foreword. [[Google Scholar](#)]
      - The Google Scholar links contains no information.
    - **Astro-biology** and **exo-biology** are basically the same thing – the search for life outside of Earth. It's not necessarily the search for extra-terrestrial *intelligence*. Maybe it's just some simple form of life form that does not think; ironically, aliens with a 200,000 IQ might think that of humans.
    - '**Darwinian evolution**' is a synonym for '**natural selection**' which basically means if you can outcompete your competitors then Mother Nature selects you. If you suck, you die.
    - The part that **Charles Darwin** didn't know is that natural selection is powered by radiation from outer space. Specifically, radiation from our sun or cosmic rays from beyond our solar system cause mutations to DNA. If it's a '**gain of function**' **mutation**, well that's awesome – maybe you're a seal and now you're better at holding your breath underwater.
- Source
  - Astrobiology
    - December 2010
    - <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3005285/>
    - [https://en.wikipedia.org/wiki/Steven\\_A.\\_Benner](https://en.wikipedia.org/wiki/Steven_A._Benner)
- Author
  - **Steven A. Benner PhD chemistry** - Foundation for Applied Molecular Evolution and The Westheimer Institute for Science and Technology, Gainesville, Florida



### Origins of Life

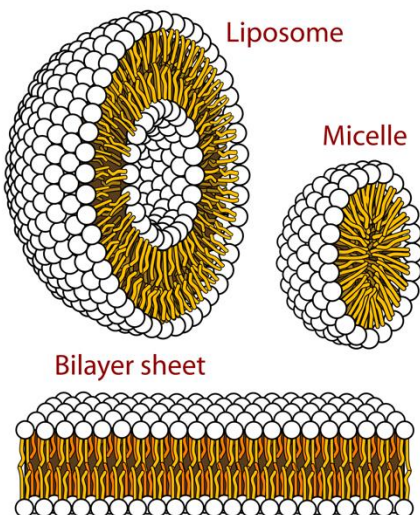
- Summary of the course (plus a few of my own comments)
  - One way to approach the question, *What is Life?*, is to ask another question, *How did Life arise?*
  - One of the themes of this phenomenal 12-hour video course is that it may be misleading to think of Life as binary: Life or Not Life. It might be a continuum.
  - For example, in **Earth's primitive oceans**, molecules of fat (a.k.a. lipids) spontaneously arranged themselves into spheres. There was no thought involved. This happens due to the chemical properties of fats in water. This spherical structure is called a **micelle** ("my cell") (structure shown below). Despite its pronunciation, it is not a cell. It is **not alive**.
  - But later on we find **DNA** inside a more advanced micelle. Now we've got a functioning cell. I've skipped many details. But the question is: Do we now consider the micelle alive? It wasn't when it was just an empty sphere.
  - This discussion blends into philosophy and the way we construct sentences and interpret grammar and language. *Is a sail a boat?* No. But if you attach a sail to a mast, now you've got a sailboat.
  - Point is, the question, *What is Life?* is not straightforward and I'm hardly doing it justice. So **check out the table of contents of the course** and you'll see how much nuance there is. This is such an amazing course. Makes you think waaaaaaaaaaaaaaaaay outside the box.
  - And I will make one preachy comment because I think it is important: The worst kind of censorship is self-censorship. YOU prevent YOU from learning. Never self-censor. Read everything. Especially books that are difficult to read (which has the added benefit that other books become easy to read). Put that Ferrari brain of yours to work. Now you can make up your own mind.
- Table of Contents - 24 Lectures
  - 1 The Grand Question of Life's Origins
  - 2 The Historical Setting of Origins Research
  - 3 What Is Life?
  - 4 Is There Life on Mars?
  - 5 Earth's Oldest Fossils
  - 6 Fossil Isotopes
  - 7 Molecular Biosignatures
  - 8 Emergence
  - 9 The Miller-Urey Experiment
  - 10 Life from the Bottom of the Sea
  - 11 The Deep, Hot Biosphere
  - 12 Experiments at High Pressure
  - 13 More Experiments Under Pressure

- 14 Deep Space Dust, Molten Rock, and Zeolite
- 15 Macromolecules and the Tree of Life
- 16 Lipids and Membrane Self-Organization
- 17 Life on Clay, Clay as Life
- 18 Life's Curious Handedness
- 19 Self-Replicating Molecular Systems
- 20 Günter Wächtershäuser's Grand Hypothesis
- 21 The RNA World
- 22 The Pre-RNA World
- 23 Natural Selection and Competition
- 24 Three Scenarios for the Origin of Life

- Source

- **The Great Courses**

- There are 24 video lectures, each about 30 minutes long.
- The narrator is **Professor Robert M. Hazen** whose PhD is in **Earth Science** (think, geology which is rocks and minerals, plus the study of the oceans, climate, and atmosphere).
- This is the same company that produced the lectures, *Understanding the World's Greatest Structures*, mentioned on page 4.
- <https://www.thegreatcourses.com/courses/origins-of-life>



### Micelle

- Summary

- Those are all **membranes** made of fat. They are rather important in any discussion of the definition of **Life**.
- Each small white circle has 2 **brown** 'tails' attached. The tails point inward. Each white circle plus its 2 tails is an individual molecule of fat.
- On the top right is a **micelle** cut in half. It is made of fat molecules that self-arrange into a sphere. It repels water. There is only a **single** layer of small white circles. The fancy term is **mono-layer**. Was this floating around in the **primordial soup** billions of years ago? Yes.
- The **bi-layer sheet** (bottom) is what forms the '**cell membrane**' that surrounds every single cell in your **body**. The **single** layer of the micelle is now a **double** layer. All *Life* as we know it has such a membrane. You exist because of it.
- The **lipo-some** (top left) is a structure found inside human cells. Not only is it made of fat, it stores fat in the interior. The stored fat is for energy. The lipo-some is cut in half in this image.

- Here's the cool part
  - Viruses do not have a cell membrane, which is part of the reason they are not considered *Life*. But viruses are experts at getting past the cell membrane of other creatures, so they can get inside a cell. That is the very essence of how they infect us.
- Source
  - <https://en.wikipedia.org/wiki/Micelle>

### Life's Rocky Start

- Summary
  - This is a 53 minute documentary also featuring Dr. Robert Hazen (who narrates the *Origins of Life* course above). It is a less technical version of the 12 hours of lectures in The Great Courses.
- imdb description
  - Four and a half billion years ago, the young Earth was a hellish place—a seething chaos of meteorite impacts, volcanoes belching noxious gases, and lightning flashing through a thin, torrid atmosphere. Then, in a process that has puzzled scientists for decades, life emerged. But how? NOVA joins mineralogist Robert Hazen as he journeys around the globe. From an ancient Moroccan market to the Australian Outback, he advances a startling and counterintuitive idea—that the rocks beneath our feet were not only essential to jump-starting life, but that microbial life helped give birth to hundreds of minerals we know and depend on today. It's a theory of the co-evolution of Earth and life that is reshaping the grand-narrative of our planet's story.
- Source
  - NOVA
    - 2016
    - [https://www.imdb.com/title/tt5341406/plotsummary?ref=tt\\_ov\\_pl](https://www.imdb.com/title/tt5341406/plotsummary?ref=tt_ov_pl)

## Is a virus alive?

### Are viruses dead or alive?

- Summary
  - This is an easy read.
  - There is a fun clipboard with 7 questions that must be answered to qualify as Life.
- Source
  - Khan Academy
    - No date, no authors.
    - <https://www.khanacademy.org/test-prep/mcat/cells/viruses/a/are-viruses-dead-or-alive>

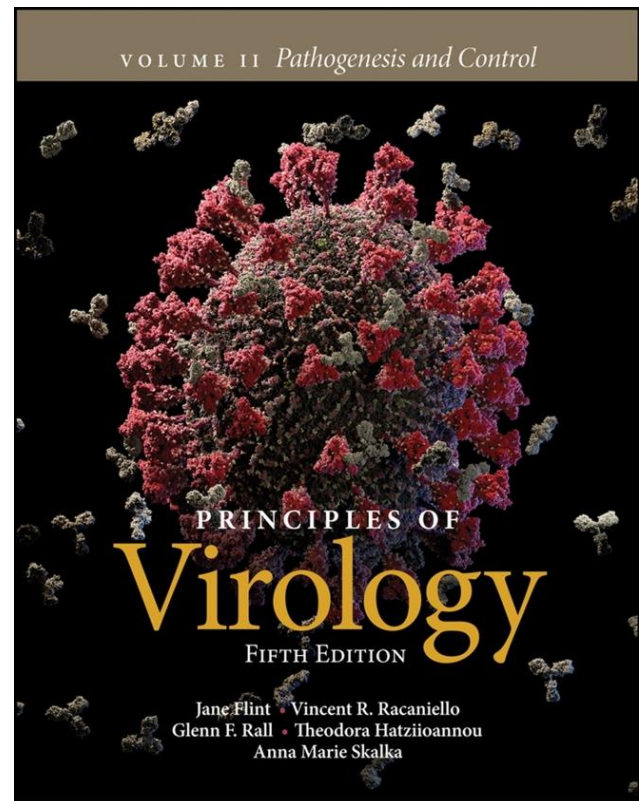
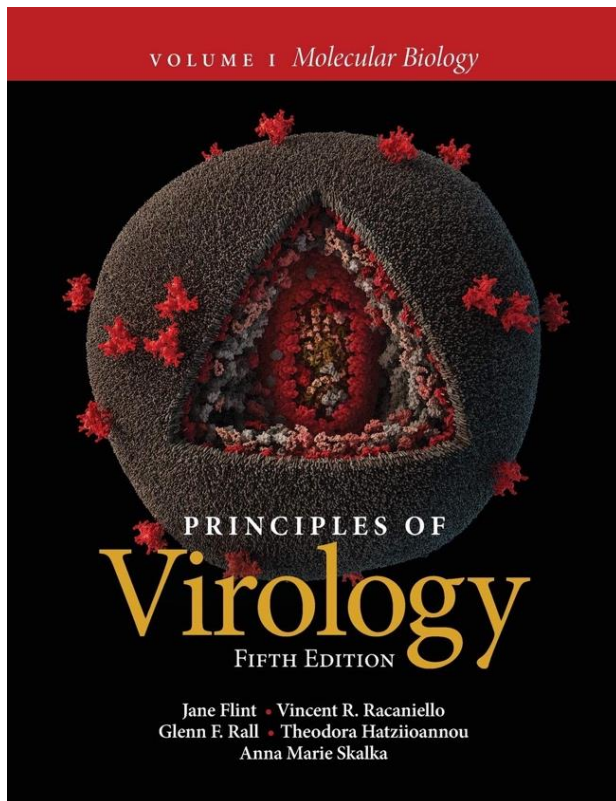
### ARE VIRUSES ALIVE?

- Summary
  - Two professors 'debate' the question of whether a virus is alive or not. It is quite technical.
- Verbatim
  - Dr. Nigel Brown
    - **No, viruses are not alive**
    - If a virus is alive, should we not also consider a DNA molecule to be alive?
- Verbatim
  - Dr. David Bhella

- **Yes, viruses are alive**
- Arguments over the life/not life status of viruses are often rooted in evolutionary biology and theories of the origins of life. All cellular organisms can claim a direct lineage to a primordial cell or cells, a continuous chain of cell divisions along which the 'spark' has been passed. Are viruses able to claim a similar ancestry?
- Hmm ...
  - These arguments are reminiscent of a thought experiment called the 'Ship of Theseus.'
    - If a ship has its **mast** replaced is it the same ship? What if the **hull** is replaced next? And then the **rudder**? Eventually, the entire ship has been replaced. Is it the same ship?
    - [https://en.wikipedia.org/wiki/Ship\\_of\\_Theseus](https://en.wikipedia.org/wiki/Ship_of_Theseus)
  - The same thought experiment has been applied to the human body since parts of it are continuously replaced, like hair, skin, and the lining of your intestines.
  - Similarly, if you remove your **eyeball** and put it on the table, is it alive for the next few hours?
  - Similarly, if you remove the **DNA** of a cell and put it on the table, is it alive?
  - What if a **virus** only can replicate when inside another cell? Are the virus and cell a temporary new entity?
  - These are questions to ask while eating Doritos during a road trip.
- Source
  - **Microbiology Society**
    - 10 May 2016
    - <https://microbiologysociety.org/publication/past-issues/what-is-life/article/are-viruses-alive-what-is-life.html>
- Authors
  - **Nigel Brown** - Emeritus Professor of Molecular Microbiology, University of Edinburgh, Scotland
    - **Emeritus** means a professor has retired.
  - **David Bhella** - Professor of Structural Virology, Centre for Virus Research, University of Glasgow, Scotland

Do viruses really infect all 5 kingdoms?

Yes.



### Principles of Virology Volume 1 & 2

#### ▪ Summary

- If you want to know everything about viruses, look no further.
- These two volumes are very technical and it helps if you've taken a biology course. There are heaps of incredibly detailed color diagrams – these are especially useful to show the sequence of events when a virus infects a cell: **Entry** into the cell → **Replication** (by hijacking the cell's genetic machinery) → **Assembly** of the virus into its proper shape → **Exit** of a few hundred new viruses from the cell so more cells can be infected.
- Get it?
  - **Entry** → **Replication** → **Assembly** → **Exit**
  - That's the basic plan.
- Even if you know zero point zero on the topic of viruses, you will learn tons and tons. Maybe you'll want to become a virologist.
- And if you're a highlighter freak like me, the paper is perfect because the highlighter ink dries pretty quickly.

#### ▪ Personal comment

- When I was doing my Master of Science (MSc) degree in neuro-science, my supervisor **Dr. Dave McCrea PhD** said to me: "Medical students don't know where information comes from. They think it magically appears in a book." It was a tongue-in-cheek comment, a friendly swipe at the future medical doctors to whom he was teaching neuro-science. He meant they'd read a medical textbook ... go apply the knowledge to patients ... get credit for it ... but never appreciate the army of PhD's who made the book possible.
- Anyways, I eventually was a medical student and I appreciated his comment. I also appreciated that in medical school you have to study 25 hours a day. Nevertheless, when I make notes (and of course, I am a freak for making notes), I sometimes read the author biography (or hunt it down) – takes a few minutes, and I copy their photo into my notes. It makes the author real, it makes the research real, it makes the world real and vivid. And I remember the topic better. Plus, I love geography – and since scientists are from all over the place I learn about new places to visit.

#### • Source

- **ASM Press**
  - **ASM = American Society for Microbiology**

- 2020
- **Volume 1 – Molecular Biology**
  - 608 Pages
  - You can **Look inside.**
    - [https://www.amazon.ca/Principles-Virology-1-Molecular-Biology/dp/1683672844/ref=asc\\_df\\_1683672844/?tag=googleshopc0c-20&linkCode=df0&hvadid=459397708039&hvpos=&hvnetw=g&hvrand=7977255540218150436&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvcml=&hvlocint=&hvlocphy=1002451&hvtargid=pla-930714480174&psc=1](https://www.amazon.ca/Principles-Virology-1-Molecular-Biology/dp/1683672844/ref=asc_df_1683672844/?tag=googleshopc0c-20&linkCode=df0&hvadid=459397708039&hvpos=&hvnetw=g&hvrand=7977255540218150436&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvcml=&hvlocint=&hvlocphy=1002451&hvtargid=pla-930714480174&psc=1)
- **Volume 2 – Pathogenesis and Control**
  - 528 Pages
  - You can **Look inside.**
    - [https://www.amazon.ca/Principles-Virology-2-Pathogenesis-Control/dp/1683672852/ref=pd\\_bxgy\\_img\\_sccl\\_1/135-7710795-2576056?pd\\_rd\\_w=cp6Ke&pf\\_rd\\_p=19eafb8a-881a-44bb-9725-85a79b8c53d4&pf\\_rd\\_r=7B80GZXKK53C7GW2F2PT&pd\\_rd\\_r=85e00e6f-61ab-4a99-a586-baec8440f667&pd\\_rd\\_wg=Lvyve&pd\\_rd\\_i=1683672852&psc=1](https://www.amazon.ca/Principles-Virology-2-Pathogenesis-Control/dp/1683672852/ref=pd_bxgy_img_sccl_1/135-7710795-2576056?pd_rd_w=cp6Ke&pf_rd_p=19eafb8a-881a-44bb-9725-85a79b8c53d4&pf_rd_r=7B80GZXKK53C7GW2F2PT&pd_rd_r=85e00e6f-61ab-4a99-a586-baec8440f667&pd_rd_wg=Lvyve&pd_rd_i=1683672852&psc=1)
- **Authors**
  - All 5 Authors are PhD's.
  - **Jane Flint, PhD**
    - Emeritus Professor of Molecular Biology, Princeton University
    - BSc biochemistry. MSc and PhD biochemistry at University College, London.
    - Focus of research is on the adeno-virus and delivery of onco-lytic virus against tumors.
      - Translation:
        - One way to treat **Cancer** is to introduce a virus into the cancer cell and kill it.
        - **Onco** = cancer
        - **Lytic** = to split
        - So **onco-lytic** means to kill a cancer cell by splitting it apart. Think, disintegrate.
        - The **adeno-virus** is the 'delivery vehicle.' It tends to be a harmless virus but can rigged up with the genetic code to kill a cancer cell.
  - **Vincent R. Racaniello, PhD**
    - Virologist, Columbia University
    - PhD in genetic reassortment in 1990 in the laboratory of Dr. Peter Palese. You'll learn more about Dr. Palese on page 27 of Hidden Zoo.
    - He is also the host of **microbe tv.**
  - **Glenn F. Rall PhD**
    - Professor of Microbiology, University of Pennsylvania
    - Focus of research is the immune system response to a CNS infection by viruses.
      - **CNS** = Central Nervous System = Brain and spinal cord
      - **PNS** = Peripheral Nervous System = all the nerves out in the body. Like when you smash your funny bone, that's the 'ulnar nerve' in your arm.
  - **Theodora Hatzioannou, PhD**
    - Laboratory of Retro-virology, Rockefeller University, NYC
    - Born in Rhodes, Greece.
    - PhD in retro-viruses, Claude Bernard University, Lyon, France
    - What is a **retro-virus**?
      - An example is the **HIV / AIDS virus.**
      - **Retro** means **backwards**, like *That 70's Show.*
      - In the case of a virus, it means that once it gets inside a human cell, it tends to do things backwards from the way regular virus does it. It does not necessarily mean primitive.
      - Details in Volume 2 (of my stuff).
  - **Anna Marie Skalka, PhD**
    - Fox Chase Cancer Center, Philadelphia
    - Interesting bio



- Summer job (as a teenager it seems) at **Pfizer** in **Williamsburg, Brooklyn**, in the billing department. Her dad worked there making **penicillin**. Got interested in biology.
- **BSc** in **biology** - supervisor was a famous **herpetologist** (someone who studies reptiles). **PhD** in **microbiology**.
- Focus of research: **retrovirus** and **onco-genes**.
  - An **onco-gene** is basically a region of DNA that can turn cell division **ON** and **OFF**. If the gene is screwed up, then cells divide continuously – that's **Cancer**.

# Page 59 – Infection Zoo – Please don't Pet the Anthrax and Salmonella

*Lippincott's Illustrated Reviews: Microbiology, 4<sup>th</sup> edition.*

- Summary
  - Virtually every organism in *Hidden Zoo* is mentioned in this comprehensive book.
  - This book was summarized on page 30 (Cholera) of the bibliography.
- Source
  - **LWW** (**Lippincott Williams & Wilkins**) (they are the book publisher)
    - 2019.
    - 448 pages.
    - Publisher website
      - <https://shop.lww.com/Lippincott--Illustrated-Reviews--Microbiology/p/9781496395856>
    - Amazon
      - [https://www.amazon.com/Lippincott-Illustrated-Reviews-Microbiology-dp-1496395859/dp/1496395859/ref=dp\\_ob\\_title\\_bk](https://www.amazon.com/Lippincott-Illustrated-Reviews-Microbiology-dp-1496395859/dp/1496395859/ref=dp_ob_title_bk)
- Authors
  - **Cynthia Nau Cornelissen PhD** (Editor)
  - **Marcia Metzgar Hobbs PhD** (Editor)

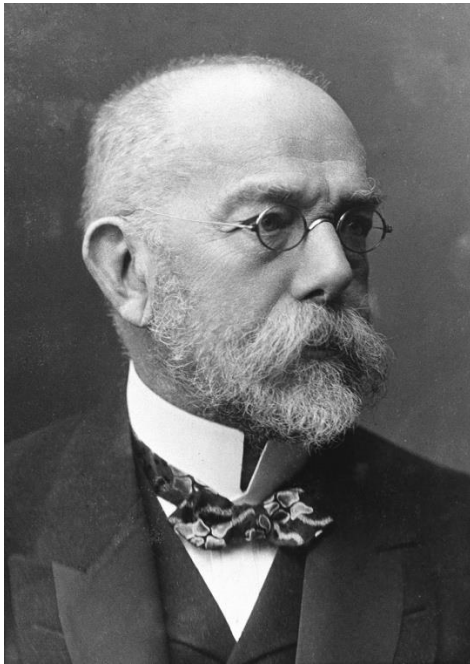
## Bubonic Plague

*Bubonic Plague* we covered on Pages 10 – 14.

## Typhus

*Typhus* we covered on Page 8.

## Anthrax



Robert Koch – He looks pretty serious.

- He discovered the bacteria that causes **Anthrax**.
- [https://en.wikipedia.org/wiki/Robert\\_Koch](https://en.wikipedia.org/wiki/Robert_Koch)

#### Anthrax Photos

- Summary
  - There are photos of the bacteria, *Bacillus anthracis*, that causes **Anthrax**.
    - When you see the word 'bacillus' it means that bacteria has a **rod** shape.
  - There are **GROSS** photos of an anthrax infection of the skin a.k.a. **Cutaneous Anthrax**.
- Source
  - **CDC**
    - 15 April 2014
    - <https://www.cdc.gov/vaccines/vpd/anthrax/photos.html>

#### Endemic Gastrointestinal Anthrax in 1960s Lebanon: Clinical Manifestations and Surgical Findings

- Summary
  - **GROSS** black & white photos of the intestines of a patient that have become infected by anthrax.
- Source
  - **Emerging Infectious Disease**
    - This is a medical journal published by the **CDC**.
    - May 2003 but the photos are from the 1960s.
    - <https://wwwnc.cdc.gov/eid/article/9/5/02-0537-f3>
- Authors
  - Zeina A Kanafani\*, Antoine Ghossain†, Ala I Sharara\*, Joseph M. Hatem†, and Souha S Kanj\*
  - Author affiliations:
    - \*American University of Beirut Medical Center, Beirut, Lebanon;
    - †Saint-Joseph University, Beirut, Lebanon



### Anthrax – CDC

- Summary
  - This is CDC home page on Anthrax. Lotsa links.
- Source
  - CDC
    - 20 November 2020.
    - <https://www.cdc.gov/anthrax/index.html>

### Risk of Anthrax When Handling Animal Products

- Summary
  - There are links on this page to learn more about **animals hides** that transmit anthrax to you.
  - The link to **Processing of Products** has information on **disinfecting** hides with stuff like heat, acids or formaldehyde (“form al duh hide”) which is a preservative.
- Source
  - CDC
    - 20 November 2020 (yes, same date as above)
    - <https://www.cdc.gov/anthrax/animal-products/index.html>

### Zoonotic Diseases of Sheep and Goats

- Summary
  - **Zoonotic** (“zoo not ik”) is a fancy word meaning a disease can spread from animals to humans, or in other direction, from humans to animals. See page 88 for details.
  -  **On the right side** of this webpage there are dark green horizontal bars. **Click the bar** to display the nasty organisms you can catch from **sheep** and **goats**.
  -  **On the left side** are more animals to investigate, like **fish**, **birds**, **cattle**, **deer**, **horses** and **pigs**.
- Source
  - U.S. Department of Agriculture (UDSA): Animal and Plant Health Inspection Service
    - 28 September 2020
    - [https://www.aphis.usda.gov/aphis/ourfocus/animalhealth/sa\\_animal\\_disease\\_information/sheep-goat/zoonotic](https://www.aphis.usda.gov/aphis/ourfocus/animalhealth/sa_animal_disease_information/sheep-goat/zoonotic)

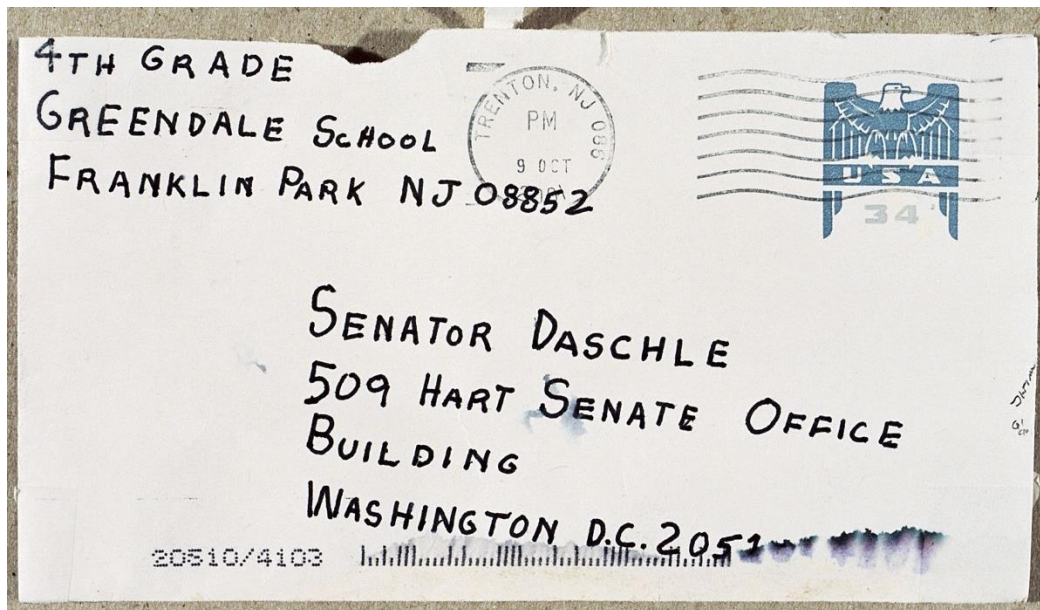
### Anthrax as a Bioterrorism Weapon

- Summary
  - There is lots of information here to explore.
- Source
  - CDC
    - 20 November 2020
    - <https://www.cdc.gov/anthrax/bioterrorism/index.html>

### Update: Investigation of Bioterrorism-Related Anthrax and Interim Guidelines for Exposure Management and Antimicrobial Therapy, October 2001

- Summary
  - This is a dated but nevertheless fascinating and very readable history of anthrax attacks in the USA.
  - The last section is called Anti-microbial Treatment. It describes treatment with the antibiotics **ciprofloxacin** (“sip row flox ah sin”) and **doxy-cycline** (“dox ee sigh klin”). It is fairly technical. The take-home message is:
    - **Inhalational Anthrax** (where spores are inhaled into the lungs) is treated with *intra-venous* (IV) anti-biotics. This achieves a higher concentration of the anti-biotic in the blood.
    - **Cutaneous Anthrax** (where spores infect the skin) is treated with *oral* (swallowed) anti-biotics.

- **This is most definitely for your information only! Do not self-treat!** If you're curious, show this page to your doctor and have a chit chat.
- Source
  - **Morbidity and Mortality Weekly Report (MMWR)**
    - This is a **CDC** publication.
    - 26 October 2001
    - <https://www.cdc.gov/mmwr/preview/mmwrhtml/mm5042a1.htm>



### 2001 anthrax attacks

- Summary
  - This is a fairly bizarre story of a **disgruntled scientist** who is an anthrax expert who decides to poison America with anthrax. Kinda like a fireman who sets fires.
  - This letter (photo above) containing anthrax powder was mailed to **US Senator Tom Daschle** in October 2001.
- Source
  - [https://en.wikipedia.org/wiki/2001\\_anthrax\\_attacks](https://en.wikipedia.org/wiki/2001_anthrax_attacks)

## Salmonella – nice version: Food poisoning

### Salmonella

- Summary
  - This is the CDC home page on **Salmonella food poisoning**.
- Source
  - **CDC**
    - 20 October 2022
    - <https://www.cdc.gov/salmonella/index.html>

### Salmonella and Eggs

- Summary
  - The **Salmonella** bacteria likes eggs. It can spread via the shell or the contents of the egg.

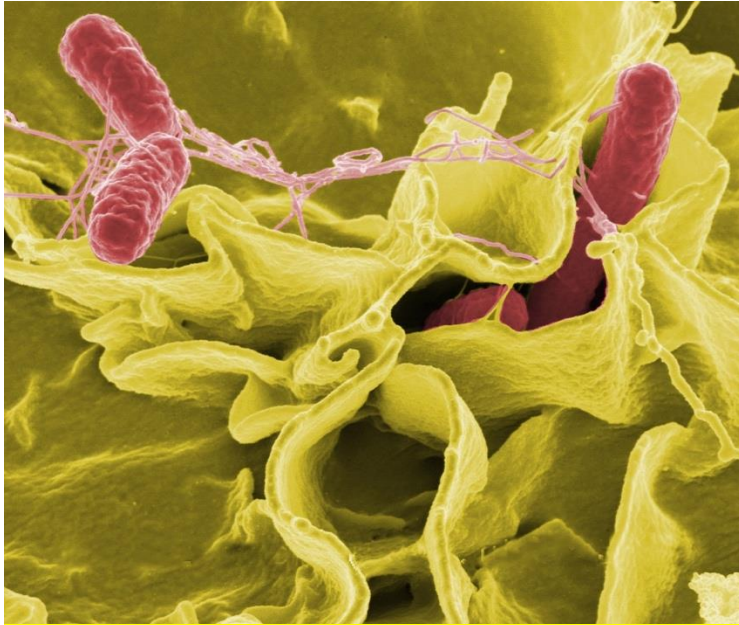
- There are instructions on properly handling eggs.
- Verbatim
  - Salmonella can get on the shells of eggs when birds lay eggs or when the eggs touch bird droppings (poop) after being laid. This is not a problem for commercial eggs (for example, eggs you buy at the grocery store) because companies wash eggs before they reach stores.
  - Salmonella also can contaminate the egg's contents while it is forming inside the chicken before shells are formed. Today, a lot fewer egg-laying hens have this problem than during the 1980s and 1990s, so eggs are safer. But some eggs are still contaminated with Salmonella.
- Source
  - CDC
    - 17 March 2022
    - <https://www.cdc.gov/foodsafety/communication/salmonella-and-eggs.html>

### *Baby Chicks and Salmonella: Tyler's Story*

- Summary
  - This is the true story of a little boy named Tyler who became mysteriously ill. Turns out he got infected by *Salmonella* from baby chicks kept in the basement of the house.
  - This takes 2 minutes to read. Pretty cool.
  - There are more stories on the left – stuff like *Salmonella* poisoning from cake batter. What the?
- Source
  - CDC
    - 9 August 2022
    - <https://www.cdc.gov/foodsafety/patient-stories/Tyler-salmonella.html>

# Page 59 – Typhoid Mary – You Should Check Her Resume

Salmonella – nasty version: Typhoid Fever



That's the nasty form of the *Salmonella enterica* bacteria photographed with an **electron microscope**.

- It basically looks the same as the nice form causing food poisoning.
- **You can see red 4 rods here** – 2 on the left and 2 on the right (one of them partially visible). The red color is digital coloring.
- <https://en.wikipedia.org/wiki/Salmonella>

### *Typhoid Fever and Paratyphoid Fever*

- Summary
  - The word *para* means beside, which is how we get the term para-medic who more or less functions alongside a medic.
  - Well, **para-typhoid fever** is similar to **typhoid fever**.
- Source
  - **CDC**
    - 22 August 2018
    - <https://www.cdc.gov/typhoid-fever/index.html>

### *Typhoid Fever & Paratyphoid Fever*

- Verbatim
  - *Salmonella enterica* serotypes Typhi and Paratyphi A, Paratyphi B, and Paratyphi C cause potentially severe and occasionally life-threatening bacteremic illnesses referred to respectively as **typhoid** and **paratyphoid fever**, and collectively as **enteric fever**.
  - **Paratyphoid fever** is usually described as less severe than typhoid fever; however, severe cases of Paratyphi A infection have been reported from Asia.
- Source
  - CDC Yellow Book
  - 4 March 2021
  - <https://wwwnc.cdc.gov/travel/yellowbook/2020/travel-related-infectious-diseases/typhoid-and-paratyphoid-fever>
- Authors
  - Grace D. Appiah
  - Michael J. Hughes
  - Kevin Chatham-Stephens

### Traveller's Health

- Summary
  - This is a guide for doctors who practice Travel Medicine.
  - This is the table of contents.
- Source
  - CDC Yellow Book
    - <https://wwwnc.cdc.gov/travel/yellowbook/2020/table-of-contents>

## Typhoid Mary



That's Typhoid Mary a.k.a. Mary Mallon in a hospital bed. It's a weird photo – the other people look like they have fake faces; but I think that's just because it's poor quality and/or old. Mary does not look too happy. She was apparently forcibly quarantined but it looks here like her hands are simply crossed, not tied. Whatever. That's the photo.

- [https://en.wikipedia.org/wiki/Mary\\_Mallon](https://en.wikipedia.org/wiki/Mary_Mallon)

### Typhoid Mary: Villain or Victim?

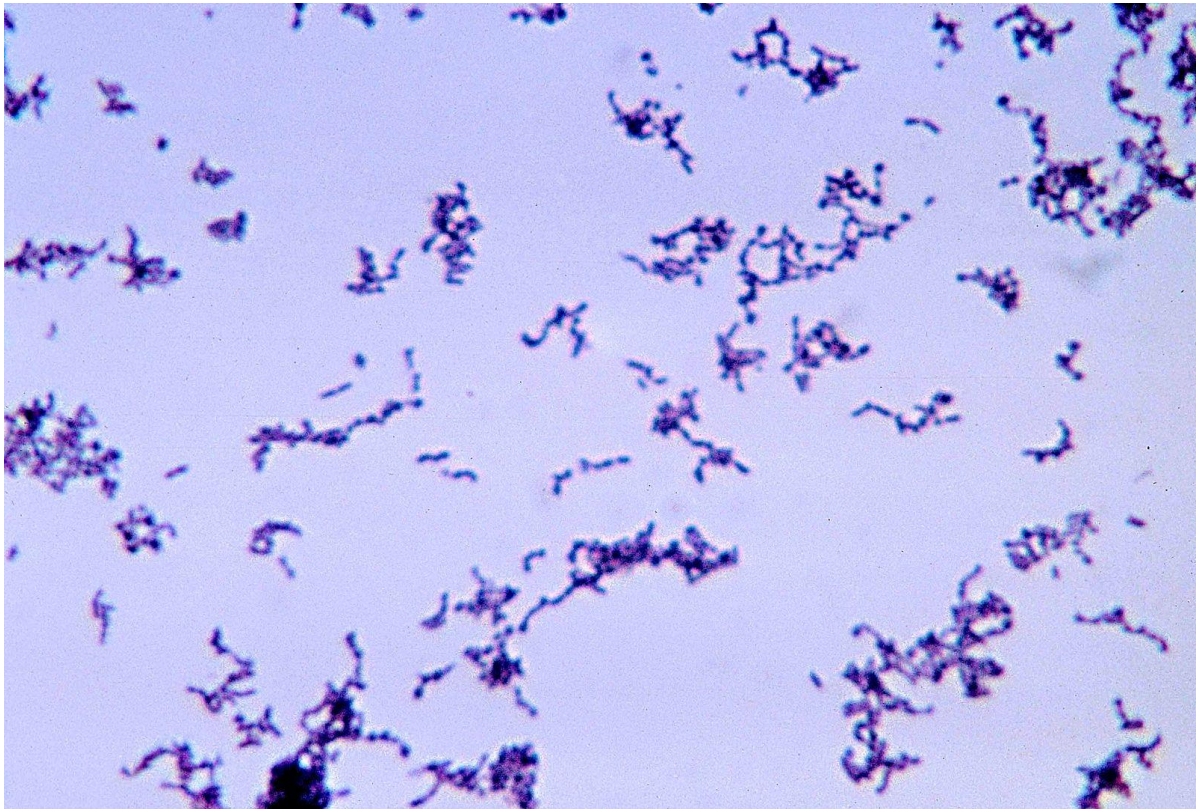
- Summary
  - Halfway down this page is a photograph of the 'carrier card' of Typhoid Mary.
  - The card says:

NAME Mallon, Mary	ADDRESS Riverside Hospital	CARRIER NO. #36
AGE 45 yrs.	SEX Female	YEAR-1907
Stools 60 positive		

- Source
  - NOVA
    - Judith Leavitt

- 11 October 2004
- <https://www.pbs.org/wgbh/nova/article/typhoid-mary-villain-or-victim/>

## Acne



### *Cutibacterium acnes*

- Summary
  - That the acne bacteria. It has a rod shape. The image here is not that crisp ... but sometimes with a microscope that's as good as you get. Oh well.
  - These are synonyms:
    - *Propionibacterium acnes*
      - Let's put a hyphen in there. *Propioni-bacterium acnes*
      - This is the original name.
    - *Cutibacterium acnes*
      - Let's put a hyphen in there. *Cuti-bacterium acnes*
      - This is the current name.
- Source
  - Wikipedia
    - [https://en.wikipedia.org/wiki/Cutibacterium\\_acnes](https://en.wikipedia.org/wiki/Cutibacterium_acnes)
    - Photo: CDC/Bobby Strong

*Propionibacterium acnes* and *Acne Vulgaris*: New Insights from the Integration of Population Genetic, Multi-Omic, Biochemical and Host-Microbe Studies.

- Verbatim



- The anaerobic bacterium *Propionibacterium acnes* is believed to play an important role in the pathophysiology of the common skin disease acne vulgaris.
- Source
  - Microorganisms
    - 2019 May; 7(5): 128.
    - <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6560440/>
- Author
  - Joseph McLaughlin,<sup>1</sup> Steven Watterson,<sup>1</sup> Alison M. Layton,<sup>2</sup> Anthony J. Bjourson,<sup>1</sup> Emma Barnard,<sup>3</sup> and Andrew McDowell<sup>1,\*</sup>

*PROPIONIBACTERIUM ACNES AND CHRONIC DISEASES*. In *The Infectious Etiology of Chronic Diseases: Defining the Relationship, Enhancing the Research, and Mitigating the Effects: Workshop Summary*. Bhatia et al. National Academies Press (US). 2004.

- Washington (DC): [National Academies Press \(US\)](#); 2004.
- Institute of Medicine (US) Forum on Microbial Threats; Knobler SL, O'Connor S, Lemon SM, et al., editors.
- <https://www.ncbi.nlm.nih.gov/books/NBK83685/>

*Acne*. Mayo Clinic Staff. Mayo Clinic.

- <https://www.mayoclinic.org/diseases-conditions/acne/symptoms-causes/syc-20368047>

*Acne*. Wikipedia.

- <https://en.wikipedia.org/wiki/Acne>

*Cultibacterium acnes*

- [https://en.wikipedia.org/wiki/Cutibacterium\\_acnes](https://en.wikipedia.org/wiki/Cutibacterium_acnes)

**E. coli**

*E. coli (Escherichia coli)*

- Summary
  - Lots of good info on E. coli.
- Source
  - CDC
    - 7 October 2022.
    - <https://www.cdc.gov/ecoli/index.html>

**Page 60 – TB (Tuberculosis)  
– Avoid, if possible**

## Diarrhea: Vibrio cholera

*Cholera* shape – see page 30 of bibliography.

## SCUBA divers: Vibrio vulnificus

*Vibrio vulnificus & Wounds*. CDC. 7 October 2019.

- <https://www.cdc.gov/vibrio/wounds.html>

## TB

*Ghon lesion*. Mostafa El-Feky. 29 Jul 2022.

- <https://radiopaedia.org/articles/ghon-lesion>

*Ghon complex*. Wikipedia.

- [https://en.wikipedia.org/wiki/Ghon%27s\\_complex](https://en.wikipedia.org/wiki/Ghon%27s_complex)

*Tuberculosis*

- Source
  - World Health Organization (WHO).
    - No date. No author
    - <https://www.who.int/westernpacific/health-topics/tuberculosis>

*HIV and Tuberculosis*

- Summary
  - If you have HIV, you're 20x more likely to get Tuberculosis (TB).
- Verbatim
  - Tuberculosis (TB) is the leading cause of death among People Living with HIV (PLHIV). HIV targets the immune system and weakens people's defense systems against infections, leading to an increased risk of TB. PLHIV have up to 20 times higher risk of developing active TB compared to those without HIV infection. TB is the leading cause of death among people living with HIV worldwide .
- Source
  - World Health Organization (WHO).
    - No date. No author
    - <https://www.who.int/westernpacific/health-topics/hiv-aids/hiv-and-tuberculosis>

*TB and HIV Coinfection*. CDC. 15 March 2016.

- <https://www.cdc.gov/tb/topic/basics/tbhivcoinfection.htm>

*Mycobacterium tuberculosis*

- Say it
  - “Mike oh back teer eh um” “too berk you low sis.”
- Summary
  - That’s a mouthful so it is shorted to “TB.”
  - This is a **rod-shaped bacteria** that causes **lung infections** and kills about **3 million people every year, mostly in developing countries.**
  - There is a **photo** of lungs infected with TB. The lungs have been removed from a dead person. If you’re on the squeamish side this could be considered a **Gruesome photo.**
- Source
  - Wikipedia
    - [https://en.wikipedia.org/wiki/Mycobacterium\\_tuberculosis](https://en.wikipedia.org/wiki/Mycobacterium_tuberculosis)

# Page 61 – The Nasty Cousins

## Gangrene – Clostridium perfringens

### *Gas gangrene and osteomyelitis of the foot in a diabetic patient treated with tea tree oil*

- Summary
  - This is a Case report.
  - **44y Female – Diabetic foot.**
  - **Self-treats with tea tree oil – a naturally-derived antibiotic. This may have seemed like a good idea but it was ineffective treatment.**
  - Develops **Gas Gangrene.**
- Source
  - International Journal of Emergency Medicine
    - April 2011
    - [https://www.researchgate.net/publication/51114139\\_Gas\\_gangrene\\_and\\_osteomyelitis\\_of\\_the\\_foot\\_in\\_a\\_diabetic\\_patient\\_treated\\_with\\_tea\\_tree\\_oil](https://www.researchgate.net/publication/51114139_Gas_gangrene_and_osteomyelitis_of_the_foot_in_a_diabetic_patient_treated_with_tea_tree_oil)
- Author
  - **Derek Cooney**, State University of New York Update Medical University, Syracuse, USA



*Confederate Army Private Milton E. Wallen lies in bed with a gangrenous amputated arm*

- Summary
  - This is US Civil War soldier **Private Milton E. Wallen** of **Company C, 1st Kentucky Cavalry**, with **gangrene** in his amputated arm. He was wounded by a **Minié ball** while in prison at **Richmond** on 4 July 1863. He was being treated for the **gangrene** in August 1863 when **Edward Stauch** traveled from **Washington** to make this painting. **Wallen** survived the infection and was furloughed from the hospital in October 1863.
- Source
  - [http://en.wikipedia.org/wiki/Gangrene#mediaviewer/File:Wallen\\_wounded\\_by\\_Minie\\_ball.jpg](http://en.wikipedia.org/wiki/Gangrene#mediaviewer/File:Wallen_wounded_by_Minie_ball.jpg)



Minié ball

- That's the type of bullet that shot Private Wallen.
- [https://en.wikipedia.org/wiki/Minié\\_ball](https://en.wikipedia.org/wiki/Minié_ball)

## Page 62 – Gangrene (continued)

### Gangrene

*Treatment of the Diabetic Foot - To Amputate or Not?* Elroy P Weledji and Pius Fokam. BMC Surg. 2014;14(83). In Medscape.

- [https://www.medscape.com/viewarticle/839596\\_3](https://www.medscape.com/viewarticle/839596_3)
- Dry Gangrene
- DM Foot
- Think ischemic tissue ie PVD.
- Affected part may auto-amputate (Medscape – Treatment of the Diabetic foot)
- [https://www.medscape.com/viewarticle/839596\\_3](https://www.medscape.com/viewarticle/839596_3)
- May progress to wet gangrene. (Medscape – Treatment of the Diabetic foot)

*Gangrene.* Johns Hopkins Medicine.

- No authors, no date.
- Gangrene is a phenomenon of bacteria – well, wet gangrene is.
- Medscape defines 3 types.
- Johns Hopkins defines 3 types.
- Gangrene comes in 2 forms, dry and wet:
- Dry gangrene occurs when the blood supply to tissue is cut off. The area becomes dry, shrinks, and turns black.

- **Wet gangrene** occurs if **bacteria invade this tissue**. This makes the area swell, drain fluid, and smell bad.
  - <https://www.hopkinsmedicine.org/health/conditions-and-diseases/gangrene>

**Plague.** Mayo Clinic Staff. Mayo Clinic.

- <https://www.mayoclinic.org/diseases-conditions/plague/symptoms-causes/syc-20351291>
- Septicemic Plague black hand
  - **Bubonic Plague**
  - **Blood clots in the tiny blood vessels of your fingers and toes can disrupt blood flow and cause that tissue to die.** The portions of your fingers and toes that have died may need to be removed (amputated).
    - **Mayo Clinic – Plague**
    - <https://www.mayoclinic.org/diseases-conditions/plague/symptoms-causes/syc-20351291>

**Frostbite.** Medscape. Bobak Zonnoor. 13 October 2020.

- <https://emedicine.medscape.com/article/926249-overview#a3>
- **Frostbite**
  - **MOA - Hunting reaction**
    - **Alternating v-c and v-d.**
    - Those **adapted to cold** have **longer and more frequent v-d** periods.
    - When it gets **too cold** the **Hunting rxn stops** → **v-c persists uninterrupted.**
  - **Verbatim**
    - **When the hunting reaction stops at colder temperatures, vasoconstriction persists uninterrupted.** This invariably leads to hypoxia, acidosis, arteriolar and venular thrombosis, and **ischemic necrosis**. Prostaglandin F<sub>2</sub> and thromboxane A<sub>2</sub>, which are released during the course of freezing and thawing, potentiate vasoconstriction, platelet aggregation, and thrombosis.
    - **Medscape – Frostbite**
      - <https://emedicine.medscape.com/article/926249-overview#a3>

# Page 63 – Botulism

## Botulism – Clostridium botulinum

**Botulism – Symptoms.** CDC. 9 February 2021.

- <https://www.cdc.gov/botulism/symptoms.html>

**Botulism.** Kirk M Chan-Tack and John Bartlett. Medscape. 15 February 2019.

- <https://emedicine.medscape.com/article/213311-overview#a8>

**Botulism – Home-Canned Foods.** CDC. 6 June 2019.

- <https://www.cdc.gov/botulism/consumer.html>

*USDA Complete Guide to Home Canning, 2015 revision*. National Center for Home Food Preservation. University of Georgia – College of Family and Consumer Sciences. 2015.

- [https://nchfp.uga.edu/publications/publications\\_usda.html#gsc.tab=0](https://nchfp.uga.edu/publications/publications_usda.html#gsc.tab=0)

## 1. Clostridium botulinum

- **Food-Borne Botulism**
  - **SS (CDC)**
    - **18 – 36 hours** later there is:
      - double vision
      - difficulty swallowing
      - difficulty breathing
    - <https://www.cdc.gov/botulism/symptoms.html>
  - **M&M (Medscape)**
    - **5-10% mortality rate.**
    - <https://emedicine.medscape.com/article/213311-overview#a8>
  - **Canning recom**
    - Seems to occur with **low-acid pH 4.6 foods**. Hmm.
    - **CDC recom using USDA recom.**
      - <https://www.cdc.gov/botulism/consumer.html>
    - **USDA**
      - The way for badness to happen is:
        - **Moist, low-acid food**
        - **T 40 F – 120 F = 4 C – 49 C**
        - **< 2% O<sub>2</sub>**
      - **Fresh food is safe because C. bot can only grow in absence of air.**
    - **Verbatim - USDA**
      - Growth of the bacterium Clostridium botulinum in canned food may cause botulism—a deadly form of food poisoning. These bacteria exist either as spores or as vegetative cells. The spores, which are comparable to plant seeds, can survive harmlessly in soil and water for many years. When ideal conditions exist for growth, the spores produce vegetative cells which multiply rapidly and may produce a deadly toxin within **3 to 4 days** of growth in an environment consisting of:
        - a moist, low-acid food
        - a temperature between 40° and 120°F
        - less than 2 percent oxygen.
      - **Botulinum spores are on most fresh food surfaces. Because they grow only in the absence of air, they are harmless on fresh foods.**
        - [https://nchfp.uga.edu/publications/publications\\_usda.html](https://nchfp.uga.edu/publications/publications_usda.html)

## Infant Botulism – Clostridium botulinum

### *Infant Botulism: Information for Clinicians*

- Verbatim
  - Infant botulism is an intestinal toxemia. The disease results after spores of the bacterium *Clostridium botulinum* or related species are swallowed, temporarily colonize an infant's large intestine, and produce botulinum neurotoxin. The neurotoxin binds to cholinergic nerve terminals and cleaves intracellular proteins

necessary for acetylcholine release, resulting in bulbar palsies, hypotonia, and a symmetric, descending, flaccid paralysis.

- CDC
  - 31 May 2022
  - <https://www.cdc.gov/botulism/infant-botulism.html>

### Botulism – Prevention

- Verbatim

Most infant botulism cases cannot be prevented because the bacteria that causes the disease is in soil and dust. The bacteria can be found inside homes on floors, carpet, and countertops—even after cleaning. For almost all children and adults who are healthy, ingesting botulism spores is not dangerous and will not cause botulism (it's the toxin that is dangerous). For reasons we do not understand, some infants get botulism when the spores get into their digestive tracts, grow, and produce the toxin.

Honey can contain the bacteria that causes infant botulism, so do not feed honey to children younger than 12 months. Honey is safe for people 1 year of age and older. Learn more about infant botulism from the [Infant Botulism Treatment and Prevention Program](#).

#### Health Alert

Several babies in Texas have become ill with infant botulism after using honey pacifiers. Do not give honey or products made with it, including honey pacifiers, to children younger than 12 months. [Find out more](#)

- Source
  - 8 June 2022
  - <https://www.cdc.gov/botulism/prevention.html>

### Black tar heroin

- *C. botulinum* can contaminate black tar heroin. So it can then contaminate the skin if the heroin (and bacteria) is injected.
- <https://www.cdc.gov/botulism/index.html>

# Page 64 – Tetanus & Difficult Diarrhea (C. diff)

## Tetanus – Clostridium tetani



- Summary
  - Anaerobic conditions allow germination of spores and production of toxins
  - Toxin binds in central nervous system
  - Interferes with neurotransmitter release to block inhibitor impulses
  - Leads to unopposed muscle contraction and spasm
  - Cannot x BBB
- Source
  - Medscape
  - January 2019
  - Author: Patrick B Hinfey, MD
  - Coauthor Jill Ripper MD MS
  - Chief Editor: John L Bruschi, MD, FACP
  - <https://emedicine.medscape.com/article/229594-overview#a3>

## C. diff diarrhea – Clostridium difficile

*C. diff* (Clostridioides difficile). CDC. 12 July 2021.

- <https://www.cdc.gov/cdiff/index.html>
- Verbatim
  - Clostridioides difficile [klos-TRID-e-OY-dees dif-uh-SEEL] is formerly known as Clostridium difficile and often called C. difficile or C. diff.
  - C. diff is a germ (bacterium) that causes diarrhea and colitis (an inflammation of the colon).
  - Most cases of C. diff infection occur while you're taking antibiotics or not long after you've finished taking antibiotics.
  - C. diff can be life-threatening.

*Your Risk of C. diff*. CDC. 27 June 2022.

- <https://www.cdc.gov/cdiff/risk.html>

*Fast Facts About The Human Microbiome*. Marilyn Hair and Jon Sharpe. Center for Ecogenetics and Environmental Health, University of Washington.

- This is about the micro-biome with a medical / illness slant.
- [https://depts.washington.edu/ceeh/downloads/FF\\_Microbiome.pdf](https://depts.washington.edu/ceeh/downloads/FF_Microbiome.pdf)

*Microbiome*. Wikipedia.

- <https://en.wikipedia.org/wiki/Microbiome>
- This is a readable introduction to what is a huge topic.

*The Microbiome*. Harvard T. H. Chan School of Public Health. The Nutrition Source.

- <https://www.hsph.harvard.edu/nutritionsource/microbiome/>
- This is the micro-biome from a nutritional standpoint.

*The intestinal microbiota dysbiosis and Clostridium difficile infection: is there a relationship with inflammatory bowel disease?*

- Justyna Bien, Vindhya Palagani, and Przemyslaw Bozko.
- Therapeutic Advances in Gastroenterology. January 2013.

- This is a 2013 article, theoretically out of date, but it's nicely written. There is enough 'English' in it to balance the technical stuff. Take a crack at this after you read the stuff in Wikipedia. You will see just how complicated the topic is. And also how fascinating.
- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3539291/>

# Page 65 – Staph versus Strep

## Staph

*Staphylococcus aureus in Healthcare Settings*. CDC. 17 January 2011.

- <https://www.cdc.gov/hai/organisms/staph.html>
- There are links to MRSA and VRSA, which are *Methicillin Resistant Staph Aureus* and *Vancomycin Resistant Staph Aureus*.
- Methicillin is a cousin of penicillin.
- Vancomycin is a strong antibiotic sometimes used when others fail.

*Diagnosis and Treatment of Staphylococcus aureus*. Minnesota Department of Health. No date, no author.

- <https://www.health.state.mn.us/diseases/staph/treat.html>
- Verbatim – Normal flora
  - *S. aureus* is part of the normal human flora (bacteria that normally reside in or on humans) and does not usually cause infection. When bacteria are living on or in the human body, but are not causing infection, it is called "colonization." Humans are most often colonized with *S. aureus* in their noses and it is also found on the skin and other body sites. Over time, 20% of the population will almost always be colonized with *S. aureus*, 60% of the population will be colonized with *S. aureus* off and on, and another 20% are almost never colonized with *S. aureus*.

*Skin infections in IV drug users*

Verbatim – abscess

- Abscesses are collections of pus. They are usually caused by infection with *S. aureus* but in drug users they occasionally contain a mixture of aerobic bacteria (that require oxygen) and anaerobic bacteria (that do not require oxygen). These mixed abscesses often result in a foul odour.
- Author is Dermatologist in New Zealand.
  - Author: **Dr Amy Stanway** MBChB, Registrar, Department of Dermatology, Waikato Hospital, Hamilton, New Zealand,
  - Dermnet
  - 2002
  - <https://dermnetnz.org/topics/skin-infections-in-iv-drug-users>

*Infective Endocarditis in Intravenous Drug Abusers*. José M. Miró, Asuncion Moreno, Carlos A. Mestres. *Current Infectious Disease Reports*. August 2003.

Verbatim – Endocarditis

- **Infective endocarditis (IE)** is one of the most severe complications in intravenous drug abusers (IVDA). IE usually involves the tricuspid valve, *Staphylococcus aureus* is the most common etiologic agent, and it has a relatively good prognosis.
- ID docs from Barcelona
  - <https://pubmed.ncbi.nlm.nih.gov/12866981/>

*Staphylococcus aureus*. Wikipedia.

- [https://en.wikipedia.org/wiki/Staphylococcus\\_aureus](https://en.wikipedia.org/wiki/Staphylococcus_aureus)

## Strep

*Streptococcus pneumoniae*. CDC. 27 January 2022.

- <https://www.cdc.gov/pneumococcal/clinicians/streptococcus-pneumoniae.html>

*Lancefield grouping*. Wikipedia.

- [https://en.wikipedia.org/wiki/Lancefield\\_grouping](https://en.wikipedia.org/wiki/Lancefield_grouping)

*Lancefield classification*. Merck Manual – Professional Division. No date, no author.

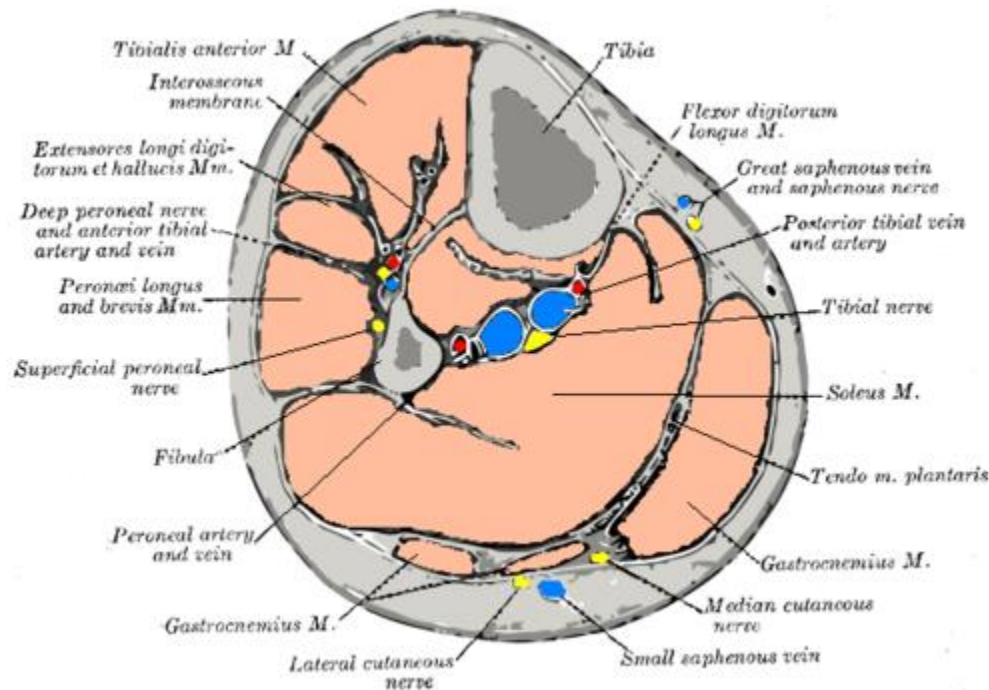
- <https://www.merckmanuals.com/en-ca/professional/multimedia/table/lancefield-classification>

**Page 66 – Flesh-Eating  
Disease – Cooler than you  
thought it was**

## Fascia

Fascia

- Nice overview of what fascia is.
- [Cleveland Clinic](#) – they are a good source of medical info.
- <https://my.clevelandclinic.org/health/body/23251-fascia>



### Fascial compartment

- That's a cross-section through the left leg at the level of the calf to show the **compartments** that contain groups of muscles. If it's confusing, that is normal.
- [https://en.wikipedia.org/wiki/Fascial\\_compartment](https://en.wikipedia.org/wiki/Fascial_compartment)

## Flesh-Eating Disease

*Streptococcus pyogenes* [Group A Strep]. Wikipedia.

- [https://en.wikipedia.org/wiki/Streptococcus\\_pyogenes](https://en.wikipedia.org/wiki/Streptococcus_pyogenes)

*Necrotizing fasciitis*. Wikipedia. **Gruesome photos.**

- [https://en.wikipedia.org/wiki/Necrotizing\\_fasciitis](https://en.wikipedia.org/wiki/Necrotizing_fasciitis)

*Necrotizing Fasciitis*. **Steven A Schulz**. Medscape. **12 October 2022**. **Gruesome photos.**

- <https://emedicine.medscape.com/article/2051157-overview>
- **Steven A Schulz**, MD Clinical Instructor/Faculty in Plastic and Reconstructive Surgery, Fellow in Reconstructive Microsurgery, Department of Plastic Surgery, Ohio State University Wexner Medical Center, Ohio State University College of Medicine

*Group A Streptococcal (GAS) Disease: Necrotizing Fasciitis: All You Need to Know*. CDC. 27 June 2022.

- <https://www.cdc.gov/groupastrep/diseases-public/necrotizing-fasciitis.html>

*Invasive strep infections and 'the flesh-eating disease'*. **Canadian Paediatric Society**. Pediatric Child Health. 1999.

- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2828232/>
- Can **Strep Throat** cause **Necrotizing Fasciitis**?
  - Yes, 1 per 1,000,000 cases.
  - Chance of **lightning strike** is 1 / 700,000.
  - Verbatim
    - Should I be concerned that if my child has strep throat he or she may develop flesh-eating disease?
    - No. Most cases of flesh-eating disease arise from skin and soft tissue disease, not from strep pharyngitis or strep throat. Millions of North American children get strep throat every year, but less than one child in a million will actually develop flesh-eating disease. Put in context, there is more than 100 times greater risk of dying from a motor vehicle accident and at least a 50% greater risk of getting struck by lightning each year in North America than there is of coming down with flesh-eating disease. Thus, only rarely will strep throat progress to flesh-eating disease.
    - **Pediatric Child Health 1999**
    - Seems to be written by **Canadian Pediatric Society**.

# Page 67 – Amazing Zoology Story & Membranes You've Never Heard Of

## Group B Strep (GBS): Chorio-amnion-itis

Chorio-amnion-itis – some background

- Note
  - **Chorioamnionitis is not a TORCH infection** (see page 84).
    - In a TORCH infection, bacteria or viruses pass through the placenta.
    - Whereas the GBS bacteria go from vagina → membranes → fetus.

*Group B streptococcal infection*. Wikipedia.

- [https://en.wikipedia.org/wiki/Group\\_B\\_streptococcal\\_infection](https://en.wikipedia.org/wiki/Group_B_streptococcal_infection)
- There is a **photo** from a microscope of the bacteria. They are the dark round circles. There are probably 100 to 200 of them. I didn't count. Remember, this is a 'coccus' meaning it's a bacteria that is shaped like a sphere.

**GROUP B STREPTOCOCCUS: PREVALENCE IN A NON-OBSTETRIC POPULATION.** Catherine M. Leclair et al. Journal of Lower Genital Tract Disease. July 2010.

- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2898746/>
- [Catherine M. LECLAIR, MD](#), [Ashley E. HART, MD](#), [Martha F. GOETSCH, MD MPH](#), [Heather CARPENTIER](#), and [Jeffrey T. JENSEN, MD, MPH](#)
- **GBS**
  - **GBS regularly colonizes 10 – 30% of OB pts.**
  - Verbatim
    - Streptococcus agalactiae or Group B streptococcus (GBS) is a known vaginal bacterial inhabitant. Previous cross-sectional studies of obstetrical patients have documented that at least 10-30% of women are regularly colonized with this organism in the vagina and rectum.

**Intrapartum Management of Intraamniotic Infection.** American College of Obstetricians and Gynecologists' Committee on Obstetric Practice. American College of Obstetricians and Gynecologists (ACOG). Number 712. August 2017.

- <https://www.acog.org/clinical/clinical-guidance/committee-opinion/articles/2017/08/intrapartum-management-of-intraamniotic-infection>

**Diagnosis and Management of Clinical Chorioamnionitis.** Alan T. N. Tita and William W. Andrews. Clinical Perinatology. June 2010.

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3008318/>

Alan T. N. Tita, MD, PhD<sup>a</sup> and William W. Andrews, PhD, MD<sup>b</sup>

Go nuts. Just a whole ton of detail here. It's very technical but it's nicely written.

Figure 1 shows how the bacteria 'ascend' to the fetus.

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3008318/>

## Amazing Zoology Story

**The Amniotic Egg.** **John Merck.** Geology 431 Vertebrate Paleobiology. Department of Geology. University of Maryland. 2015.

- <https://www.geol.umd.edu/~jmerck/geol431/lectures/d06eggs.html>
- This is a bit technical but it nicely contrasts **amphibian eggs** with **reptile eggs**.
- When you read the word 'amnion' or 'amniote', think birds, reptiles and mammals.

### Amniotes

- **Lumen Learning.**
  - No date, no author
  - <https://courses.lumenlearning.com/suny-wmopen-biology2/chapter/amniotes/>
- **Figure 1** is a drawing of an **egg** (either a **reptile** or **bird**) with an **amnion** and **chorion**.
- Verbatim

- The first amniotes evolved from amphibian ancestors approximately **340 million years ago** during the Carboniferous period.

### Amniote

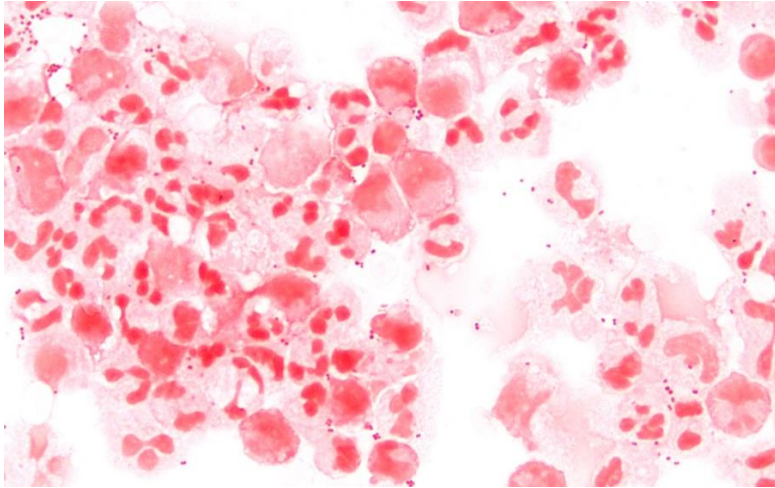
- [Wikipedia](#).
- <https://en.wikipedia.org/wiki/Amniote>
- The first amniotes, referred to as "basal amniotes", resembled small lizards and evolved from the amphibious reptiliomorphs about **312 million years ago**,<sup>[9]</sup> in the Carboniferous geologic period.

# Page 68 – Meningitis & Lyme Disease

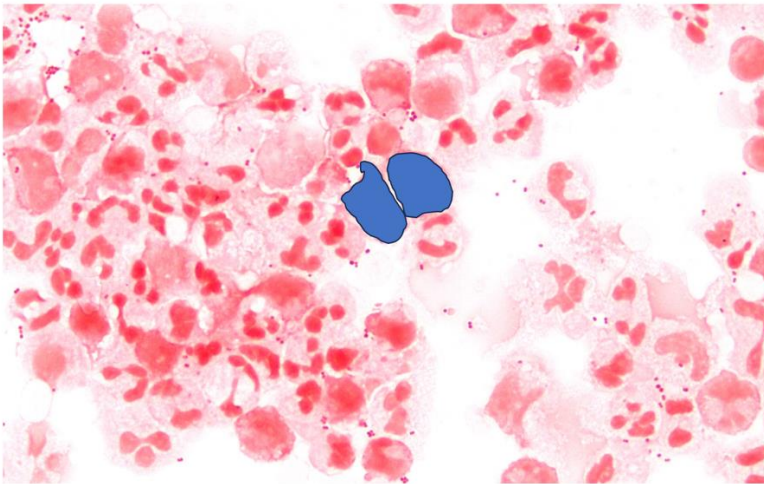
## Meningitis

### Some background

- Strange shape
  - **Meningo-coccus** has a distinctive shape. It looks like you took 2 of those sponge stress balls and squished them against each other.
  - So it is 2 cocci? Yes. 2 cocci (balls a.k.a. spheres) squished against each other.
  - See the images below.
- Nasty synonyms
  - **Meningitis bacteria**
    - This is a very unofficial term but it's easy to say).
  - **Meningo-coccus**
    - "Men ing go – cock us"
  - **Neisseria meningitidis**
    - "Nye" – nye rhymes with eye – "seer ee ah" "men in jit ih dis."
- Tip-offs
  - Is a **stiff neck** a tip-off to **Meningitis**? Yes.
  - Does everyone with a stiff neck have **Meningitis**? No. Maybe you're a wrestler and you did bridges yesterday.
  - What about a **stiff neck + headache + fever + decreased level of consciousness**? Yeah, now we're leaning towards **Meningitis**.
- Treatment
  - If it's serious, you get intra-venous (IV) **ceftriaxone** ("seff try ax own"), a cousin of **penicillin**.



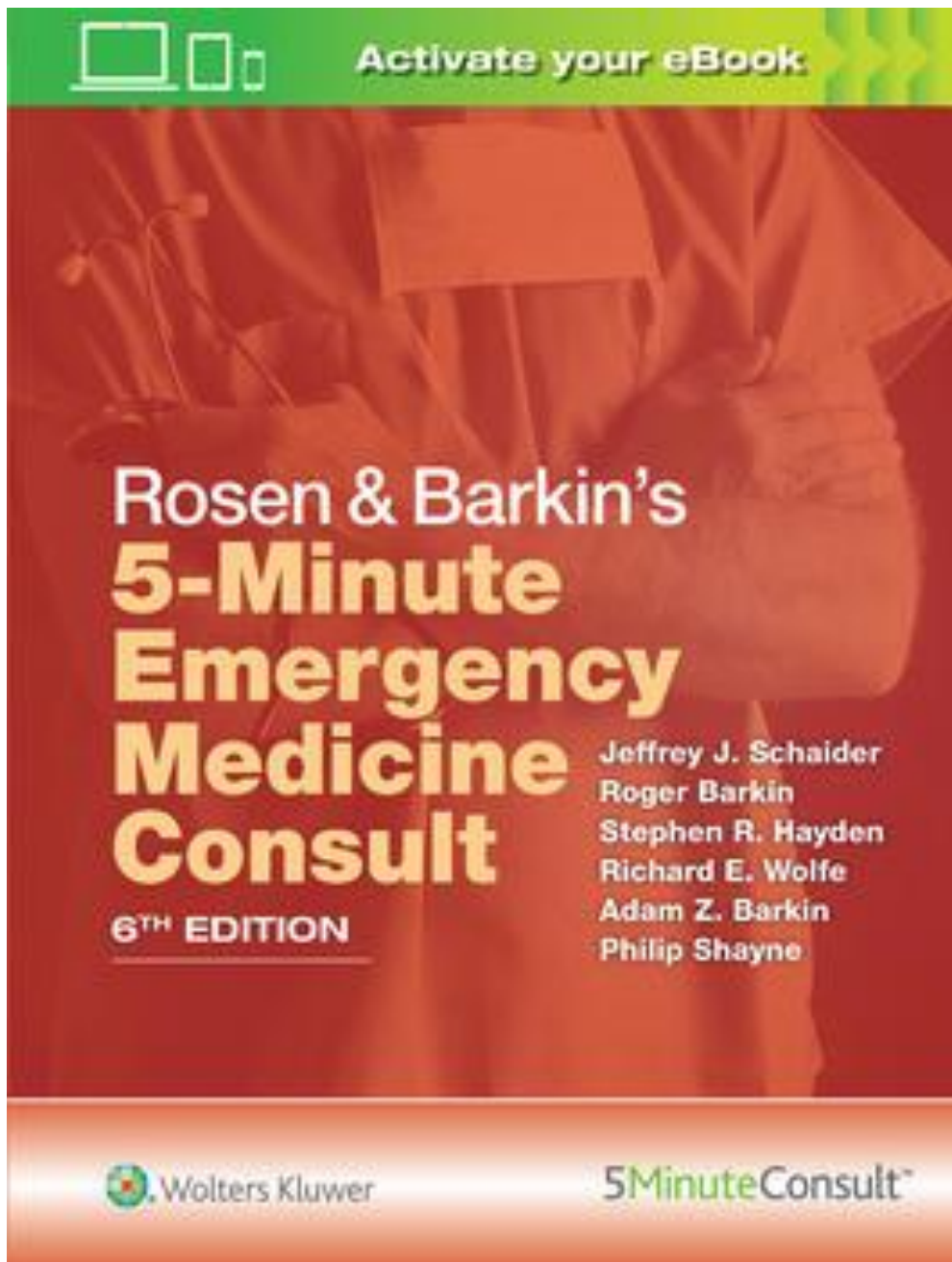
Original image.



**Meningitis bacteria** growing in the fluid that surrounds the brain and spinal cord a.k.a. **Cerebro-Spinal Fluid (CSF)**. The magnification is 1000 x.

- Those 2 shapes are the 2 balls squished against each other. This is the Meningitis bacteria.
- I added in the blue coloring in PowerPoint.
- The image is from Wikipedia.
- [https://en.wikipedia.org/wiki/Neisseria\\_meningitidis](https://en.wikipedia.org/wiki/Neisseria_meningitidis)





*Rosen & Barkin's 5-Minute Emergency Medicine Consult, 6<sup>th</sup> Edition*

- Summary

- This is an awesome textbook of Emergency Medicine. It is 1256 pages of bulleted points, with each illness summarized in 1 or 2 pages. It weighs 6 ½ pounds (3 kg) – that's heavy enough to do physiotherapy exercises. Is Meningitis in this book? You bet.
- By the way, Emergency Medicine doctors are totally switched on. They have to know what kills people *right now*. They are masters of multi-tasking. After I finished my training in Family Medicine, I did 10 months of Emergency Medicine training. Turns out I was not good at multi-tasking.

Boss Doctor: *Hey, Jones, what are you doing?*

Me: *I'm eating fig newtons.*

Boss Doctor: *There are seven patients waiting to be seen.*

Me: *I have to see more than one at a time?*

Boss Doctor: *Get out. Never come back.*

- And that's how I ended up drawing cartoons.
- Source
  - **Wolters Kluwer**
    - At medical conferences there are usually booksellers present. Medical books published by **Wolters Kluwer** (it's a **Dutch** company) are often for sale.
  - <https://shop.lww.com/Rosen---Barkin-s-5-Minute-Emergency-Medicine-Consult/p/9781496392954>
- Authors
  - Jeffrey J. Schaider MD**  
Professor, Department of Emergency medicine  
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Chairman, Department of Emergency Medicine  
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  - Stephen R. Hayden MD**  
Professor of Clinical Medicine, Associate Dean for Graduate Medical Education and DIO, Department of Emergency Medicine, University of California San Diego Medical Center, San Diego, CA; Editor-in-Chief, Journal of Emergency Medicine
  - Richard E. Wolfe MD**  
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  - Adam Z. Barkin MD**  
Clinical Instructor, Department of Emergency Medicine, University of Colorado School of Medicine, Aurora, CO; Attending Physician, Emergency Medicine, Rose Medical Center, Denver, CO
  - Philip Shayne MD**  
Associate Professor, Vice Chair for Education and Residency Program Director, Department of Emergency Medicine, Emory University School of Medicine, Atlanta, GA
  - Peter Rosen, MD**  
**The book is named after him.**  
Formerly, Clinical professor at the University of Arizona Department of Emergency Medicine
  - Roger M. Barkin MD**  
**And him.**  
Clinical Professor of Pediatrics, University of Colorado School of Medicine; Emergency Physician, CarePoint/Rose Medical Center, Denver, CO

## Meningitis

- Summary
  - **There are links to the various kinds of Meningitis caused by different types of organisms:**
    - **Bacterial** Meningitis
      - For example, the bacteria **Meningo-coccus**, the 2 balls squished together.
    - **Viral** Meningitis
      - For example, the **measles virus** can ravage the brain. That's why there is a measles vaccine.
    - **Fungal** Meningitis
      - For example, the fungus called **Aspergillus** can get into the brain but that's pretty rare.
    - **Parasitic** Meningitis
      - Think, **tiny worms**.
      - For example, **Angio-strongylus** lives in snails. It gets into you if you eat undercooked snails.
      - **"An jee oh strong gull us"**

- **Amoebic** Meningitis
  - Think, **nasty amoeba**.
  - The classic nasty here is called **Naegleria fowleri**. It lives in fresh water. It is usually fatal if it gets into our brain.
  - “Nay gler ee ah” “fowl er eye”
- **Non-Infectious** Meningitis
  - This is stuff that is not an infection.
  - For example, **Lupus** is a disorder where the immune system attacks the body. If it attacks the meninges (lining of the brain), that’s Non-Infectious Meningitis. This is a rare event in Lupus.
  - This is also called **Aseptic Meningitis**.
- The moral of the story is lots of critters like to get into our brain and mess it up. Fortunately they are not that common. Nevertheless, **Emergency Medicine doctors** need to be aware of them so they can hand off the patient to **Infectious Disease specialists** who will manage them.
- **CDC**
  - 30 March 2022
  - <https://www.cdc.gov/meningitis/index.html>

### Meningococcal Photos

- Summary
  - **GROSS** photos of babies with **gangrene** of the hands and legs due to **Meningo-coccemia** (“men ing go cock see me ah”) which is the **Meningitis bacteria** (a.k.a. **Meningo-coccus**) growing in the blood.
- Source
  - **CDC**
    - 31 May 2019
    - <https://www.cdc.gov/meningococcal/about/photos.html>

### Bonus material

- Ever head of **Gonorrhea**? It’s a **Sexually Transmitted Infection (STI)**. It is caused by **Neisseria gonorrhea**, a cousin of **Neisseria meningitidis**.
- Because there waaaay too many syllables and vowels in those names, we just say this to differentiate them:
  - **Meningo-coccus**
  - **Gono-coccus**

## Lyme Disease

### **Borrelia burgdorferi NEU2011**

- Summary
  - There is a **photo** of the bacteria that causes **Lyme Disease**. The bacteria clearly has a **corkscrew** shape.
  - This is a good website. Check out the **Microbial Mythology link on the left** to dispel some myths.
  - **Copyright notice**. Readers may view, browse, and/or download material for **noncommercial personal purposes**. Please credit our site for use. Materials on our site obtained with permission from other sources require permission from those sources for further reproduction.
- Source
  - **MicrobWiki**
    - [https://microbewiki.kenyon.edu/index.php/Borrelia\\_burgdorferi\\_NEU2011](https://microbewiki.kenyon.edu/index.php/Borrelia_burgdorferi_NEU2011)



That's the classic 'target lesion' of Lyme Disease.

- This woman's **right arm is raised overhead**, so that's the back of her upper arm.
- [https://en.wikipedia.org/wiki/Lyme\\_disease](https://en.wikipedia.org/wiki/Lyme_disease)

What are 3 things are needed to get Lyme Disease?



Corkscrew bacteria



deer tick (vector)



human

- Summary

- The bacteria is inside the tick. The tick bites the human. Now the bacteria is inside the human.

- The corkscrew bacteria is *Borrelia burgdorferi*. That's "Bore ee lee ah" "burg door fer ee" (or "burg door fer eye").
- Lyme Disease is named after [Lyme, Connecticut](#).
- Source
  - 2 images on Left: [https://en.wikipedia.org/wiki/Lyme\\_disease](https://en.wikipedia.org/wiki/Lyme_disease)
  - Man in suit: <https://en.wikipedia.org/wiki/Suit>

### Lyme Disease

- Summary
  - This is the CDC home page on [Lyme Disease](#). There are oodles of links.
  - There is a cool photo of 4 [deer ticks](#) side-by-side on a US Dime. I am pretty sure that is the face of [President Franklin Delano Roosevelt \(FDR\)](#). I had to hunt down a photo of the dime on the website of the [US Mint](#). Is it FDR?
    - <https://www.usmint.gov/coins/coin-medal-programs/circulating-coins/dime>
- Source
  - [CDC](#)
    - 19 January 2022
    - <https://www.cdc.gov/lyme/index.html>

### Why is CDC concerned about Lyme disease?

- Summary
  - There is a [dot map](#) showing how [Lyme Disease](#) clusters in the [north-east USA](#).
- Verbatim
  - Lyme disease is the most common vector-borne disease in the United States.
    - Remember, the **vector** is basically the middle man who transmits a bacteria or virus or amoeba to a human. Think of the vector as the courier from Hell.
- Source
  - [CDC](#)
    - 13 January 2021
    - <https://www.cdc.gov/lyme/why-is-cdc-concerned-about-lyme-disease.html>

**Page 69 – Impressive, most impressive, Malaria**



### Anopheles

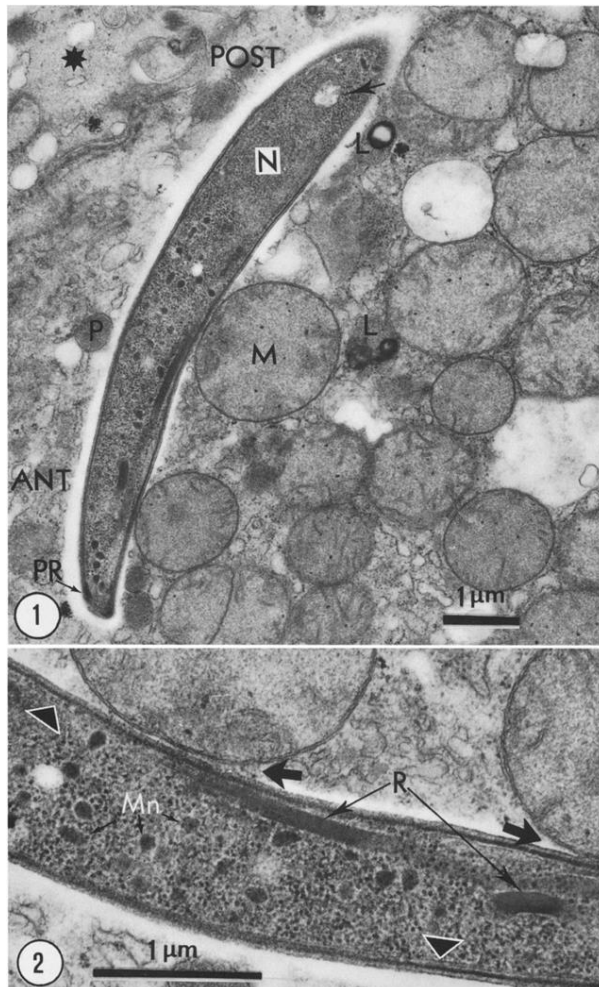
- Summary
  - This is the mosquito that transmits **Malaria**. That's a female in the photo. Her belly is full of human blood.
- Verbatim
  - An Anopheles stephensi mosquito is obtaining a blood meal from a human host through its pointed proboscis. Note the droplet of blood being expelled from the abdomen after having engorged itself on its host's blood. This mosquito is a known malarial vector with a distribution that ranges from Egypt all the way to China. Source: CDC
- Source
  - <https://en.wikipedia.org/wiki/Anopheles>



### Plasmodium

- Source
- **Wikipedia**
- <https://en.wikipedia.org/wiki/Plasmodium>
- Summary

- This is the **sporozoite** that gets injected into your blood by the mosquito. There are dozens of them here. [The nucleus is the dark spot. Remember, the single-celled organisms in the Amoeba Kingdom have a nucleus].



*The demonstration of Plasmodium berghei sporozoites in rat hepatocytes one hour after inoculation.*

- Zeitschrift für Parasitenkunde 67(3):345-8. **February 1982.**
- Jacques Meis. J P Verhave. Paul Jap. J H Meuwissen.
- **Figure 1** is really nice electron microscope image of a **sporozoite** in a rat liver cell.
- <https://www.researchgate.net/publication/16446396> The demonstration of Plasmodium berghei sporozoites in rat hepatocytes one hour after inoculation

*Malaria – Biology.* CDC. 16 July 2020.

- <https://www.cdc.gov/malaria/about/biology/index.html>
- **Malaria life cycle here.** It's confusing even when labelled.

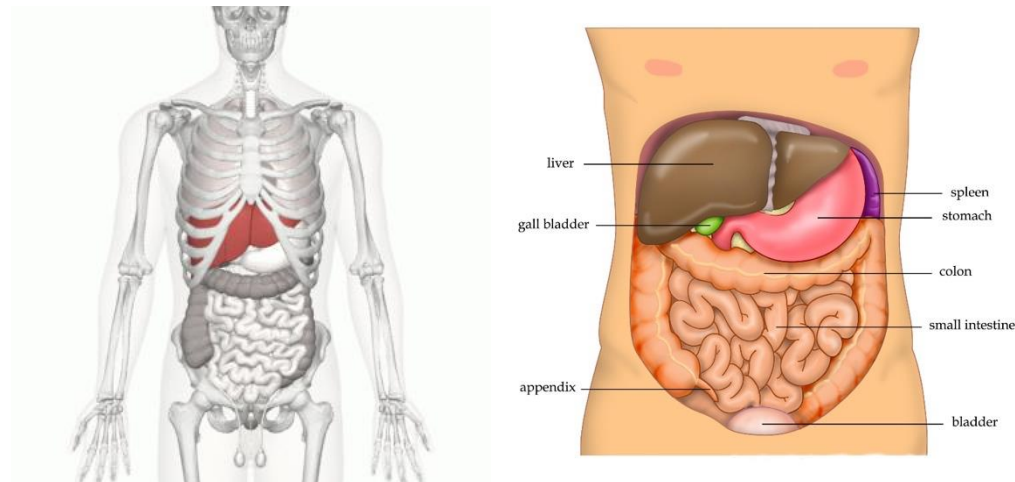
*Transgenic Anopheles stephensico expressing single-chain antibodies resist Plasmodium falciparum development.*

- **Alison T. Isaacs, Nijole Jasinskiene, Mikhail Tretiakov, +3, and Anthony A. James**
- **PNAS.** 109 (28) E1922-E1930.
- **11 June 2012**
- <https://www.pnas.org/content/109/28/E1922/1>

- Figure P1 is wonderfully detailed step-by-step photo of the life cycle in the mosquito.

# Page 70 – Hydroxy-chloro-quine – Not where you expected it?

## Liver

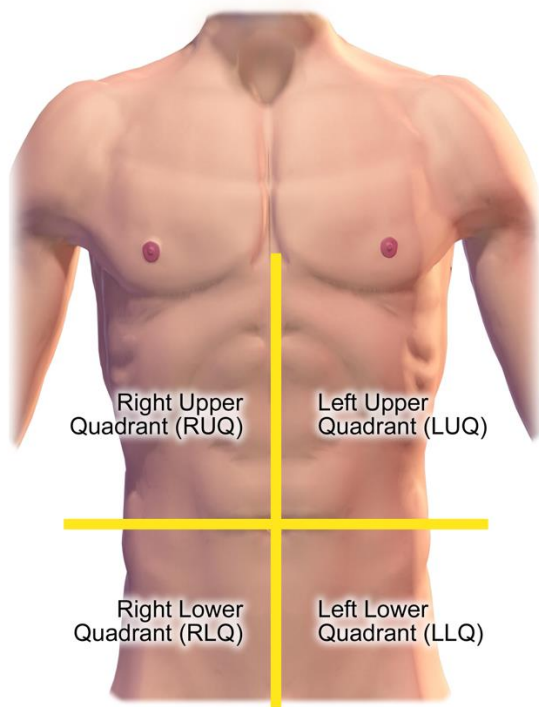


### Liver

- Source
  - Wikipedia
    - <https://en.wikipedia.org/wiki/Liver>
- Summary
  - Since the liver is where the single-celled Malaria organism *Plasmodium* initially goes, it's useful to know what the liver looks like and where it's located.
  - The liver is usually drawn in a brown color in anatomy books. In the spinning dude, it's red. In real life, it's sort of ½ red ½ brown. You may have to go to the Wikipedia page to see the spinning.

## Quadrants

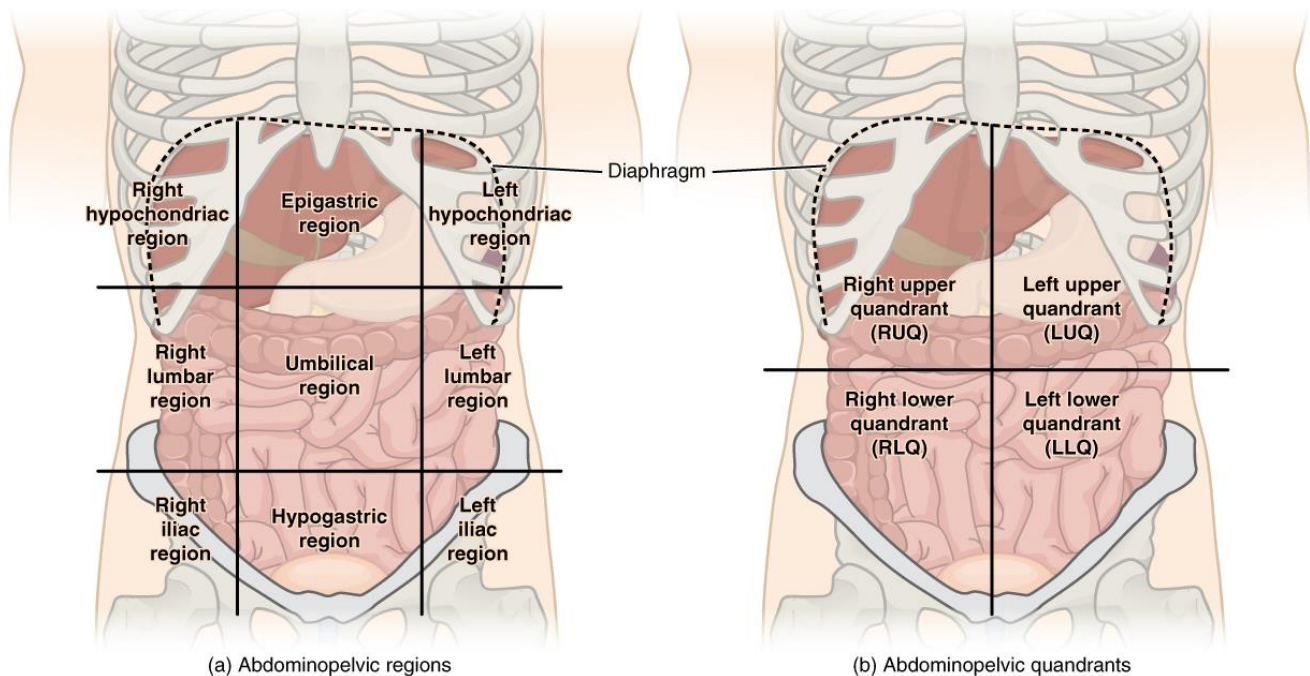




## Abdominopelvic Quadrants

### *Quadrants and regions of abdomen*

- Source
  - Wikipedia
    - [https://en.wikipedia.org/wiki/Quadrants\\_and\\_regions\\_of\\_abdomen](https://en.wikipedia.org/wiki/Quadrants_and_regions_of_abdomen)
- Summary
  - 🖐️ Draw a vertical line through your belly button (navel) (“nay vul”). Now a horizontal line. That divides the abdomen into 4 quadrants.
  - When you tell the doctor, “my stomach hurts,” we don’t believe you. We ask you to point with one finger where it hurts in order to know which quadrant it is. Of course, you can have pain in all 4 quadrants a.k.a. **diffuse abdominal pain**, so that makes our life as doctors more difficult. Please try to have pain in just one spot. ‘Diffuse’ is a fancy way of saying spread all over. I guess you could say that peanut butter is spread diffusely on a piece of bread.
  - Technically, they are **abdomino-pelvic regions**. Don’t sweat it.



IGNORE THIS

LOOK AT THIS

### Summary

- The abdomen plus pelvis can be divided into 4 or 9 regions. Let's stick to 4 regions – it's more intuitive.
- **Your liver lives in the Right Upper Quadrant (RUQ).** It's the brownish/reddish shape. It's partially protected by the ribs but a 'liver punch' in boxing can still hurt like hell.
- The **stomach** (the tan color in the drawing) lives in the Left Upper Quadrant. So does your **spleen**. And **left kidney**.
- This is the same Wikipedia source as the previous image.

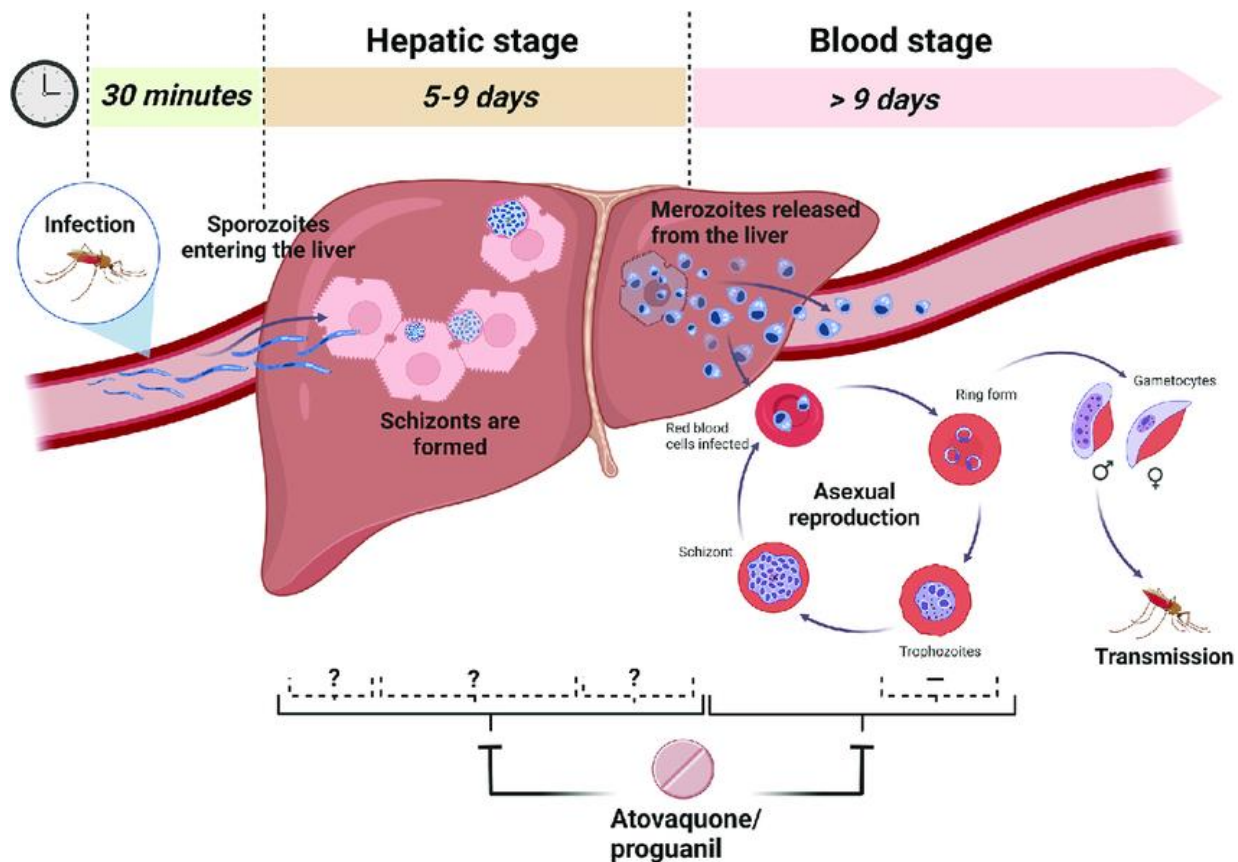
## Malaria treatment overview)

### Background info on the treatment of malaria

- The treatment of **Malaria** is complicated and confusing.
- It's *confusing* because all the drugs have strange names and abbreviations:
  - **chloro-quine (CQ)**
  - **hydroxy-chloro-quine (HCQ)**
  - **meflo-quine (MQ)**
  - **prima-quine (PQ)**
  - Any many others. So it helps if you took a course in organic chemistry in university.
- It's *confusing* because the drugs target the malaria organism in different parts of the human body:
  - Liver a.k.a. **pre-erythrocyte state**.
  - Red Blood Cells (RBC) a.k.a. **erythro-cyte stage**.
- It's *confusing* because the drugs target different forms (think, different shapes) of the malaria organism:
  - **Sporozoite** (that's the **love child** I drew).
  - **Schizont** a.k.a. **ring form**
    - This guy lives in our red blood cells.
  - **Gamete**

- These guys (actually, guys and gals, as they are the 'sexual' stage of the organism) live in the mosquito. The drugs don't affect it.
- It's *complicated* because there are 'special populations' of patients to consider:
  - **Pregnant females** (or those who might be considering becoming pregnant while in the malaria region).
    - They can't take certain malaria drugs.
  - **Children**
    - They can't take certain malaria drugs.
  - **Last-minute traveller**
    - They decided at the last minute they want to visit a malaria-stricken region of the world. Their flight departs in 16 hours. It's too late to start them on certain drugs.
- It's *complicated* because the malaria organism (*Plasmodium*) (think, single-celled amoeba), constantly evolves to become resistant to the drugs. For example:
  - **Chloroquine-resistant *Plasmodium falciparum***.
    - That means **chloroquine** no longer works. So the doctors and nurses that give advice to travellers have to consult maps that show resistant regions. This information is constantly updated.
- It's *complicated* because the drugs are different depending on how sick you are:
  - 1) You are not ill. You have not left on your trip yet.
    - You're not ill. You start the drug before you depart on your holiday, continue it during the holiday, and maybe for a few weeks after get home (in case the organism is still inside you). This is called **prophylaxis** ("pro fa lax iss").
  - 2) **Mild illness**
    - That means **Mild Malaria**.
  - 3) **Severe illness**
    - That means **Severe Malaria**.
    - This is malaria that can kill you. You're more likely now to get intra-venous (IV) drug treatment now.

**Malarone (it's a drug to treat malaria)**



*On the potential for discontinuing atovaquone-proguanil (AP) ad-hoc post-exposure and other abbreviated AP-regimens: Pharmacology, pharmacokinetics and perspectives*

- Summary
  - There is a ton going on in this image. If you can explain it to a stranger on the bus then you have a good handle on Malaria.
  - Here's the deal: The **sporozoites** (love children born in the mosquito) get injected (a.k.a. inoculated) into you by the mosquito → The sporozoites head to the liver within 30 minutes. *Chop, chop there's work to do, people!* → There they turn into a **shizont** → which turn into a **merozoite** → that heads to the blood and invades red blood cells → Now they assume a ring shape called the **ring form** → The ring forms eat the red blood cell (RBC) from the inside but that's not the reason the RBC dies → The ring forms multiply and this splits the RBC apart (that's **erythro-lysis**) (erythro means red, lysis means split) → Now the ring form morphs into males and females called **gameto-cytes** (think of them as sperm and egg) → Those males and females get sucked up in the blood by the next feeding mosquito → They have little babies a.k.a. love child a.k.a. sporozoites → the cycle starts all over.
  - Atovaquone / proguanil is a pill with 2 drugs in it. The brand name is MALARONE™. It seems to kill the sporozoites in the liver and the ring form in the blood.
- Say it
  - "Spore oh zoh ite"
  - "Shiz ont"
  - "Mere oh zoh ite"
  - "Gam eat oh sights"
- What's with the funky names?
  - As is usual in marketing, the brand name is catchy and contains some reference to the ailment. The 'mal' part of malaria forms the beginning of the drug MALARONE.
- Verbatim

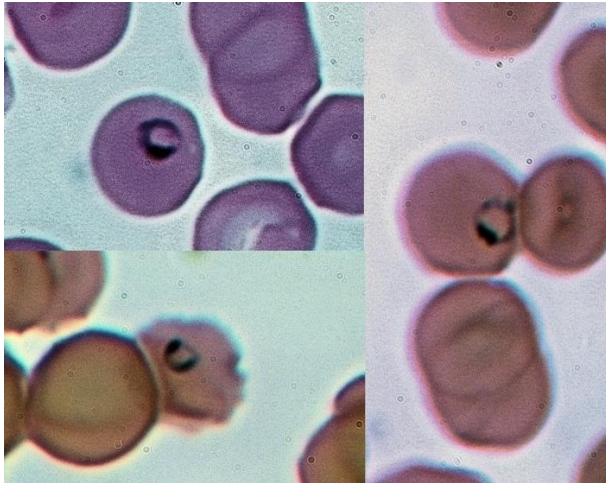
- The sites of action in the Plasmodium life cycle of atovaquone and proguanil. Sporozoites invade the liver cells **within 30 minutes** after inoculation [2,3] and then mature into schizonts. **After 5-9 days**, these schizonts rupture, releasing merozoites from the liver into the bloodstream. These merozoites invade erythrocytes and then mature from ring stages to trophozoites to schizonts, with some ring stages differentiating into gametocytes. Atovaquone and proguanil have suppressive effects on both the hepatic and blood stage [3-7]. During the blood stage, atovaquone and proguanil have their peak activity at the trophozoite stage [48,49]. Then, the susceptibility to atovaquone-proguanil of liver stages might also vary during their development [8]. This figure was created with Biorender.com.
- Source
  - Travel Medicine and Infectious Disease
    - This is a medical journal.
    - A small excerpt from the original journal article is the figure above. It is on the website **ResearchGate** where images from journals are compiled.
    - December 2022
    - <https://www.researchgate.net/publication/366255610> On the potential for discontinuing atovaquone-proguanil AP ad-hoc post-exposure and other abbreviated AP-regimens Pharmacology pharmacokinetics and perspectives
- Authors
  - Jenny Schnyder
  - Hanna K. de Jong
  - Emmanuel B. Bache
  - Reinier M. van Hest
  - Patricia Schlagenhaut
  - Steffen Borrmann
  - Thomas Hanscheid
  - Martin Grobusch

## Primaquine (it's a drug to treat malaria)

Primaquine (PQ)

- Summary
  - The way PQ works is very specific. It gets into the human liver cells and it is there that the PQ is converted to other things (a.k.a. metabolites) that then generate **hydrogen peroxide** (H<sub>2</sub>O<sub>2</sub>). Does that mean you can treat malaria by simply drinking hydrogen peroxide? No! No! No! If you drink hydrogen peroxide you'll just end up with a nasty chemical burn of your foodpipe and your life will suck.
  - Here's the proper sequence of events: Swallow primaquine pill → pill dissolves in small intestine → molecules of PQ exit the small intestine and enter the blood stream → PQ molecules carried in blood to the Liver → Liver converts PQ to metabolites → metabolites generate H<sub>2</sub>O<sub>2</sub> → H<sub>2</sub>O<sub>2</sub> kills the Plasmodium.

**More malaria info**



**Plasmodium**

Wikipedia

<https://en.wikipedia.org/wiki/Plasmodium>

This is the **ring form** that lives and feeds inside your red blood cell.

**Laboratory diagnosis of malaria – Plasmodium falciparum.**

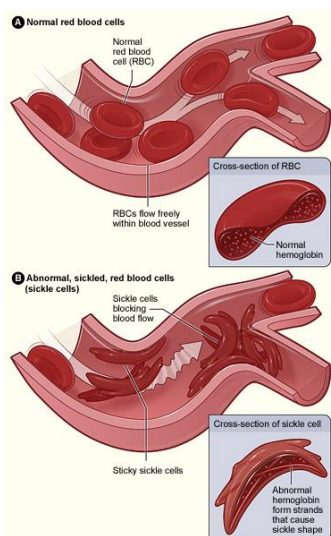
- CDC. No date, no author
- [https://www.cdc.gov/dpdx/resources/pdf/benchAids/malaria/Pfalciparum\\_benchaidV2.pdf](https://www.cdc.gov/dpdx/resources/pdf/benchAids/malaria/Pfalciparum_benchaidV2.pdf)
- This is blood smear of the various life stages of the nasty form of malaria.

**Malaria**

Kathrine R. Tan and Paul M. Arguin.

CDC Yellow Book. 1 July 2019.

- <https://wwwnc.cdc.gov/travel/yellowbook/2020/travel-related-infectious-diseases/malaria>
- This is a thorough explanation of the treatment of malaria.



**Sickle Cell Anemia**

- Wikipedia.
- [https://en.wikipedia.org/wiki/Sickle\\_cell\\_disease](https://en.wikipedia.org/wiki/Sickle_cell_disease)
- The red blood cells in the top blood vessel are normal.

*Biology: Sickle Cell.* CDC. 16 July 2020.

- <https://www.cdc.gov/malaria/about/biology/index.html>
- **There are horizontal tabs. Click on Sickle Cell.**

*Sickle Cell Disease.*

- **MedlinePlus. 25 November 2020.** No author.
- <https://medlineplus.gov/sicklecelldisease.html>
- **This has tons of links to great sources.**

*Guidelines for Treatment of Malaria in the United States.* CDC. 2019.

- [https://www.cdc.gov/malaria/resources/pdf/Malaria\\_Treatment\\_Table\\_120419.pdf](https://www.cdc.gov/malaria/resources/pdf/Malaria_Treatment_Table_120419.pdf)
- **This is a table used by doctors. Lots of detail.**

*Hydroxychloroquine.* MedlinePlus. 15 October 2020.

- <https://medlineplus.gov/druginfo/meds/a601240.html>

*FDA cautions against use of hydroxychloroquine or chloroquine for COVID-19 outside of the hospital setting or a clinical trial due to risk of heart rhythm problems. Does not affect FDA-approved uses for malaria, lupus, and rheumatoid arthritis*

- **U. S. Food & Drug Administration (FDA)**
- **1 July 2020**
- <https://www.fda.gov/drugs/drug-safety-and-availability/fda-cautions-against-use-hydroxychloroquine-or-chloroquine-covid-19-outside-hospital-setting-or>
- **Lots of info.**

*PLAQUENIL® HYDROXYCHLOROQUINE SULFATE TABLETS, USP*

- Copyright **Concordia Pharmaceuticals.** / FDA Factsheet 2020. **January 2017.** No author.
  - They still make it as of **30 Oct 2022** in **Epocrates.**
- [https://www.accessdata.fda.gov/drugsatfda\\_docs/label/2017/009768s037s045s047lbl.pdf](https://www.accessdata.fda.gov/drugsatfda_docs/label/2017/009768s037s045s047lbl.pdf)
- **MOA<sub>Malaria</sub> (FDA Factsheet 2017)**
  - Mechanism of action: The precise mechanism by which hydroxychloroquine exhibits activity against *Plasmodium* is not known. Hydroxychloroquine, like chloroquine, is a weak base and may exert its effect by concentrating in the **acid vesicles** of the **parasite** and by **inhibiting polymerization of heme**. It can also inhibit certain enzymes by its interaction with DNA. (page 2a)

*Artemisinin resistance and artemisinin-based combination therapy efficacy*

- Source
  - **WHO**
- Verbatim
  - WHO recommends artemisinin-based combination therapies (ACTs) for the treatment of uncomplicated malaria caused by *Plasmodium falciparum*.
    - <https://www.who.int/docs/default-source/documents/publications/gmp/who-cds-gmp-2018-26-eng.pdf>

*Medicines for the Prevention of Malaria While Traveling Hydroxychloroquine (Plaquenil™)*

- Source
  - CDC
    - <https://www.cdc.gov/malaria/resources/pdf/fsp/drugs/hydroxychloroquine.pdf>
- Summary
  - Hydroxy-chloro-quine (HCQ) is not used much for treating malaria.
- Verbatim
  - Hydroxychloroquine can only be used in places where chloroquine (a related medicine) is still effective. There are only a few places left in the world where hydroxychloroquine is still effective including parts of Central America and the Caribbean.

## Sickle Cell Anemia

See *All Things Blood* on page 715 of the bibliography.

# Page 71 – A lowly Amoeba kills Alexander the Great – Amoebic Dysentery

## Amoeba basics



Amoeba.

- That is your standard amoeba. It is just 1 cell. It is alive.



- The name of this particular guy is *Amoeba proteus* (“Ah mee ba” “pro tee us”). It lives in ponds and does not harm humans.
- <https://en.wikipedia.org/wiki/Amoeba>
- Image author: SmallRex



### *Entamoeba histolytica*

- History
  - That's the amoeba that may have killed **Alexander the Great**.
- Size
  - It's about **15 microns** wide. The distance between the tips of this letter 'u' is about **1000 microns** (1 milli-meter). So if you chop the distance between the tips of 'u' into 1000 pieces, 15 of them is how wide the amoeba is.
- The amoeba kills you in 2 ways:
  - **The amoeba kicks the crap out of your liver.**
    - The infection is called an **abscess** (“ab sess”). Imagine a zit the size of a grapefruit inside your liver. That would be a large abscess. You'd have a fever.
    - The technical term is **Liver Abscess** or **Hepatic Abscess**.
  - **The amoeba kicks the crap out of your large intestines (colon).**
    - That's the dys-entery, as in, bad-intestines.
    - So it's called **Amoebic Dys-entery**.
  - The umbrella term for all of the above is **Amebiasis** (“am eeb eye ah sis”).

- As I mentioned with Plague, *Precision of Speech is the Lubrication of Science*. This is super-important in medicine because doctors must communicate with exacting detail.
- Source
  - [https://en.wikipedia.org/wiki/Entamoeba\\_histolytica](https://en.wikipedia.org/wiki/Entamoeba_histolytica)

## Theories on the death of Alexander the Great

*Amoebic Liver Abscess – A Historical Review*. Dr. O. P. Kapoor. *Bombay Hospital Journal*. Volume 57 No. 03. July 2015

- <https://www.bhj.org.in/books/liver/s1c01.htm>
- Summary
- This article suggests Alexander the Great died from the nasty amoeba, *Entamoeba histolytica*. Specifically, from an infection in his liver.
  - “Ent am eeb ah”
  - “hiss toe lit ick ah”
- Verbatim
- Shortly after the death of Hippocrates, in 356 B.C. Alexander the Great was born. When still young, he became King of Macedonia and Emperor of a vast empire. In his eastern campaign, he reached as far as the Indus and for a short while stepped into an area where amoebiasis must have been endemic. Badly exhausted by sickness, insomnia and injured in ferocious fighting against the Brahmanic people, he made his way back over the Gedrosia desert and died at the young age of **33 years** at Babylon probably of an amoebic liver abscess.

*The death of Alexander the Great*. Hektoen International – A Journal of Medical Humanities. George Dunea, MD. Spring 2012.

- <https://hekint.org/2017/01/22/the-death-of-alexander-the-great/>
- Summary
  - This article suggests that Alexander the Great may have died from these infections:
    - 1) Malaria.
    - 2) The same amoeba as in the preceding paper, ie *Entamoeba histolytica*.
    - 3) Dysentery ... which could be a lot of things, including the amoeba.
    - 4) Yellow Fever. Alexander was close enough to the African continent to get it. Check out maps of his journey, starting in Greece (specifically, Macedonia).
    - 5) Pneumonia.
    - 6) Typhoid Fever.
  - Or poisoned wine.
- Verbatim
  - Alexander probably died from an infectious disease –malaria, amebiasis, or dysentery; perhaps yellow fever, pneumonia, or typhoid—and the royal diaries report that he had a high fever, was already speechless as the army filed past him, and died after an illness of about 12 days. In an alternative version Alexander filled a huge beaker with unmixed wine, downed it in a gulp, instantly shrieked aloud as if smitten by a violent blow, and died in great pain, suggesting an abdominal catastrophe or poisoning by his enemies from Greece. Several authors have denied this version, but “those accustomed to the deaths of powerful men will not be surprised that Alexander’s death is a mystery which is hard to solve beyond all dispute.”

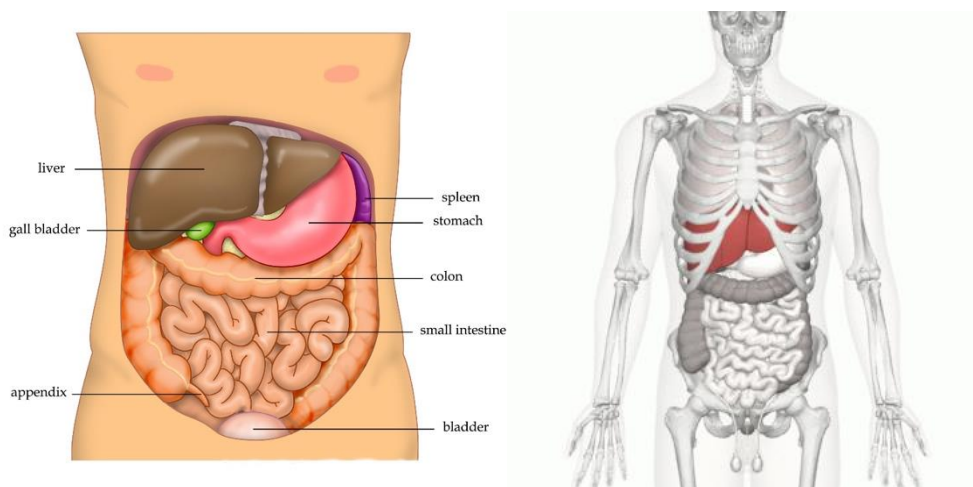
*Alexander the Great and West Nile Virus Encephalitis*.

- Summary
  - This fascinating paper suggests that the **West Nile virus** killed **Alexander the Great**. And that it may have been transmitted to him from a **mosquito** that sucked the blood of an infected **raven**. Wow.
  - **But other possibilities were:**
    - **Poison** ... but considered unlikely because they would not have caused a **2-week** fever.
    - Typhoid Fever ... as in **Salmonella typhi** (the same bacteria **Typhoid Mary** spread in Manhattan).
    - **Vibrio vulnificus** ... that's the cousin of **Cholera** (**Vibrio cholera**) that infects wounds in **SCUBA divers**. It can also infect **alcoholics**, and Alexander fit that description.
    - Malaria ... but he seemed to lack the right kind of fever.
    - 2 different **amoebas** from **Entamoeba** (the **paper above**).
  - Medical historians have fun with this stuff.
  - Oh, **encephalitis** is inflammation of the brain.
    - "En sef ah light iss"
    - "En kef ah light iss"
    - Take your pick.
- Verbatim
  - Alexander the Great died in Babylon in **323 BC**. His death at **age 32** followed a **2-week** febrile illness.
    - [Febrile illness is a fancy way of saying you have a fever. ]
    - [Some sources say he died at the age of **32**. Other say **33**. Whatever.]
  - After reviewing ancient accounts and modern theories, we have concluded that Alexander may have died of West Nile encephalitis.
    - West Nile virus infections in vertebrates may have been occurring in the Middle East for centuries.
    - In Iraq, several mosquito species, including *Culex tritaeniorhynchus*, *Cx. theileri*, and *Aedes caspius* have been implicated in West Nile virus transmission.
    - Annual spring flooding of the Tigris [river] and Euphrates [river] provides ideal breeding grounds for *Culex* spp.
    - Ravens dropping dead from the skies likely were also a surprise to Alexander.
  - Few poisons induce fever, and few of these were available in Alexander's time—except plant salicylates, which disturb temperature regulation; alkaloids, which interfere with perspiration; and ergot mycotoxins, which produce a subjective sensation of heat. Plutarch mentions that Aristotle (Alexander's tutor) procured arsenic to poison Alexander (7). But plants, mycotoxins, and arsenic are not the likely causes of death since none would have caused the reported high, sustained fever.
  - Typhoid fever and its complications have also been thoroughly considered (1). Alexander had a 2-week febrile illness culminating in terminal encephalopathy. As do encephalitis, endocarditis, pneumococcal pneumonia, psittacosis, rickettsial disease, and tularemia, typhoid causes sustained or continuous fever (14). The typical course of typhoid fever lasts one month. In fatal cases, death usually occurs at the end of week 2. Typhoid's neurologic manifestations, which also include delirium and expressionless demeanor, are seen in week 3. Other signs include cough, diarrhea, "rose spots," epistaxis, and bloody stool (15). None of these signs or other illnesses similar to Alexander's were documented by Plutarch. Most other enteric infections have no neurologic sequelae and are generally self-limited.
  - *Vibrio vulnificus* infection, which may cause fatal sepsis in heavy drinkers (as was Alexander), causes rapid death, accompanied by skin and muscle lesions and bleeding.
  - Malaria, a diagnosis postulated by previous authors (1-3), occurred in Mesopotamia (10,11), and is common in today's Middle East (12). Some

of Alexander's symptoms are compatible with malaria: continuous fever, chills, diaphoresis, prostration, myalgia, progressive weakness, stupor, diminished sensorium, delirium; however, dark urine, so called "black water fever," or intermittent fevers were not reported. Today, most malaria in Iraq is due to *Plasmodium vivax* (13). Given Alexander's travel history, had his illness been malaria, it would have been due to *P. falciparum*; however, absence of *P. falciparum*'s dramatic signature fever curve diminishes the possibility of malaria as a probable cause.

- Source
  - **Emerging Infectious Disease**
    - 9(12): 1599–1603
    - December 2003
    - <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3034319/>
- Authors
  - **John S. Marr** - Virginia Department of Health, Richmond, Virginia, USA
  - **Charles H. Calisher** - Department of Microbiology, Immunology and Pathology, College of Veterinary Medicine and Biomedical Sciences, Colorado State University, Fort Collins, CO

## The normal liver



### Liver

- Source
  - <https://en.wikipedia.org/wiki/Liver>
- Summary
  - Your liver lives in the **Right Upper Quadrant (RUQ)** of your abdomen.
  - It's a reddish brown color in real life but in anatomy books, somewhat by convention, it's drawn in **brown**.
  - Anyways, that's a normal liver in the drawing.

## The liver gets beat up by the amoeba

**Amebic liver abscess.** MedlinePlus. **20 June 2021.**

- <https://medlineplus.gov/ency/imagepages/19924.htm>
- **Jatin M. Vyas**, MD, PhD, Associate Professor in Medicine, Harvard Medical School; Associate in Medicine, Division of Infectious Disease, Department of Medicine, Massachusetts General Hospital, Boston, MA.
- Also reviewed by **David Zieve**, MD, MHA, Medical Director, Brenda Conaway, Editorial Director,
- and the **A.D.A.M. Editorial team**. **Animated Dissection of Anatomy for Medicine**
- **There is a drawing of a Liver Abscess due to the amoeba. Think, huge infection.**

**Morphological Characteristics of Liver Abscesses According its Etiology** [*Características Morfológicas de los Abscesos Hepáticos Según su Etiología*]. Sergio Castillo and Carlos Manterola. **International Journal of Morphology**. **28 November 2019**. **Gruesome photo.**

- [https://www.scielo.cl/scielo.php?script=sci\\_arttext&pid=S0717-95022020000200406](https://www.scielo.cl/scielo.php?script=sci_arttext&pid=S0717-95022020000200406)
- **Sergio Castillo**<sup>1 2</sup>
- **Carlos Manterola**<sup>1 3 4</sup>
  - 1 Doctoral Program in Medical Sciences, Universidad de La Frontera, Temuco, Chile.
  - 2 Clínica RedSalud Mayor Temuco, Temuco, Chile.
  - 3 Department of Surgery, Universidad de La Frontera, Temuco, Chile.
  - 4 Center of Morphological and Surgical Studies (CEMyQ), Universidad de La Frontera, Temuco, Chile.
- **Check out Figure 4, about half-way down the page.**
  - **Amebic Hepatic Abscess (AHA)**
  - **Fig. 4 Section of surgical piece of hepatectomy by PHA. Well circumscribed cavity, with uneven contours, with dark material (“anchovy paste”) content.**
  - **This is a photograph of a liver. This is called a ‘gross specimen’ or ‘gross pathology.’ Gross does not mean ‘ew, that’s gross.’ In Medicine, ‘gross’ means visible to the naked eye and it usually refers to specimens.**
  - **Since the liver has been removed, the patient is either deceased or had a liver transplant. Clearly, the liver has been brutalized by the amoeba (think, millions of them).**

## Liver and intestines beat up by the amoeba

**Amoebiasis - Pathology mini tutorial.** 4 minute video. **Geoffrey Hulman** MD FRCPath. Pathology mini tutorials.

- <https://www.youtube.com/watch?v=bqMmBtpOKx8>
- **This is an extremely informative 4-minute video narrated by a pathologist (doctor who specializes in dead tissues, for the most part). A pathologist is the doctor who performs an autopsy.**
- **At the 2:20 mark is the appearance of the colon (large intestine) ravaged by the amoeba. Now of course it’s not just 1 amoeba doing this, more like millions of them.**
- **Pathologists also look at tissues removed from live people. Get it? The surgeon does the biopsy (cuts out suspicious tissue, like the lump on your arm), and the pathologist examines it under the microscope and reports the findings back to the surgeon.**

**Amoebiasis.** Medscape. **8 April 2022.**

- <https://emedicine.medscape.com/article/212029-overview#a2>
- Authors
- **Vinod K Dhawan**, MD, FACP, FRCPC, FIDSA Clinical Professor, Department of Clinical Medicine, University of California, Los Angeles, David Geffen School of Medicine; Clinical Professor, Department of Clinical Medicine, Charles R Drew University of Medicine and Science
- **Kerry O Cleveland**, MD Professor of Medicine, University of Tennessee College of Medicine; Consulting Staff, Department of Internal Medicine, Division of Infectious Diseases, Methodist Healthcare of Memphis

- **J Robert Cantey**, MD Professor, Department of Medicine, Division of Infectious Diseases, Medical University of South Carolina College of Medicine
- This is a very thorough article. It's pretty dense with medical terminology.

*Amoebiasis*. Wikipedia.

- <https://en.wikipedia.org/wiki/Amoebiasis>
- There different ways to spell. An 'o' is added in by the British. Do not sweat it.
  - Amebiasis
  - Amoebiasis
  - Amebic dysentery
  - Amoebic dysentery
- There are 2 diagrams of the amoeba life cycle.

*Dysentery*. Online Etymology Dictionary.

- <https://www.etymonline.com/search?q=dysentery>

## Amoeba proteus, the peaceful Buddhist amoeba

*Amoeba proteus*. Wikipedia.

- [https://en.wikipedia.org/wiki/Amoeba\\_proteus](https://en.wikipedia.org/wiki/Amoeba_proteus)
- There is a **video clip** of the amoeba moving about.
- There is a **video clip** of the amoeba eating ('engulfing') some food, in this case a diatom which is tiny algae. So life was bad for that day for the diatom ("die at om").

*Cytoplasmic filaments of Ameoba proteus - I. The Role of Filaments in Consistency Changes and Movement.* Thomas D. Pollard and Susumu Ito. **THE JOURNAL OF CELL BIOLOGY** . VOLUME 46, pages 267-259. **1970**.

- **THOMAS D . POLLARD** and **SUSUMU ITO**
  - From the Department of Anatomy, Harvard Medical School, Boston, Massachusetts 02115. Dr. Pollard's present address is National Heart and Lung Institute, Section on Cellular Biochemistry and Ultrastructure, National Institutes of Health, Bethesda, Maryland 20014
- <https://rupress.org/jcb/article-pdf/46/2/267/1263396/267.pdf>
- Summary
- You can see the cell membrane a.k.a. plasma membrane a.k.a. **PM** in the photo on **page 271**.

# Page 72 – Cat Lover's Page

## Cat Scratch Disease

*Cat Scratch Disease*. CDC. 17 January 2020.

- <https://www.cdc.gov/healthypets/diseases/cat-scratch.html>

- Verbatim
  - About 40% of cats carry *B. henselae* at some time in their lives, although most cats with this infection show NO signs of illness.
  - By scratching and biting at the fleas, cats pick up the infected flea dirt under their nails and between their teeth.

Fleas. CDC. 8 December 2018.

- <https://www.cdc.gov/dpdx/fleas/index.html>
- The life cycle of fleas is shown. Bartonella (the bacteria) is transmitted by the cat flea *Ctenocephalides felis*.
  - “Ten oh sef al ih dees”
  - “fee liss”

Interactions of Pathogens with the Host in *Pathobiology of Human Disease - A Dynamic Encyclopedia of Disease Mechanisms*. 2014, Pages 214-216

- This is about 1/3 down the page.
- <https://www.sciencedirect.com/science/article/pii/B9780123864567017019>
- D.H. Walker University of Texas Medical Branch, Galveston, TX, USA
  - David H. Walker, a pathologist, is director of the Center for Biodefense and Emerging Infectious Diseases where he and his faculty are investigating arboviral infections, emerging viral hemorrhagic fevers, and rickettsioses in state-of-the-art BSL-3 and BSL-4 facilities.
- Yes, *Bartonella henselae* spreads via lymphatics just like *Yersinia pestis*.
  - *Bartonella henselae* enter the skin via a scratch wound by a kitten and spread via cutaneous lymphatic vessels to the draining lymph nodes that become impressively enlarged in cat scratch disease.

## Cat Bite

An angry cat causing *Pasteurella multocida* endocarditis and aortic valve replacement—A case report

- International Journal of Surgery Case Reports. 24: 91-93. 2016
  - Anders Ahlsson<sup>a c</sup>
  - Örjan Friberg<sup>a c</sup>
  - Jan Källman<sup>b c</sup>
  - a Department of Cardiothoracic and Vascular Surgery, Örebro University Hospital, SE-701 85 Örebro, Sweden
  - b Department of Infectious Diseases, Örebro University Hospital, SE-701 85 Örebro, Sweden
  - c School of Health and Medical Sciences, Örebro University, SE-701 82 Örebro, Sweden
  - <https://www.sciencedirect.com/science/article/pii/S2210261216301420>
- Summary
  - Of note, the angry cat was in Sweden. Kind of surprising, really. I didn't think there would be angry cats in Sweden.
- Verbatim
  - Cat bite infections usually involve a mix of anaerobic and aerobic bacteria including species of *Pasteurella*, *Streptococcus*, *Staphylococcus*, *Bacteroides*, and *Fusobacterium*. We report a case of *Pasteurella multocida* infection from cat bites leading to endocarditis and subsequent aortic valve replacement.
  - A 70-year-old male was admitted because of fever, tachycardia, and malaise. He had a history of alcohol abuse and was living alone with a cat in a rural area.

Rosen & Barkin's 5-Minute Emergency Medicine Consult, 6<sup>th</sup> Edition.

- Jeffrey J. Schaidler et al. Wolters Kluwer. 2019.
  - <https://shop.lww.com/Rosen---Barkin-s-5-Minute-Emergency-Medicine-Consult/p/9781496392954>

### *Pasteurella Multocida Infection.*

- Sara L Cross and Michael Gelfand. Medscape. **26 July 2022.**
- <https://emedicine.medscape.com/article/224920-overview>.
- **Sara L Cross**, MD Assistant Professor, Department of Internal Medicine, Division of Infectious Diseases, Assistant Professor, Department of Medical Education, University of Tennessee Health Science Center College of Medicine
- **Michael Gelfand**, MD, FACP Chief, Professor, Department of Internal Medicine, Division of Infectious Diseases, Methodist Healthcare of Memphis, University of Tennessee Health Science Center College of Medicine

## Toxoplasma

### *Parasites – Toxoplasmosis (Toxoplasma infection): Biology.* CDC. **10 November 2020.**

- <https://www.cdc.gov/parasites/toxoplasmosis/biology.html>
- The life cycle of the parasite is shown. There is a **cat** and a **cat litter box** – those are your clues.
- Verbatim
  - The only known definitive hosts for *Toxoplasma gondii* are members of family **Felidae** (domestic cats and their relatives).
  - In the human host, the parasites form tissue cysts, most commonly in skeletal muscle, myocardium, brain, and eyes; these cysts may remain throughout the life of the host. Diagnosis is usually achieved by serology, although tissue cysts may be observed in stained biopsy specimens <sup>10</sup>. Diagnosis of congenital infections can be achieved by detecting *T. gondii* DNA in amniotic fluid using molecular methods such as PCR <sup>11</sup>.

### *Life Cycle of Toxoplasma gondii.* Michael W. Black, John C. Boothroyd. **Microbiology and Molecular Biology Reviews.** **1 September 2000.**

- [Michael W. Black](#),
- [John C. Boothroyd](#)
- <https://mmbbr.asm.org/content/64/3/607>
- **Krazy amounts of detailed information.**

### *Preventing Congenital Toxoplasmosis*

- Source
  - **MMWR March 2000**
  - Authors = CDC MD's and PhD's
    - National Center for Infectious Diseases  
**James M. Hughes, M.D.**  
*Director*
    - Division of Parasitic Diseases  
**Daniel G. Colley, Ph.D.**  
*Director*
    - Preventing Congenital Toxoplasmosis
    - **Adriana Lopez, M.H.S.**  
**Vance J. Dietz, M.D.**  
**Marianna Wilson, M.S.**  
**Thomas R. Navin, M.D.**  
**Jeffrey L. Jones, M.D., M.P.H.**  
*Division of Parasitic Diseases*  
*National Center for Infectious Diseases*



- Verbatim
  - **Etiologic Factors:** *Toxoplasma* can be transmitted to humans by three principal routes: a) ingestion of raw or inadequately cooked infected meat; b) ingestion of oocysts, an environmentally resistant form of the organism that cats pass in their feces, with exposure of humans occurring through exposure to cat litter or soil (e.g., from gardening or unwashed fruits or vegetables); and c) a newly infected pregnant woman passing the infection to her unborn fetus.
  - <https://www.cdc.gov/mmwr/preview/mmwrhtml/rr4902a5.htm>
- Summary 3 routes
  - 1) ingest raw meat.
    - Cat meat??
  - 2) ingest oocyst in cat feces.
  - 3) Vertical Tx mother to fetus.

# Page 73 – Athlete’s Foot

## Fungal infections of the skin

*Tinea corporis*. Medscape. Shweta Shukla et al. 17 September 2020.

- <https://emedicine.medscape.com/article/1091473-overview#a5>
- 'Ringworm' is not a worm. It's a fungus.
- **Shweta Shukla**, MD Resident Physician, Department of Dermatology, State University of New York Downstate Medical Center
- **Amor Khachemoune**, MD Director of Mohs and Laser Surgery, Dermatopathology, Premier Dermatology, PC; Associate Program Director, Mohs Micrographic Surgery Fellowship Training Program, Co-Chief of Dermatologic Surgery, Consulting Staff Physician, Dermatology Service, VA Hospital of Brooklyn; Mohs Surgeon, Veterans Affairs Hospital of Baltimore; Chair Professor, Vitiligo Research Chair, Department of Dermatology, King Saud University; Consultant Dermatologist, Kadina Medical Center, KSA
- **Richard P Vinson**, MD Assistant Clinical Professor, Department of Dermatology, Texas Tech University Health Sciences Center, Paul L Foster School of Medicine; Consulting Staff, Mountain View Dermatology, PA
- **Rosalie Elenitsas**, MD Herman Beerman Professor of Dermatology, University of Pennsylvania School of Medicine; Director, Penn Cutaneous Pathology Services, Department of Dermatology, University of Pennsylvania Health System
- **Dirk M Elston**, MD Professor and Chairman, Department of Dermatology and Dermatologic Surgery, Medical University of South Carolina College of Medicine
- **Janet Fairley**, MD Professor and Head, Department of Dermatology, University of Iowa, Roy J and Lucille A Carver College of Medicine
- **Jack L Leshner, Jr**, MD Chief, Professor, Department of Internal Medicine, Section of Dermatology, Medical College of Georgia

*Tinea Pedis*. Courtney M Robbins et al. Medscape. 11 September 2020.

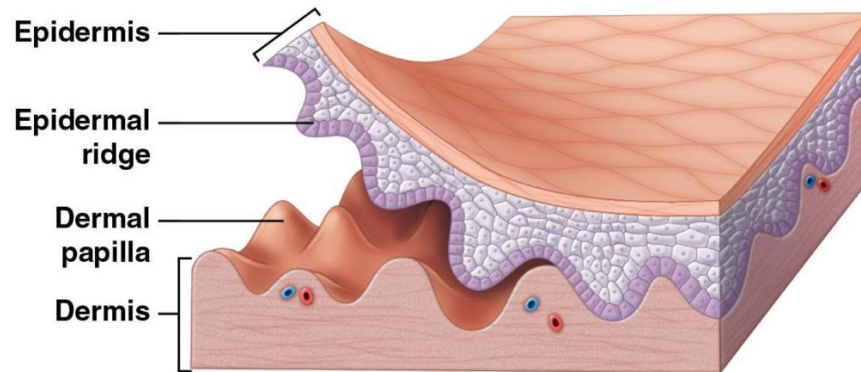
- **Courtney M Robbins**, MD Dermatologist, Associated Dermatologists, Birmingham, AL
- **Boni E Elewski**, MD Professor, Department of Dermatology, University of Alabama at Birmingham
- **Michael J Wells**, MD, FAAD Dermatologic/Mohs Surgeon, The Surgery Center at Plano Dermatolog
- **Lester F Libow**, MD Dermatopathologist, South Texas Dermatopathology Laboratory

- **Dirk M Elston**, MD Professor and Chairman, Department of Dermatology and Dermatologic Surgery, Medical University of South Carolina College of Medicine
- **Gregory J Raugi**, MD, PhD Professor, Department of Internal Medicine, Division of Dermatology, University of Washington at Seattle School of Medicine; Chief, Dermatology Section, Primary and Specialty Care Service, Veterans Administration Medical Center of Seattle
- [https://emedicine.medscape.com/article/1091684-overview?\\_ga=2.99598366.1420654383.1667255833-990879587.1667255831](https://emedicine.medscape.com/article/1091684-overview?_ga=2.99598366.1420654383.1667255833-990879587.1667255831)
- Verbatim
  - Tinea pedis is the term used for a dermatophyte infection of the soles of the feet and the interdigital spaces.
    - Yup, that's how doctors like to talk.

*Trichophyton rubrum showing deep dermal invasion directly from the epidermis in immunosuppressed patients.*

- **British Journal of Dermatology. August 2001.**
  - <https://pubmed.ncbi.nlm.nih.gov/11531807/>
- **K J Smith<sup>1</sup>, M Welsh, H Skelton**
  - The only author with the <sup>1</sup> is Smith.
  - <sup>1</sup>Department of Dermatology and Pathology, University of Alabama, EFH Suite 414, 1720 University BLVD, Birmingham, AL 35294-0009, USA.
  - Dope
    - Immune-compromised – hyphae can extend into dermis → but low risk of systemic spread.
  - Verbatim
    - *Trichophyton rubrum* is the most widely encountered dermatophyte infection, and is usually regarded as exclusively keratinophilic often leading to chronic cutaneous and nail infections, even in healthy individuals. We present three patients with acute leukaemias, with ill-defined pre-existent cutaneous eruptions that were treated with a potent topical corticosteroid. All three patients received aggressive marrow toxic chemotherapy. These patients had progression of their cutaneous disease, which showed deep dermal invasion of *T. rubrum*, invading directly from the epidermis with no evidence of systemic spread. We conclude that systemic pancytopenia, in association with prolonged local immunosuppression, may increase the risk of direct dermal invasion of dermatophyte infections. However, even in these patients, the risk of systemic spread still appears very low. Amphotericin B did not appear effective in treating these dermatophyte infections.

**Skin layers and fingerprints**



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### Visual Anatomy and Physiology, 3<sup>rd</sup> edition

- Summary
  - Okay, this is a fantastic drawing. It's a bit of semantics as to whether our fingerprint is created by **Dermal papilla** or the **Epidermal ridge** since the two structures are intimately connected.
- Source
  - **Pearson**
    - **Pearson is the publisher of the book.** They have 20,000 employees. In other words, a big publisher.
    - <https://www.pearson.com/en-us/subject-catalog/p/visual-anatomy--physiology/P200000006849/9780137503100>
  - amazon.ca
    - **You can Look inside.**
    - <https://www.amazon.ca/Visual-Anatomy-Physiology-Frederic-Martini/dp/0134394690>
- Authors
  - Frederic Martini, Ph.D. - Comparative and functional anatomy. University of Hawaii at Manoa.
  - William Ober
  - Judi Nath, Ph.D. – Biology professor. Lourdes University.
  - Edwin Bartholomew, M.S.
  - Kevin Petti, Ph.D.

### How The Skin Works Animation - Structure and Function of the Human Skin Video - Skin Layers Anatomy

- 2-minute video. **AniMed. YouTube.** 22 February 2016.
- <https://www.youtube.com/watch?app=desktop&v=nCzGflPoHa0>
- **Skin layers and structures can be hard to understand. This is a great 2-minute video to get you started.**

### Introduction to Skin Anatomy and Physiology

- 9 minute video. **Armando Hasudungan. YouTube.** 1 October 2019.
- **This is detailed. Armando methodically talks you through all the structures in the skin.**
- <https://www.youtube.com/watch?v=xUW3E6eDbzU>

### Wheater's Functional Histology: A Text and Colour Atlas

- Barbara Young, Geraldine O'Dowd, Phillip Woodford. Elsevier Canada; 6th edition. 4 November 2013.
  - [https://www.amazon.ca/Wheaters-Functional-Histology-Colour-Atlas-dp-0702047473/dp/0702047473/ref=dp\\_ob\\_title\\_bk](https://www.amazon.ca/Wheaters-Functional-Histology-Colour-Atlas-dp-0702047473/dp/0702047473/ref=dp_ob_title_bk)
- Summary
  - **This is a book you buy in medical school. It's extremely detailed and technical. But really wonderfully written and readable.**
  - **But it's an amazing book you should buy anyways!**

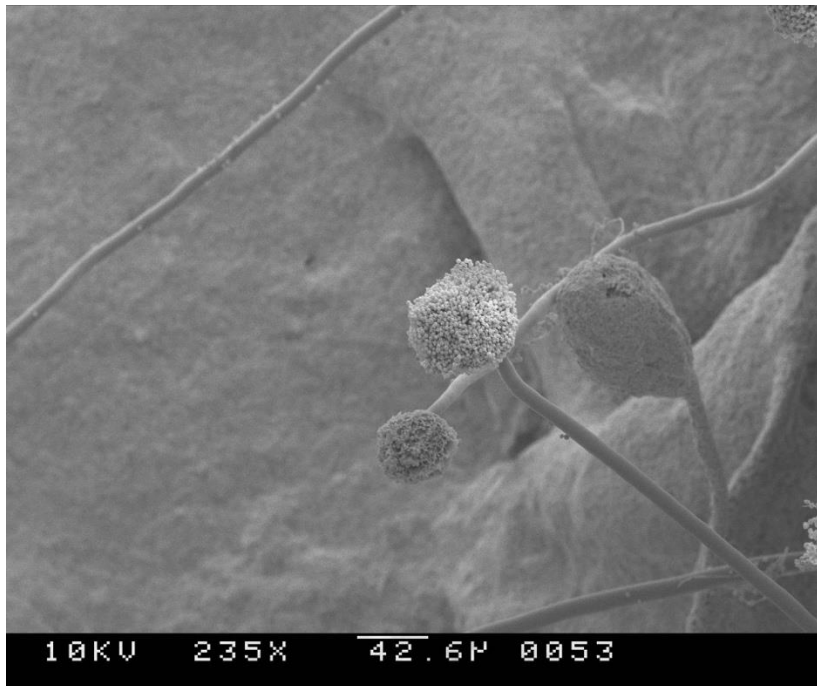
### ANATOMY AND PHYSIOLOGY OF ADULT FRICTION RIDGE SKIN

- Alice V. Maceo.
- <https://www.crime-scene-investigator.net/fingerprintsourcebookchp2.pdf>
- Incredible amount of detail on fingerprints.
- Section 2.4 is on the Friction Ridge that creates the fingerprint.
- The persistent nature of the friction ridge skin makes it an ideal anthropological feature to use as a means of identifying individuals.
  - [ In other words, when you rob a bank at age 90 you'll still get caught.]
- Scars persist for the same reason that the friction ridges persist: attachment sites and regulation of keratinocyte mitosis.

### EMBRYOLOGY AND MORPHOLOGY OF FRICTION RIDGE SKIN

- Kasey Wertheim. US Department of Justice – Office of Justice Programs.
- <https://www.ojp.gov/pdffiles1/nij/225323.pdf>
- From the same book, it seems, as the source above.
- There is even more detail on fingerprints. It starts with the fingerprints of the fetus developing in the uterus.

## 74 – Aspergillus #1



### Aspergillus

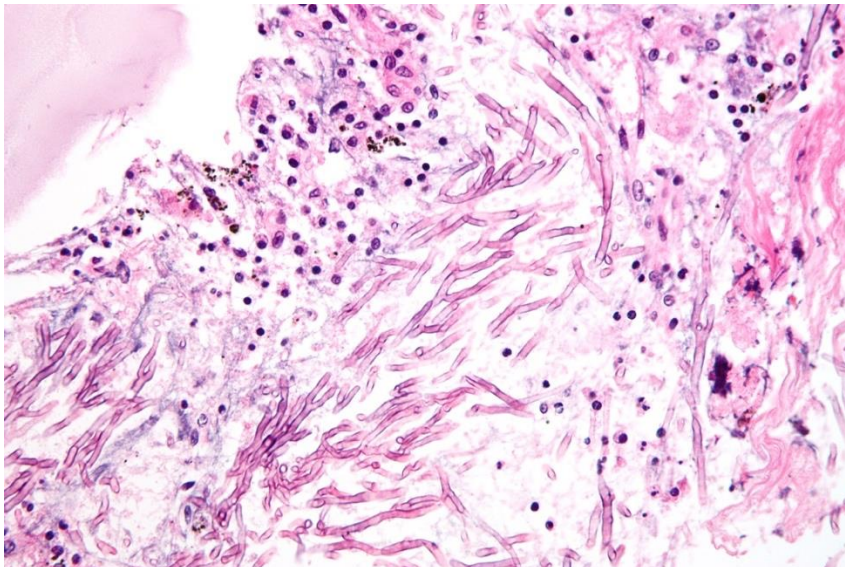
- Wikipedia.
- <https://en.wikipedia.org/wiki/Aspergillus>

- The **Black & White photo** is the view of the *Aspergillus* fungus with an electron microscope.
  - The skinny thing that looks like a **stalk** is called a **hypha**. "Hi fa".
  - The plural is **hyphae**. "Hi fay".
  - **Zoom in if you can** - those tiny little bits are the **spores**. They are all clumped together.



### Hypha

- Wikipedia
- <https://en.wikipedia.org/wiki/Hypha>
- This is a fungus growing on tomato paste. It's not Aspergillus.
- Those very fine white strands are the hypha. Now look at the **image below**.



### Aspergillus

- <https://en.wikipedia.org/wiki/Aspergillus>
- This is **lung** infected with the *Aspergillus* fungus.
- Those **pink filaments** are the **stalks (hypha)**.
- The **dark purple roundish objects** are the **spores**.
  - Get a pathologist to tell me what they are.

*Conidium*. Wikipedia.

- <https://en.wikipedia.org/wiki/Conidium>
- These are specialized hyphae.

*Aspergillus fumigatus*—What Makes the Species a Ubiquitous Human Fungal Pathogen?

- PLoS Pathogens
- 5 December 2013.
- **Kyung J. Kwon-Chung** and **Janyce A. Sugi**
  - Molecular Microbiology Section, Laboratory of Clinical Infectious Diseases, National Institute of Allergy and Infectious Diseases, National Institutes of Health, Bethesda, Maryland, United States of America
  - Duke University Medical Center, United States of America
- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3857757/>
- Verbatim
  - The following features make *A. fumigatus* a ubiquitous pathogen: 1) survival and growth in a wide range of environmental conditions, 2) effective dispersal in the air, 3) physical characteristics that allow conidia to reach the distal airways, and 4) swift adaptability to the host environment.

*9.4 Aspergillus conidiophores* In *21st Century Guidebook to Fungi, Second Edition*. David Moore, Geoffrey D. Robson and Anthony P. J. Trinci.

- [http://www.davidmoore.org.uk/21st\\_Century\\_Guidebook\\_to\\_Fungi\\_PLATINUM/Ch09\\_04.htm](http://www.davidmoore.org.uk/21st_Century_Guidebook_to_Fungi_PLATINUM/Ch09_04.htm)

*Pulmonary Aspergilloma: A Treatment Challenge in Sub-Saharan Africa*. Christian Pohl et al.

PLoS Neglected Tropical Diseases. October 2013.

- [https://www.researchgate.net/publication/258029154\\_Pulmonary\\_Aspergilloma\\_A\\_Treatment\\_Challenge\\_in\\_Sub-Saharan\\_Africa](https://www.researchgate.net/publication/258029154_Pulmonary_Aspergilloma_A_Treatment_Challenge_in_Sub-Saharan_Africa)
  - • **Christian Pohl** King Edward Memorial Hospital - Perth
  - • **Levan Jugheli**
  - • **Fredrick Haraka** Elizabeth Glaser Pediatric AIDS Foundation
  - • **Elirehema Mfinanga** Ifakara Health Institute
  - • **Khadija Said** Ifakara Health Institute
  - • **Klaus Reither** Swiss Tropical and Public Health Institute
- **Scroll down to the x-rays. Click on the one on the far left. See the circular shape at the top left of the lung in the image? That is the aspergillus fungus ball.**
- **Note: R is L. L is R.**
- Verbatim
  - **Chest radiography showing a fungus ball with an air crescent in the right upper lobe.**

*Air Quality*. Aspergillus & Aspergillosis.

- <https://www.aspergillus.org.uk/air-quality-3/>

*Aspergillosis*. CDC. 7 May 2021.

- <https://www.cdc.gov/fungal/diseases/aspergillosis/index.html>

*Aspergillosis*. Medscape. Eloise M Harman et al. 12 May 2021.

- <https://emedicine.medscape.com/article/296052-overview#a2>
- **Eloise M Harman, MD** Staff Physician and MICU Director, Pulmonary Division, Gainesville Veterans Affairs Medical Center

- **Francisco Talavera, PharmD, PhD** Adjunct Assistant Professor, University of Nebraska Medical Center College of Pharmacy; Editor-in-Chief, Medscape Drug Reference
- **Guy W Soo Hoo, MD, MPH** Professor of Clinical Medicine, University of California, Los Angeles, David Geffen School of Medicine; Director, Medical Intensive Care Unit, Chief, Pulmonary, Critical Care and Sleep Section, West Los Angeles VA Healthcare Center, Veteran Affairs Greater Los Angeles Healthcare System
- **Oleh Wasył Hnatiuk, MD** Program Director, National Capital Consortium, Pulmonary and Critical Care, Walter Reed Army Medical Center; Associate Professor, Department of Medicine, Uniformed Services University of Health Sciences
- Summary
  - **Aspergilloma Intracavitary Fungus Ball**
    - **Occurs in pre-existing cavity due to:**
      - **TB**
        - 17% had it on one study (**Medscape**) so they make the point it's not common overall but is common in this TB population.

*Aspergillosis.* Mayo Clinic Staff. Mayo Clinic.

- <https://www.mayoclinic.org/diseases-conditions/aspergillosis/symptoms-causes/syc-20369619>

## Page 75 – Aspergillus #2

Lab values

- Summary
  - Sugar cubes. This is all about sugar cubes. Actually, I'll make it easier – one sugar cube.

*Immunocompetent*

- **National Cancer Institute (NCI): NCI Dictionaries**
- <https://www.cancer.gov/publications/dictionaries/cancer-terms/def/immunocompetent>
- **Having the ability to produce a normal immune response.**

*immunocompromised*

- **National Cancer Institute (NCI): NCI Dictionaries**
- <https://www.cancer.gov/publications/dictionaries/cancer-terms/def/immunocompromised>
- **Having a weakened immune system. People who are immunocompromised have a reduced ability to fight infections and other diseases. This may be caused by certain diseases or conditions, such as AIDS, cancer, diabetes, malnutrition, and certain genetic disorders. It may also be caused by certain medicines or treatments, such as anticancer drugs, radiation therapy, and stem cell or organ transplant. Also called immunosuppressed.**

*Primary immunodeficiency*

- **Mayo Clinic Staff. Mayo Clinic.**
- <https://www.mayoclinic.org/diseases-conditions/primary-immunodeficiency/symptoms-causes/syc-20376905>

*Fatal Invasive Aspergillosis and Coronavirus Disease in an Immunocompetent Patient.* Marion Blaize et al. Emerging Inf Disease Vol 26: #27. July 2020.

- [https://wwwnc.cdc.gov/eid/article/26/7/20-1603\\_article](https://wwwnc.cdc.gov/eid/article/26/7/20-1603_article)

**Immunocompetent**

Exceptions occur:

Severe **Influenza**.**Coronavirus** case report to **CDC** of *Aspergillus fumigatus* in **France****74-y immunocompetent man.** Coronavirus + ie COVID-19. **Intubated. ICU.**Verbatim Abstract:

**Invasive pulmonary aspergillosis** is a complication in critically ill patients with **acute respiratory distress syndrome**, especially those with severe influenza pneumonia. We report a fatal case of invasive pulmonary aspergillosis in an immunocompetent patient in France who had severe coronavirus disease-associated pneumonia.

**Invasive aspergillosis** is a well-described complication of severe influenza pneumonia (4,5), but many **intensivists** seem to overlook this **superinfection**.

So they use **invasive pulmonary aspergillosis** and **invasive aspergillosis** interchangeably.

And it is considered a **superinfection**.

The severe damage to lung tissue can lead to secondary infections within a median of 17 days after onset of coronavirus disease (**COVID-19**).

He dies of **Invasive Pulmonary Aspergillosis**.

*Fatal Invasive Aspergillosis and Coronavirus Disease in an Immunocompetent Patient*

**Emerging Infec Disease** Vol 26: #27. **July 2020** (even though I'm reading it **22 June 2020**)

Microbiologist **Marion Blaize**, University Hospitals Pitié Salpêtrière, 13<sup>th</sup> arrondissement, Paris

**See map** above!

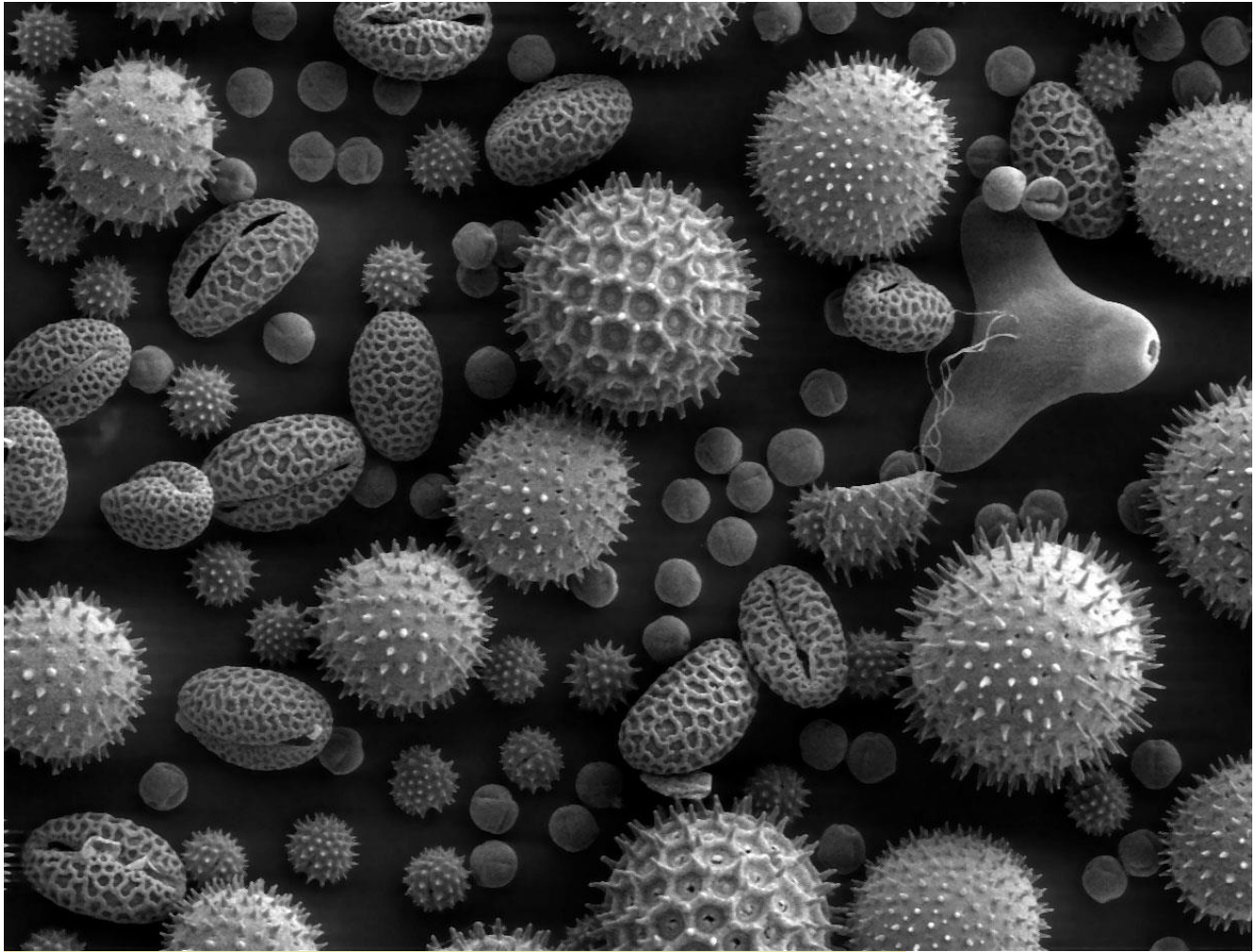
**Marion Blaize, Julien Mayaux, Cécile Nabet, Alexandre Lampros, Anne-Geneviève Marcelin, Marc Thellier, Renaud Piarroux, Alexandre Demoule, and Arnaud Fekkar**✉

Author affiliations: Assistance Publique–Hôpitaux de Paris, Groupe Hospitalier La Pitié-Salpêtrière, Paris, France (M. Blaize, J. Mayaux, C. Nabet, A. Lampros, A.-G. Marcelin, M. Thellier, R. Piarroux, A. Demoule, A. Fekkar); Sorbonne Université, Paris (C. Nabet, A.G. Marcelin, M. Thellier, R. Piarroux, A. Fekkar)

# Page 76 – Plants

**Pollen**





Those are **pollen grains** photographed with a **scanning electron microscope**.

- [https://en.wikipedia.org/wiki/Scanning\\_electron\\_microscope](https://en.wikipedia.org/wiki/Scanning_electron_microscope)

*What is pollen? (background sheet)*. The University of Western Australia. 2011.

- <https://www.uwa.edu.au/study/-/media/Faculties/Science/Docs/What-is-pollen.pdf>
- Pollen grains show considerable variation in size, from the tiny forget-me-not with a diameter of 6  $\mu\text{m}$  to the impressive 100  $\mu\text{m}$  of the birch tree. Most pollen grains are 10–70  $\mu\text{m}$  in diameter. A mere pinch of pollen may contain thousands of individual grains. Pollen size is often directly related to the pollination agent. The smallest pollen grains tend to be wind dispersed, while those carried by living organisms or in water are often larger.

*Aerodynamics of saccate pollen and its implications for wind pollination*. Andrew B. Schwendemann et al. American Journal of Botany. 1 August 2007

- <https://bsapubs.onlinelibrary.wiley.com/doi/full/10.3732/ajb.94.8.1371>
- Andrew B. Schwendemann, [George Wang](#), [Meredith L. Mertz](#), [Ryan T. McWilliams](#), [Scott L. Thatcher](#), [Jeffrey M. Osborn](#)
- [Aero\\*dynamics](#)
  - Doesn't seem to be a huge thing.
  - Experiment
    - **Sacci**

- = air-filled sac
  - Basically makes the pollen lighter
- Hypothesis preamble
  - Pollen grains of many wind-pollinated plants contain 1-3 air-filled bladders, or sacci. Sacci are thought to help orient the pollen grain in the pollination droplet. Sacci also increase surface area of the pollen grain, yet add minimal mass, thereby increasing dispersal distance; however, this aerodynamic hypothesis has not been tested in a published study.
- M&M
  - Mathematical modeling of pollen from 3 conifers
    - *Pinus*
    - *Falcatifolium*
    - *Dacrydium*
- Results
  - Inc dispersal
    - Modeling pollen both with and without sacci indicated that sacci can reduce pollen settling speeds, thereby increasing dispersal distance

## Allergic Rhinitis

*Allergic Conjunctivitis*. Sezen Karakus, M.D. ophthalmologist. Johns Hopkins Medicine. No date.

- <https://www.hopkinsmedicine.org/health/conditions-and-diseases/allergic-conjunctivitis>
- SAR and PAR are addressed right away.

*Patient education: Allergic rhinitis (Beyond the Basics)*. UpToDate. 21 June 2021.

- <https://www.uptodate.com/contents/allergic-rhinitis-beyond-the-basics#H4>
- Authors:
  - [Richard D deShazo, MD](#)
  - [Stephen F Kemp, MD](#)
- Section Editor:
  - [Jonathan Corren, MD](#)
- Deputy Editor:
  - [Anna M Feldweg, MD](#)
- Click on the left column SAR vs PAR. Fig 1 shows some allergens.

## Poison Ivy

*Poison ivy rash*. Mayo Clinic Staff. Mayo Clinic. No date

- <https://www.mayoclinic.org/diseases-conditions/poison-ivy/symptoms-causes/syc-20376485>

*Toxicodendron Contact Dermatitis: A Case Report and Brief Review*. Joe Monroe. The Journal of Clinical and Aesthetic Dermatology. 1 September 2021.

- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7733371/>
- **Joe Monroe, MPAS, PA**
  - Mr. Monroe is a Fellow of the **American Academy of Physician Assistants**; is Founder, Past President, and Current Fellow of the Society of Dermatology Physician Assistants; and practices general and surgical dermatology in Tulsa, Oklahoma.

- This is a bit on the technical side but still very readable for the 'layman' who knows nothing of dermatology (the study of the skin).
- Fig 5 shows the leaves of three
- Sap from the injured leaves, stems, and berries of these plants contain an oily resin called urushiol, to which 85 to 90 percent of adults are allergic.
- The most dependable identifying feature of the poison ivy plant is the legendary "leaves of three" (inspiring the saying "Leaves of three, let it be!") (Figure 5).

### Sporotrichosis

- [Fast Facts - CDC](#)
- <https://www.cdc.gov/niosh/docs/pdfs>
- PDF
- by P Plants – Do not burn plants or brush piles that may contain poison ivy, poison oak, or poison sumac. x Inhaling smoke from burning plants can cause severe allergic ...

## Rose Handler's Disease

### Sporotrichosis. CDC.

CDC sporotrichosis. Add this in when CDC site running.

### Sporotrichosis. Wikipedia.

- <https://en.wikipedia.org/wiki/Sporotrichosis>
- Summary
  - Quite a severe infection of an arm. Gruesome photo.
  - 
  - Cats get this disease too. There is a photo a cat's paw infected. Gruesome photo.
  -

Sporotrichosis. Merck Vet Manual. Last full review/revision March 2018. Content last modified Oct 2022.

### Joseph Taboada

- , DVM, DACVIM, Office of Student and Academic Affairs, School of Veterinary Medicine, Louisiana State University
- [https://www.merckvetmanual.com/generalized-conditions/fungal-infections/sporotrichosis?gclid=Cj0KCQiA37KbBhDgARIsAlzce16Fdyxt69irIESAWwWEAdPZmmrYkBdmileGTHyrVamyG51dKEyBsLYaAk2NEALw\\_wcB&gclsrc=aw.ds](https://www.merckvetmanual.com/generalized-conditions/fungal-infections/sporotrichosis?gclid=Cj0KCQiA37KbBhDgARIsAlzce16Fdyxt69irIESAWwWEAdPZmmrYkBdmileGTHyrVamyG51dKEyBsLYaAk2NEALw_wcB&gclsrc=aw.ds)

# Page 77 – River Blindness

# #1

*Parasitism: The Diversity and Ecology of Animal Parasites 1st Edition*

- by [Albert O. Bush](#) (Author), [Jacqueline C. Fernández](#) (Author), [Gerald W. Esch](#) (Author), [J. Richard Seed](#) (Author)
- **Cambridge University Press**; 1st edition (**April 9, 2001**)
- [https://www.amazon.com/Parasitism-Diversity-Ecology-Animal-Parasites/dp/0521664470/ref=sr\\_1\\_1?Adv-Srch-Books-Submit.x=0&Adv-Srch-Books-Submit.y=0&keywords=parasitology&qid=1668186599&refinements=p\\_27%3ABush&s=books&sr=1-1&unfiltered=1](https://www.amazon.com/Parasitism-Diversity-Ecology-Animal-Parasites/dp/0521664470/ref=sr_1_1?Adv-Srch-Books-Submit.x=0&Adv-Srch-Books-Submit.y=0&keywords=parasitology&qid=1668186599&refinements=p_27%3ABush&s=books&sr=1-1&unfiltered=1)
- You can buy a more recent edition on amazon.
- Dr. Albert Bush who was my professor during my zoology degree.

*Parasitology: The biology of animal parasites* Jan. 1 1982. **Noble & Noble.**

- Lippincott Williams and Wilkins
- Elmer Ray Noble,
- Glenn Arthur Noble
- <https://www.amazon.ca/Parasitology-Parasites-Elmer-R-Noble/dp/0812108191>
- [https://www.thriftbooks.com/w/parasitology-the-biology-of-animal-parasites\\_elmer-ray-noble/1799801/item/54680877/?gclid=Cj0KCQiA37KbBhDgARIsAlzce14\\_JqyxkMIUolLOm\\_3Je9EPGmlIr47mdq2CdMdbU5W95W5TpOjfApYaAgFaEALw\\_wcB#idiq=54680877&edition=58239395](https://www.thriftbooks.com/w/parasitology-the-biology-of-animal-parasites_elmer-ray-noble/1799801/item/54680877/?gclid=Cj0KCQiA37KbBhDgARIsAlzce14_JqyxkMIUolLOm_3Je9EPGmlIr47mdq2CdMdbU5W95W5TpOjfApYaAgFaEALw_wcB#idiq=54680877&edition=58239395)

# Page 78 – River Blindness

## #2

*Parasites - Onchocerciasis (also known as River Blindness)*

- **CDC. 6 September 2019.**
- <https://www.cdc.gov/parasites/onchocerciasis/index.html>
- This is a really good resource. There are multiple links to explore river blindness.
  - **Click Biology at the left** to see the **life cycle**.

*Onchocerciasis*

- **WHO.** 11 January 2022.
- <https://www.who.int/news-room/fact-sheets/detail/onchocerciasis>

# Page 79 – River Blindness

## #3

*Onchocerciasis*. Wikipedia.

- <https://en.wikipedia.org/wiki/Onchocerciasis>

*Eye Anatomy: Parts of the Eye and How We See*

- Kierstan Boyd (not an MD), David Turbert (not an MD), and Ninel Z Gregori MD (reviewed the article). *American Academic of Ophthalmology*. 9 March 2021.
- <https://www.aao.org/eye-health/anatomy/parts-of-eye>
- Good diagrams. Understandable explanations.

## Cataracts

*What are cataracts?* Kierstan Boyd (not an MD), J Kevin McKinney MD, David Turbert (not an MD). *American Academic of Ophthalmology*. 6 September 2022.

- <https://www.aao.org/eye-health/diseases/what-are-cataracts>
- Really good illustrations of what things look like if you have cataracts.

## Merck

*Onchocerciasis in Animals*

- **Richard W. Gerhold, Jr. DVM, PhD**, Department of Biomedical and Diagnostic Sciences, College of Veterinary Medicine, University of Tennessee
- Merck Manual – Veterinary Manual. Last full review/revision Sep 2019 | Content last modified Oct 2022.
- <https://www.merckvetmanual.com/integumentary-system/helminths-of-the-skin/onchocerciasis-in-animals>

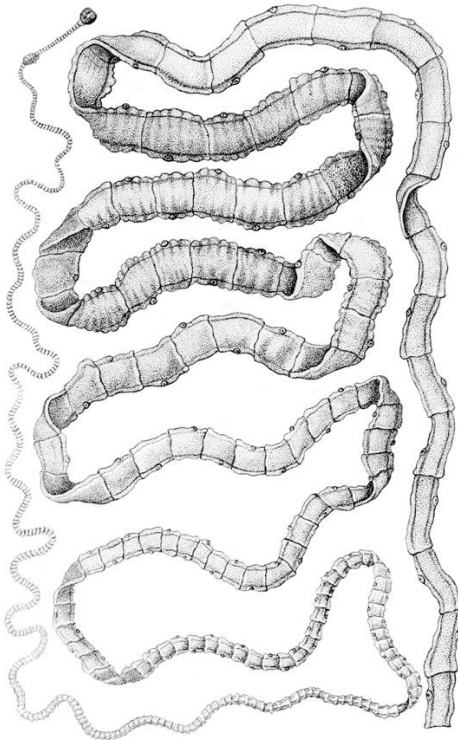
*William C. Campbell (scientist)*

- Wikipedia.
- [https://en.wikipedia.org/wiki/William\\_C.\\_Campbell\\_\(scientist\)](https://en.wikipedia.org/wiki/William_C._Campbell_(scientist))

*The Case of Ivermectin: Lessons and Implications for Improving Access to Care and Treatment in Developing Countries*

- Community Eye Health. 2001.
- **Jeffrey L Sturchio**, PhD. Executive Director, Public Affairs Human Health — Europe, Middle East & Africa, Merck & Co., Inc, Box 100, Whitehouse Station, New Jersey 08889 – 0100, USA
- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1705916/>
- Verbatim
  - On October 21, 1987, Merck & Co., Inc., announced plans to donate Mectizan (ivermectin), a new medicine designed to combat onchocerciasis ('river blindness'), for as long as it might be needed.
  - The Merck Mectizan Donation Program (MDP) is now the largest ongoing donation program of its kind. There are active treatment programs in 33 of 35 countries in sub-Saharan Africa, Latin America, and Yemen in the Middle East, where onchocerciasis is endemic. To date, more than half a billion Mectizan tablets have been donated and shipped since the inception of the Program. An estimated 25 million individuals are treated annually, with the 200 millionth treatment scheduled to take place this year.
  - In over a decade of experience, we have learned that simply removing cost as a barrier (by providing medicine free of charge) is not enough in itself to ensure that the medicine gets to the people who need it most.

# Page 80 – Tapeworms



Pork tapeworm a.k.a. *Taenia solium* (“tay knee ah” “soul ee um”)

- Look how long it is!
- <https://en.wikipedia.org/wiki/Taeniasis>

## Cestodes

*Parasitology: The biology of animal parasites*. Elmer Ray Noble and Glenn Arthur Noble. Lippincott Williams and Wilkins. 1 January 1982.

- This is my old school *Noble & Noble*. Mention this is how the book is referred to by the professor, Dr Bush.

- <https://www.amazon.ca/Parasitology-Parasites-Elmer-R-Noble/dp/0812108191>

- **Scolex**

- = It belongs to cestodes.
- = head with 3 hold-fast structures:
  - Suckers
    - = acetabula
    - Singular = acetabulum
    - Etym ([dic.com](http://dic.com))

- 1660-70; < Latin: hip socket, cup-shaped part of a plant (Pliny), literally, small cup, orig. for vinegar, equivalent to *acēt(um)* vinegar + *-ā-* by analogy with verbal derivatives (cf. vocable) + *-bulum* suffix denoting instrument or vessel

- Muscular slit
  - = bothria
    - Weak suction powers (Noble & Noble p197ix)
- Grappling hooks
  - = rostellum
- Dope

Beef tapeworm	<i>Taenia saginatus</i>	4 suckers
Fish tapeworm	<i>Di-phylo-bothrium latum</i>	2 grooves
Pork tapeworm	<i>Taenia solium</i>	4 suckers + hooks

### 56 Cestodes

- Basicmedical Key – Fastest Basicmedical Insight Engine. No author, no date.
- <https://basicmedicalkey.com/56-cestodes/>
- Great diagrams.
- **Pork tapeworm** - FIGURE 56-4. Cysticercosis of brain. This brain from a 16-year-old girl shows multiple cysticercal cysts primarily at the junction of white and gray matter. (Reproduced with permission from Connor DH, Chandler FW, Schwartz DQ, et al: *Pathology of Infectious Diseases*. Stamford CT: Appleton & Lange, 1997.) **Gruesome photo.**

### Parasites. Taeniasis

- CDC. 29 September 2020.
- <https://www.cdc.gov/parasites/taeniasis/index.html>
- Color photos of the tapeworm head with suckers and grappling hooks.

### BIOM 441 LAB- Cestodes

- Author "E H." Chegg.
- No date.
- <https://www.chegg.com/flashcards/biom-441-lab-cestodes-cfcaddc7-59b3-4a19-bc10-11f5794f5e21/deck>
- Chegg does flashcards.
- This is really good.
- **Do a Ctrl-F (find) of 'Diph'** to get some questions on the fish tapeworm (official name, *Diphyllobothrium latum*).

### Sucker (zoology). Wikipedia.

- [https://en.wikipedia.org/wiki/Sucker\\_\(zoology\)](https://en.wikipedia.org/wiki/Sucker_(zoology))
- Makes you think about what a 'sucker' is.

### TOOLS FOR PASSIONATE SCRABBLE PLAYERS - IS YOUR WORD AN OFFICIAL SCRABBLE ONE?

- Hasbro.
- <https://scrabble.hasbro.com/en-us/tools>
- Summary
  - Yup, SCOLEX is worth 15 points.
  - Hasbro is the gaming company that makes the SCRABBLE game.
  - By the way, an amazing book is *Word Freak: Heartbreak, Triumph, Genius, and Obsession in the World of Competitive Scrabble Players* by Stefan Fatsis. It's fascinating even if you suck at Scrabble (me). The quirky players go to insane lengths to win – they memorize all the 2-letter words, then 3-letters, then 4-letters, etc., and with each step there are exponentially (25 points) more words to memorize.
    - Amazon.com

- You can **Look inside**.
- [https://www.amazon.com/Word-Freak-Heartbreak-Obsession-Competitive-ebook/dp/B00C4GX69A/ref=sr\\_1\\_1?Adv-Srch-Books-Submit.x=0&Adv-Srch-Books-Submit.y=0&qid=1668112673&refinements=p\\_28%3A+Genius%5Cc+Triumph%5Cc+and+Obsession+in+the+World+of+Competitive+Scrabble+Players%5CcWord+Freak%3A+Heartbreak&s=books&sr=1-1&unfiltered=1](https://www.amazon.com/Word-Freak-Heartbreak-Obsession-Competitive-ebook/dp/B00C4GX69A/ref=sr_1_1?Adv-Srch-Books-Submit.x=0&Adv-Srch-Books-Submit.y=0&qid=1668112673&refinements=p_28%3A+Genius%5Cc+Triumph%5Cc+and+Obsession+in+the+World+of+Competitive+Scrabble+Players%5CcWord+Freak%3A+Heartbreak&s=books&sr=1-1&unfiltered=1)

## Fish tapeworm

### *Parasites - Diphyllbothrium Infection.*

- **CDC. 23 September 2020.**
- <https://www.cdc.gov/parasites/diphyllobothrium/index.html>
- **This is the fish tapeworm.**

### *PART THREE. SPECIFIC EXCRETED PATHOGENS: ENVIRONMENTAL AND EPIDEMIOLOGY ASPECTS. SECTION IV. HELMINTHS. Cestodes. Diphyllbothriidae.*

- **Global Water Pathogen Project (GWPP).** 7 June 2018.
- <https://www.waterpathogens.org/book/diphyllobothriidae>
- **Scroll down to Figure 2** (about 1/5th down the page) for a fantastic black and white photograph from an electron microscope of the fish tapeworm scolex.

## Anemia

See *All Things Blood* on page 715 of the bibliography.

# Page 81 – Tapeworm life cycle

a.k.a. Lifestyles of the Fish and Famous

### *Parasites - Diphyllbothrium Infection: Biology: Life Cycle*

- **Fish tapeworm life cycle.** I used this to make my drawing.
- **CDC.** 14 May 2019.
- <https://www.cdc.gov/parasites/diphyllobothrium/biology.html>

### *Cyclops (copepod)*

- **Photos of Cyclops.**
- [https://en.wikipedia.org/wiki/Cyclops\\_\(copepod\)](https://en.wikipedia.org/wiki/Cyclops_(copepod))



# Page 82 – Transmission I – How the bugs get into us

*Principles of Epidemiology in Public Health Practice: Lesson 1: Introduction to Epidemiology: Section 10: Chain of Infection.* CDC. 8 May 2012.

- <https://www.cdc.gov/csels/dsepd/ss1978/lesson1/section10.html>
- Summary
  - There are extremely useful definitions here. In fact, they are so fundamental that on Day 1 of the pandemic this is what should have been taught to everyone so we were all on the same page. IMHO, and bearing in mind that 'Hindsight is 20/20.'
  - **Reservoir**
  - **Mode of Tx**
    - **Direct**
      - Direct contact
      - Droplet spread
    - **Indirect**
      - Airborne
      - Vehicle borne
        - Fomites
          - Bedding
          - scalpels

## *Intermediate host*

- **Biology online**
  - No author, no date.
  - <https://www.biologyonline.com/dictionary/intermediate-host>
- Summary 1
  - Remember the 'Epidemiology triangle'?
  - Do you remember the **vector**? That's the guy who transmits the disease. For example, the **mosquito** is the vector for the **Yellow Fever virus**.
  - Well, when it comes to parasitic worms, there are so many players involved that the terminology gets tweaked.
  - The vector may be called the **intermediate host**. Indeed, here we have a few intermediate hosts:
    - **Cyclops**
    - **Small fish**
    - **Big fish**
  - The final host where the **adult worm** lives is called the **definitive host**.
    - That would be the **human** or **seagull, dog, or seal**.
- Summary 2
  - This is a really good page. They have a table comparing Definitive Host and Intermediate host, and lots of examples.

# Page 83 – Transmission II – How the bugs get into us

Same references as page 82.

# Page 84 – Vertical Transmission during pregnancy – TORCH Infections

## Anatomy of the umbilical cord, placenta, and uterus

*Umbilical cord*. Wikipedia.

- [https://en.wikipedia.org/wiki/Umbilical\\_cord](https://en.wikipedia.org/wiki/Umbilical_cord)
- There is photograph of a cross-section of the umbilical cord and the parts are labelled.

*CIBA Collection of Medical Illustrations Volume 2: the Reproductive System*. Frank H. Netter.

- These are iconic books in medicine. I bought the entire set when I was a medical student.
- Frank Netter was a medical doctor and medical illustrator. No one can match him in the breadth and depth of his illustrations. Leonardo da Vinci would love these 8 volumes.
- Ciba Pharmaceutical Co; Presumed 1st Edition (January 1, 1954)
- <https://www.amazon.com/CIBA-Collection-Medical-Illustrations-Reproductive/dp/B000N282T6>

*Wheater's Functional Histology: A Text and Colour Atlas*. Barbara Young, Geraldine O'Dowd, Phillip Woodford. Elsevier Canada; 6th edition. 4 November 2013.

- [https://www.amazon.ca/Wheaters-Functional-Histology-Colour-Atlas-dp-0702047473/dp/0702047473/ref=dp\\_ob\\_title\\_bk](https://www.amazon.ca/Wheaters-Functional-Histology-Colour-Atlas-dp-0702047473/dp/0702047473/ref=dp_ob_title_bk)

# Fetal hemoglobin

See *All Things Blood* on page 715 of the bibliography.

## TORCH letters

### TORCH Infections

- **Cleveland Clinic. Cleveland Clinic medical professional. 21 June 2022.**
- Last reviewed by a Cleveland Clinic medical professional on 06/21/2022.

TORCH infection is an acronym that stands for the following conditions:

Toxoplasmosis.

Other infections like HIV, syphilis, parvovirus B19 (fifth disease), varicella (chickenpox) and (Zika).

Rubella.

Cytomegalovirus (CMV).

Herpes simplex virus (HSV).

<https://my.clevelandclinic.org/health/diseases/23322-torch-syndrome>

*TORCH Infections. Toxoplasmosis, Other (syphilis, varicella-zoster, parvovirus B19), Rubella, Cytomegalovirus (CMV), and Herpes infections*

- **Current Women's Health Reports. August 2002.**
- **Barbara J Stegmann 1, J Christopher Carey**
- **1Department of OB/GYN, Phoenix Integrated Residency in OB/GYN, Maricopa Medical Center, 2601 E. Roosevelt, Phoenix, AZ 85008, USA.**
- Abstract
  - Perinatal infections account for 2% to 3% of all congenital anomalies. TORCH, which includes Toxoplasmosis, Other (syphilis, varicella-zoster, parvovirus B19), Rubella, Cytomegalovirus (CMV), and Herpes infections, are some of the most common infections associated with congenital anomalies. Most of the TORCH infections cause mild maternal morbidity, but have serious fetal consequences, and treatment of maternal infection frequently has no impact on fetal outcome. Therefore, recognition of maternal disease and fetal monitoring once disease is recognized are important for all clinicians. Knowledge of these diseases will help the clinician appropriately counsel mothers on preventive measures to avoid these infections, and will aid in counseling parents on the potential for adverse fetal outcomes when these infections are present.
  - <https://pubmed.ncbi.nlm.nih.gov/12150751/>

*Birth Defects Surveillance Toolkit – 5. Congenital Infectious Syndromes.* CDC. 27 November 2020. **Gruesome photo.**

- <https://www.cdc.gov/ncbddd/birthdefects/surveillancemanual/chapters/chapter-5/chapter5.html>
- **Summary**
  - They skips some letters here. They do not mention the term TORCH.
  - T

- O – Syphilis, Zika
- R - Rubella
- C - CMV
- H

## Vertical Transmission – general principles

- *Microbial vertical transmission during human pregnancy*
  - Summary
    - This is information on the principles of how **microbes** (think, bacteria) are transmitted from mother to baby during pregnancy. It's pretty technical.
    - 3 options
      - **Pre-natal**
        - = before delivery
      - **Peri-natal**
        - = during delivery
      - **Post-natal**
        - = after delivery
    - Verbatim
      - The placenta is arguably the most critical barrier in human life, yet the precise mechanisms by which microbes breach this barrier remain largely unknown.
  - Source
    - **Cell Host Microbe**
    - 10 May 2017.
    - [Nitin Arora](#),<sup>1,2</sup> [Yoel Sadovsky](#),<sup>3,4</sup> [Terence S. Dermody](#),<sup>1,2,5</sup> and [Carolyn B. Coyne](#)<sup>1,2,5,\*</sup>
    - <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6148370/>

## Vertical Transmission of Coronavirus – source #1

- *Coronavirus Disease 2019 (COVID-19)*
  - **CDC COVID-NET** data (as of **Sept 2020**)
    - **598 hospitalized PG women** with **COVID-19**.
      - **55%** asymptomatic at admission.
      - Symptomatic PG women
        - **16%** ICU
        - **8%** ventilator
        - **1%** death
      - **2%** **loss of PG** for hospitalized pts who were both symptomatic/asymptomatic.
    - Spanish study
      - **16 Spanish hospitals**.
      - **242 PG women** dx with **COVID-19** in T3.
      - **248 newborns** from these **242 women**
        - ie **6 more babies** than mom's so must have been:
          - **3 sets of twins**
          - or
          - **2 sets of triplets**.
      - Higher risk of **premature delivery**.
      - No **fetal deaths**.

- "No vertical or horizontal transmission was detected."
- Cohort study
  - 64 PG women with severe or critical COVID.
  - Hospitalized at 12 US hospitals bw 5 March 2020 – 20 April 2020.
  - 81% got HCQ.
    - The major concern with HCQ is that it can affect the electrical rhythm of the heart, and this can be worse in setting of myocarditis. And questionable benefit in clinical trials. Ergo: Risk > Benefit.
  - 7% with severe disease (but number not given): remdesivir
  - 65% with critical disease (but number not given): remdesivir
    - They were also anti-coagulated.
  - 1 maternal cardiac arrest.
  - No CMO.
  - No maternal deaths.
  - 32 of the 64 delivered during hospitalization.
  - 88% with critical illness delivered pre-term.
    - 16 of 17 delivered by C/S.
    - So I think that means that at least 17 women were critically ill.
  - No stillbirths.
  - No neonatal deaths.
  - No vertical tx.
- Case series
  - 6 PG women with severe or critical COVID.
  - Nitric oxide rx improved cardiopulmonary function.
- Zhu et al
  - 9 mothers with COVID.
  - 10 babies = 8 singletons + 1 twins
  - 9 of 10 neonates were COVID NEG from days 1-9 Postpartum.
  - 6 premature deliveries.
  - 1 mother died.
- Zeng et al
  - 33 (not stated) mothers with COVID.
  - 33 neonates. So I assume 33 moms.
  - 3 newborns with COVID. They had Early Onset Pneumonia. All recovered.
  - They raise the possibility of vertical tx.
- Chen et al
  - 9 mothers with COVID in Wuhan.
  - No severe COVID.
  - No maternal deaths
  - 9 C/S.
  - There was fetal distress in 9 babies but all 9 had "excellent" APGAR score.
  - In 6 neonates (no mention of the other 3), samples were SARS-CoV-2 NEGATIVE from:
    - Amniotic fluid
    - Cord blood
    - Neonatal throat swab
    - BM
- Yu et al
  - 7 mothers with COVID in Wuhan.
    - SS:
      - 86% fever
      - 14% cough
      - 14% SOB
      - 14% diarrhea
  - All deliver by C/S.
  - 3 neonates tested for SARS-CoV-2

- **1 neonate was SARS-CoV-2 POSITIVE 36 hours postpartum.**
- Verbatim
  - The U.S. [COVID-19 PRIORITY study](#) (Pregnancy coRonavirus Outcomes RegIsTrY) pregnancy registry is open. Additionally, the study has a dashboard for real time data.
  - The CDC COVID-NET data published in September 2020 reported that among **598 hospitalized pregnant women** with COVID-19, 55% were asymptomatic at admission. Severe illness occurred among symptomatic pregnant women, including intensive care unit admissions (16%), mechanical ventilation (8%), and death (1%). Pregnancy losses occurred for 2% of pregnancies completed during COVID-19-associated hospitalizations, and were experienced by both symptomatic and asymptomatic women. <sup>[95]</sup>
  - A [multicenter study](#) involving 16 **Spanish hospitals** reported outcomes of **242 pregnant women** diagnosed with COVID-19 during their third trimester from March 13 to May 31, 2020. The women and their **248 newborns** were monitored until the infant was 1 month old. COVID-19 positive who were hospitalized had a higher risk of ending their pregnancy via C-section (P = 0.027). Newborns whose mothers had been admitted owing to their COVID-19 infection had a higher risk of premature delivery (P = 0.006). No infants died and no vertical or horizontal transmission was detected. Infants exclusively breastfed at discharge was 41.7% and was 40.4% at 1month. <sup>[96]</sup>
  - A [cohort study](#) of **pregnant women** (n = 64) with severe or critical COVID-19 disease hospitalized at 12 US institutions between March 5, 2020, and April 20, 2020 has been published. At the time of the study, most women (81%) received hydroxychloroquine; 7% of women with severe disease and 65% with critical disease received remdesivir. All women with critical disease received either prophylactic or therapeutic anticoagulation. One 1 case of maternal cardiac arrest occurred, but there were no cases of cardiomyopathy or maternal death. Half of the women (n=32) delivered during their hospitalization (34% severe group; 85% critical group). Additionally, 88% with critical disease delivered preterm during their disease course, with 16 of 17 (94%) pregnant women giving birth through cesarean delivery. Overall, 15 of 20 (75%) women with critical disease delivered preterm. There were no stillbirths or neonatal deaths or cases of **vertical transmission**. <sup>[97]</sup>
  - A [case series](#) of 6 pregnant patients hospitalized with severe or critical COVID-19 received inhaled **nitric oxide therapy (160-200 ppm by mask twice daily)**. Cardiopulmonary function improved after initiating nitric oxide, as observed by increased systemic oxygenation in each administration session among those with evidence of **baseline hypoxemia** and **reduced tachypnea** in all patients in each session. <sup>[98]</sup>
  - [Zhu et al](#) analyzed the outcomes of **10 neonates** born to mothers with confirmed COVID-19. <sup>[99]</sup> Of the **9 mothers** (one gave birth to twins), 4 were symptomatic prior to delivery, 2 became symptomatic at delivery, and 3 developed symptoms in the postpartum period. Nine of the 10 neonates tested negative for COVID-19 from 1-9 days following delivery. One mother died, 5 were discharged, and 4 were hospitalized. The infants most commonly experienced respiratory distress, but abnormal liver function and thrombocytopenia aware also observed. Premature birth was observed in 6 women, consistent with a case report by Wang et al. <sup>[100]</sup>
  - [Zeng et al](#) presented data on **33 neonates** born to mothers with COVID-19. <sup>[101]</sup> They reported good outcomes overall but drew attention to three newborns with COVID-19, all of whom presented with early-onset pneumonia but eventually recovered. The authors note that each was delivered via cesarean delivery while infection-control precautions were observed to minimize the risk of transmission. **Therefore, they**

raise the possibility of vertical infection. This is in contrast to data analyzed by Schwartz et al, finding no instances of vertical transmission in 38 pregnant women with COVID-19. <sup>[102]</sup>

- Chen et al reported data on 9 pregnant women with COVID-19 with live births delivered via cesarean delivery in Wuhan, China. <sup>[103]</sup> Seven of the 9 women presented with a fever; other symptoms included cough (4 of 9 patients), myalgia (3), sore throat (2), and malaise (2). Five of nine patients had lymphopenia ( $< 1.0 \times 10^9$  cells/L). Three patients had increased aminotransferase concentrations. None of the patients developed severe COVID-19 pneumonia or died as of Feb 4, 2020. Among the 9 neonates, 2 were reported to have fetal distress. All fared well, with excellent Apgar scores. Amniotic fluid, cord blood, neonatal throat swab, and breastmilk samples from 6 of the neonates were tested for SARS-CoV-2, all with negative results.
- Yu and colleagues presented data on 7 pregnant patients with COVID-19. The mean age was 32 years (range, 29-34 years), and the mean gestational age was 39 weeks plus 1 day (range, 37 weeks to 41 weeks plus 2 days). They observed fever in 86% of the women, cough in 14%, shortness of breath in 14%, and diarrhea in 14%. All underwent cesarean delivery within 3 days of clinical presentation, with an average gestational age of 39 weeks plus 2 days, with good outcomes. Three neonates were tested for SARS-CoV-2, and one neonate was infected with SARS-CoV-2 36 hours after birth. <sup>[104]</sup>

○ Source

- **Coronavirus Disease 2019 (COVID-19).** David J Cennimo et al. Medscape. **10 November 2022.**

- **Medscape**

- Updated **10 November 2022.**
- ¾ down the page
- <https://emedicine.medscape.com/article/2500114-overview#a5>

- Author

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## Vertical Transmission of Coronavirus – source #2

### Vertical Transmission of Coronavirus – source #2

- *Vertical transmission of coronavirus disease 2019: a systematic review and meta-analysis*

- Defn – Vertical Tx
  - = Tx of pathogen from mother to fetus during:
    - Ante-partum
      - Placenta *in utero*
    - Intra-partum
      - Body fluids contact during childbirth
    - Post-partum
      - Direct contact from BF
  - Verbatim
    - Vertical transmission is defined as the transmission of the infectious pathogen from the mother to the fetus during the antepartum and intrapartum periods, or to the neonate during the postpartum period via the placenta in utero, body fluid contact during childbirth, or through direct contact owing to breastfeeding after birth
- Systematic review of neonates born to PG women with COVID-19.
  - Case reports (n = 30)
    - 43 “tested neonates”
  - Case series / Cohort studies (n = 38)
    - 936 “tested neonates”
- % vertical Tx by site
  - SARS-CoV-2 viral RNA from:
    - nasopharyngeal swab
      - 936 “tested neonates”
      - 27 were SARS-2 POS
      - 27 / 936
        - = 3% vertical Tx ... that’s from Nasopharyngeal swab
    - Cord blood
      - 3% (1/34)
    - Placenta
      - 8% (2/26)
    - Amniotic fluid
      - 0% (0/51)
    - Urine (fetal, I assume)
      - 0% (0/17)
    - Rectal swab
      - 10% (3/31)
  - Neonatal serology
    - IgM
      - 4% (3/82)
  - Verbatim - statistics
    - Of note, the pooled proportion of severe acute respiratory syndrome coronavirus 2 positivity in neonates by nasopharyngeal swab in studies from China was 2.0% (8/397), which was similar to the pooled proportion of 2.7% (14/517) in studies from outside of China. Severe acute respiratory syndrome coronavirus 2 viral RNA testing in neonatal cord blood was positive in 2.9% of samples (1/34), 7.7% of placenta samples (2/26), 0% of amniotic fluid (0/51), 0% of urine samples (0/17), and 9.7% of fecal or rectal swabs (3/31).



Neonatal serology was positive in 3 of 82 samples (3.7%)  
(based on the presence of immunoglobulin M).

- % vertical Tx by country
  - USA 3.2% (27/936)
  - China 2.0% (8/397)
  - Outside China 2.7% (14/517)
- Data analysis tool
  - Newcastle-Ottawa scale (what?)
  - Databases accessed by a medical librarian were:
    - Cochrane Library
    - DisasterLit
    - Ovid Embase
    - Ovid Medline
    - Google Scholar
    - LitCovid
    - MedRxiv
    - Pubmed
    - Scopus
    - Web of Science Core Collection
  - A medical librarian conducted a systematic search of the literature from Cochrane Library, DisasterLit, Ovid Embase, Ovid Medline, Google Scholar, LitCovid, MedRxiv, Pubmed, Scopus, and Web of Science Core Collection databases to find relevant articles published from inception of the database to May 28, 2020, to identify cohort studies, case series, and case reports of pregnant women with COVID-19 that include information regarding fetal or neonatal COVID-19 testing.
- General principles of infections as concerns O/G
  - Trimester
    - T1 = inc infm/immune activity
    - T2 = less infm/immune activity
    - T3 = inc infm/immune activity
      - Coronavirus Tx occurs in T3.
  - PG is already a hypercoagulable state.
    - Micro-thrombi in placenta of COVID-19 women.
      - Yes this seems to happen in cohort studies.
      - Of note, our systematic review found several cohort studies and case reports describing an association between maternal COVID-19 infection and placental evidence of maternal vascular malperfusion, particularly maternal vessel injury and intervillous thrombi. One may speculate that COVID-19 may result in the activation of endothelial damage pathways predisposing to the development of hypertensive disorders of pregnancy with associated adverse maternal and neonatal outcomes (ie, prematurity, growth restriction) over the long term. This is one of the many issues that remain open for study.
- Epid
  - SARS
    - No Vertical Tx
  - MERS
    - No Vertical Tx
  - MERS
    - Vertical Tx occurs.
- ACE 2
  - ACE2 is expressed in:

- Placenta
      - Syncytiotrophoblast
      - Cytotrophoblast
      - Endothelium
      - Vascular SM
        - Primary villi
        - Secondary villi
  - Verbatim
    - ACE2 is expressed in the placenta<sup>19</sup> and is found in the syncytiotrophoblast, cytotrophoblast, endothelium, and vascular smooth muscle from both primary and secondary villi.
- Source
  - American Journal of Obstetrics and Gynecology
  - 31 July 2020
  - Vertical transmission of coronavirus disease 2019: a systematic review and meta-analysis
  - Authors are O/G from Yale
    - Alexander M. Kotlyar, MD,<sup>a,\*</sup> Olga Grechukhina, MD,<sup>b</sup> Alice Chen, BS,<sup>a</sup> Shota Popkhadze, MD,<sup>b</sup> Alyssa Grimshaw, MSLIS,<sup>c</sup> Oded Tal, PhD,<sup>d</sup> Hugh S. Taylor, MD,<sup>a</sup> and Reshef Tal, MD, PhD<sup>a</sup>
  - <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7392880/>

### Breast Feeding

- Study
  - 64 milk samples from 18 mothers infected with COVID-19.
  - Samples collected before/after COVID-19 Dx.
  - No virus found in the PG mom's milk samples.
  - Experimental milk samples were infected with SARS-CoV-2 as a control.
- Verbatim
  - A study by Chambers et al found human milk is unlikely to transmit SARS-CoV-2 from infected mothers to infants. The study included 64 milk samples provided by 18 mothers infected with COVID-19. Samples were collected before and after COVID-19 diagnosis. No replication-competent virus was detectable in any of their milk samples compared with samples of human milk that were experimentally infected with SARS-CoV-2. <sup>[105]</sup>
  - Same Medscape source above for PG.

# Page 85 – Predators and micro-Predators

## Kingdom technical names

### Dope

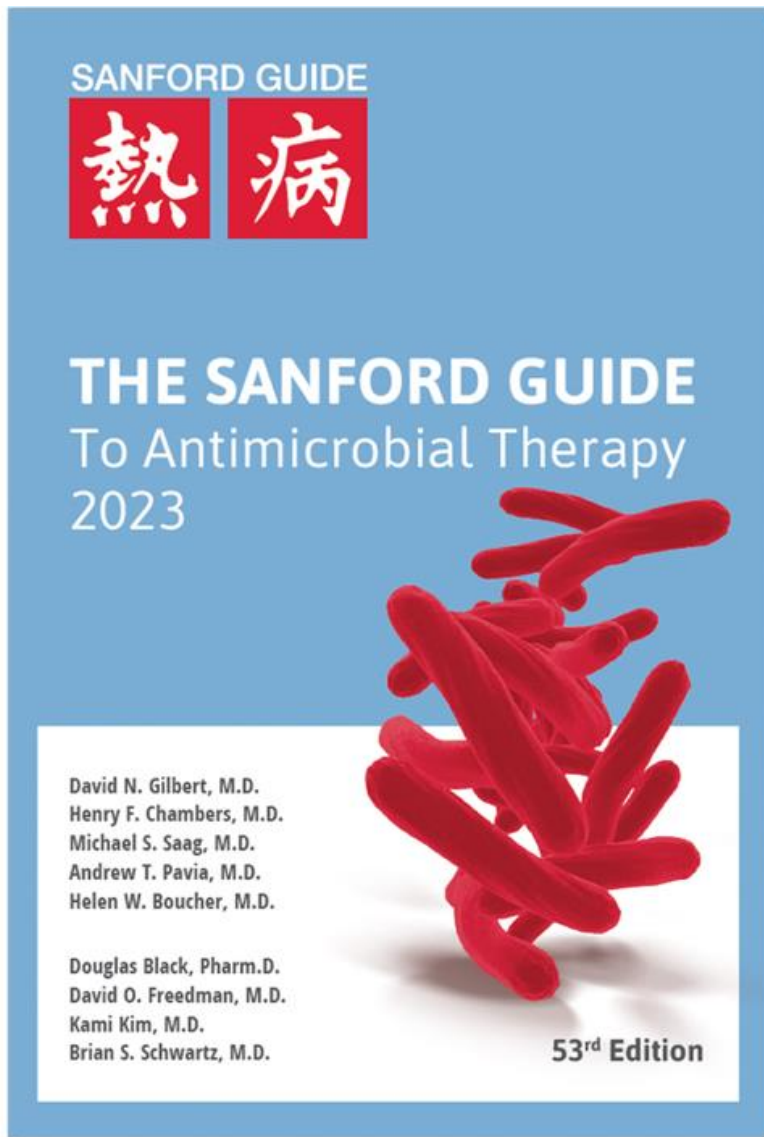
- Kingdom Protista
  - Phylum Amoebozoa

- *Amoeba proteus*
- *Entamoeba histolytica*
- <https://en.wikipedia.org/wiki/Amoebozoa>
- Phylum Apicomplexa
  - *Plasmodium*
  - *Toxoplasma*
  - <https://en.wikipedia.org/wiki/Apicomplexa>

## Big Picture: Microbiology versus Infectious Disease

### *Lippincott's Illustrated Reviews: Microbiology, 4<sup>th</sup> Edition*

- Summary
  - This book was mentioned on page 30.
  - **Micro-biology** is the study of **micro-organisms** using a **micro-scope**.
  - Sometimes the term **Medical Micro-biology** is used – the emphasis is on organisms that infect humans.
- A reminder of an important distinction:
  - **Microbiology**
    - **Microbiology describes the organisms.** How big are they? What do they look like? What nutrients do they need? Do they like sugar? Do they need oxygen? What environments are they found in, outside humans? What disease do they cause when inside humans?
  - **Infectious Disease**
    - **This is a medical specialty.** These **Infectious Disease (ID) doctors** go hog wild on the disease aspect. They have to figure out what organism is causing illness in a patient. Then give the antibiotic that kills it.
- Source
  - **LWW (Lippincott Williams & Wilkins)** (they are the book publisher)
    - 2019.
    - 448 pages.
    - Publisher website
      - <https://shop.lww.com/Lippincott--Illustrated-Reviews--Microbiology/p/9781496395856>
    - Amazon
      - [https://www.amazon.com/Lippincott-Illustrated-Reviews-Microbiology-dp-1496395859/dp/1496395859/ref=dp\\_ob\\_title\\_bk](https://www.amazon.com/Lippincott-Illustrated-Reviews-Microbiology-dp-1496395859/dp/1496395859/ref=dp_ob_title_bk)
- Authors
  - Cynthia Nau Cornelissen PhD (Editor)
  - Marcia Metzgar Hobbs PhD (Editor)



*The Sanford Guide to Antimicrobial Therapy*

- Source
  - Sanford Guide
    - 2022
    - <https://store.sanfordguide.com/antimicrobial-therapy-c2.aspx>
- Summary
  - This is a miniature bible of antibiotics that medical students and interns carry in their lab coat.
  - **Doxy-cycline** (“dox ee sigh klin”) for treating **Epidemic Typhus** is mentioned in here.

## Parasitology

*Parasitism: The Diversity and Ecology of Animal Parasites 1st Edition*. Albert O. Bush et al. Cambridge University Press; 1st edition. 9 April 2001.

- [https://www.amazon.com/Parasitism-Diversity-Ecology-Animal-Parasites/dp/0521664470/ref=sr\\_1\\_1?Adv-Srch-Books-Submit.x=0&Adv-Srch-Books-](https://www.amazon.com/Parasitism-Diversity-Ecology-Animal-Parasites/dp/0521664470/ref=sr_1_1?Adv-Srch-Books-Submit.x=0&Adv-Srch-Books-)

[Submit.y=0&keywords=parasitology&qid=1668186599&refinements=p\\_27%3ABush&s=books&sr=1-1&unfiltered=1](#)

- I mentioned this book for the worm that causes River Blindness (page 77).

*Parasitology: The biology of animal parasites*. Elmer Ray Noble and Glenn Arthur Noble. Lippincott Williams and Wilkins. 1 January 1982.

- <https://www.amazon.ca/Parasitology-Parasites-Elmer-R-Noble/dp/0812108191>
- I mentioned this book for the worm that causes River Blindness (page 77).

## Is the fetus a parasite?

Is the fetus a parasite?

- This is one of those questions whose answer is rooted in semantics, which is to say, the meanings of words.
- Let's play both sides of the fence.

### The fetus is NOT a parasite

- Argument #1
  - By definition, a parasite is a different species from the host. Is a **human fetus** a *Homo sapiens*? Yes. Is the **pregnant woman** a *Homo sapiens*? Yes. Since both are the same species, the fetus cannot be a parasite. (Recall that *Homo* is the Genus, and *sapiens* is the species).
- Argument #2
  - The **fetus** is taking oxygen from the mother. So does that make it a parasite? Well, once the fetus is born and is now called a **newborn**, it gets oxygen for free from the atmosphere. But the newborn does drink mother's milk. And mother for sure donates that milk; indeed that is part of the definition of being a **mammal**. So if the mother is donating her milk to the newborn, willingly, it seems likely that the mother would be donating her oxygen to the fetus, willingly. Does this feel like word games?

### The fetus is a parasite

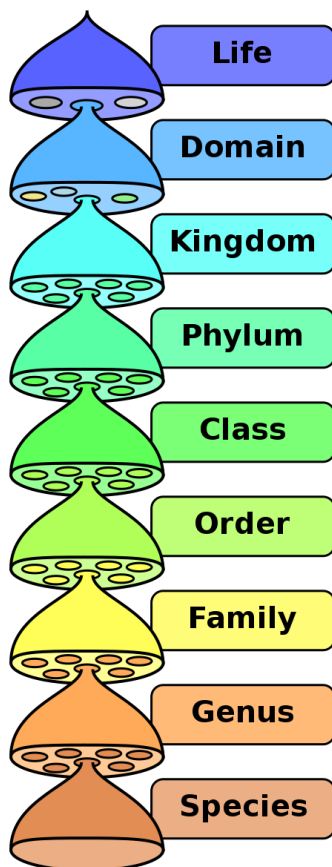
- One must admit, this paper is interesting ...

*The placenta really does act like a parasite, Reading research suggests – University of Reading*

- Summary
  - The placenta is the interface between the **pregnant woman** and **fetus**. The placenta is able to 'disguise' itself from the pregnant woman's immune system via a molecule called **phospho-choline** ("foss foe kow lean"). That same molecule is used by **parasitic worms** to avoid the human immune system.
  - My take on this is that the placenta, acting as a sort of proxy for the fetus, means the fetus is like a parasitic worm. Word games, yes, but in reality the fetus is ½ mom and ½ dad ... which means the dad ½ is foreign protein growing inside the mom ... and the immune system will attack it. This is precisely why the fetus has to be protected from the mother's immune system, so this disguise stuff is part of that.
- Verbatim
  - The placenta uses a cloaking device similar to that used by parasites to avoid detection by the mother's immune system.
- Verbatim (Professor Phil Lowry)
  - "What we found next was most unusual. It appeared the placental NKB contained the molecule phosphocholine which is used by filarial nematodes, a type of parasitic worms to escape host immune systems! I have had two or three 'Eureka!' moments in my career. This one, at 63, I am happy to bow out on."

- Source
  - University of Reading (that's in Reading, UK).
    - <https://www.reading.ac.uk/news-archive/press-releases/pr9938.html>
    - This is the paper the article is based on
      - Lowry PJ et al (2007). *Identification of a novel mammalian post-translational modification, phosphocholine, on placental secretory polypeptides*. Journal of Molecular Endocrinology, 39, 189-198. DOI: 10.1677/JME-07-0007.

# Page 86 – TAXONOMY #1 – purple drawers



## Kingdom

- Summary
  - This diagram, which to me resembles stacked mushroom caps, is how the 5 Kingdoms of life are classified. The term 'Domain' is not really referred to that much.
  - The way that viruses are classified is a touch different – see page 113 of the bibliography.

- Source
  - [https://en.wikipedia.org/wiki/Kingdom\\_\(biology\)](https://en.wikipedia.org/wiki/Kingdom_(biology))

*The Life of Vertebrates, 3<sup>rd</sup> Edition*

- J. Z. Young. Oxford University Press. 1981.
  - <https://www.amazon.com/Life-Vertebrates-J-Z-Young/dp/0198571720>
  - This is a 700 page textbook of zoology.

# Page 87 – TAXONOMY #2 – more purple drawers

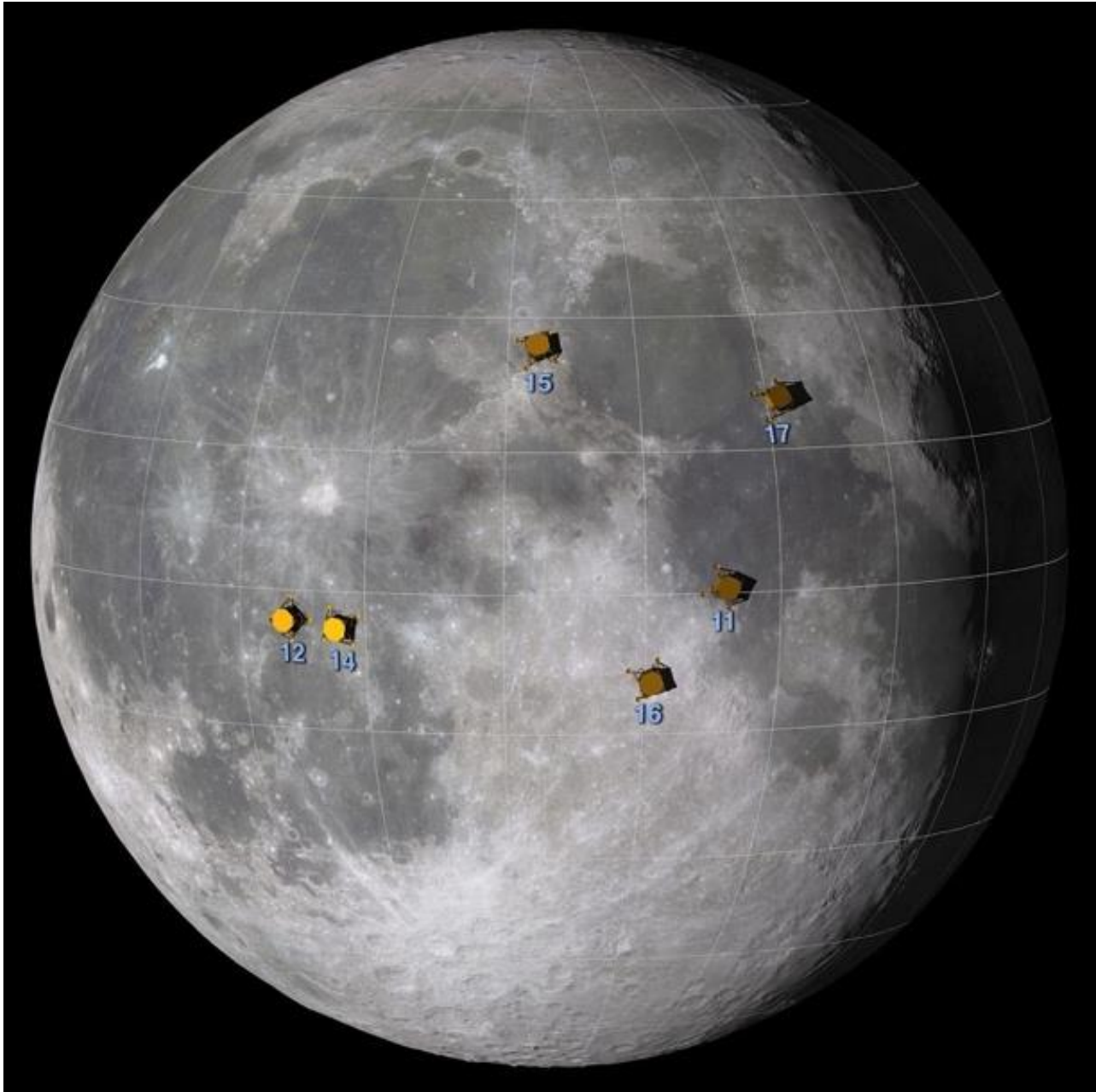
Same source as page 86. ##

## Number of species of mammals

*How many species of mammals are there?*

- Summary
  - This article states there are 6399 extant (alive) species of mammals.
- Verbatim
  - We found 6,495 species of currently recognized mammals (96 recently extinct, 6,399 extant), compared to 5,416 in MSW3 (75 extinct, 5,341 extant)—an increase of 1,079 species in about 13 years, including 11 species newly described as having gone extinct in the last 500 years.
- Source
  - Journal of Mammalogy
    - 1 February 2018
    - <https://academic.oup.com/jmammal/article/99/1/1/4834091>
- Authors
  - Connor J Burgin - Department of Biological Sciences, Boise State University, Boise, ID, USA
  - Jocelyn P Colella - Department of Biology and Museum of Southwestern Biology, University of New Mexico, Albuquerque, NM, USA
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## Apollo landing sites



Those are the landing sites for the Apollo missions.

- [https://en.wikipedia.org/wiki/Moon\\_landing](https://en.wikipedia.org/wiki/Moon_landing)

## Walrus and Seals

### *Carnivorous walrus and some Arctic zoonoses*

- Summary
  - A **walrus** is a carnivore? Yes! Sometimes a walrus kills and eats a **seal**! Wow. That's like, *Don't Mess with Texas*.
  - This article also mentions how a **walrus** can be a source of the worm *Trichinella spiralis*. It's a type of parasitic worm called a **nematode** ("knee ma toad"). Don't confuse it with the **fish tapeworm**.



Totally different. In fact, so different that tapeworms and nematodes each have their own distinct Phylum in the Animal Kingdom.

- Phylum Nematoda
  - *Trichinella spiralis*
- Phylum Platy-helminthes
  - The fish tapeworm belongs here.
  - *Platy* means *flat*.
  - *Helminth* means *worm*.
  - So a platy-helminth is a flat worm. And that is exactly what a tapeworm looks like – flat. Like you made a worm out of Scotch tape – sort of. Point is, it is flat in appearance.
- Verbatim
  - That walrus (*Odobenus rosmarus*) sometimes develop a habit of eating seals is generally recognized by arctic maritime Eskimos and has been mentioned frequently in scientific and popular literature.
  - Zoonoses are diseases of animals that can be transmitted to man.
- Source
  - Arctic
    - 1960
    - This is reference no. 27 in *Wikipedia – Walrus*.
    - <https://pubs.aina.ucalgary.ca/arctic/Arctic13-2-111.pdf>
- Author
  - Francis H. Fay - Arctic Health Research Center, Public Health Service, US. Department of Health, Education, and Welfare, Anchorage, Alaska

### Classification (Overall)

- Summary
  - Sea lions eat meat and lions eat meat so both are carnivores.
  - Restated, seals used to be classified as Order Pinnipedia (“pin ih pee dee ah”) but then they were reclassified as carnivores, hence Order Carnivora.
- Source
  - The main article is called *Pinnipedia* and has a bunch of sub-articles.
  - *Classification (Overall)* is in the *Encyclopedia of Marine Mammals* (Second Edition), 2009.
    - <https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/pinnipedia>
- Author
  - Dale W. Rice

### Pinniped

- Summary
  - Despite the conclusions of the paper above, zoologists – out of tradition? – seem to think of only the lions as carnivores. This type of ‘dispute’ over taxonomy is very common in zoology and botany.
- Verbatim
  - As a group, Pinnipedia is often considered a separate order distinct from other carnivores (order Carnivora).
- Source
  - *Encyclopedia Britannica*
    - <https://www.britannica.com/animal/pinniped>

## Whales

### Cetacean

- Summary
  - Whales are sometimes classified as **Order Cetacea** (“set a see ah”).
  - Whales are sometimes classified as **Order Artio-dactyla** (“art ee oh dack tih la”) (**even-toed herbivores**) because they evolved from them and then returned to the water (over millions of years).
- Source
  - **Encyclopedia Britannica**
    - <https://www.britannica.com/animal/cetacean>

## Primates

### Summary of Primates

- Primates are basically monkeys, apes and humans, plus anything that looks like monkeys, apes, and humans. That’s the Keep It Simple Stupid version.
- Getting a touch more formal ... primates can be divided into 3 groups:
  - Prosimians (“pro sim ee uns”)
  - Monkeys
  - Apes (this includes humans)
- † means extinct.

#### 1) Prosimians

Aye aye  
Loris  
Lemurs

#### 2) Monkeys

##### Old World monkeys (Africa + Asia)

138 species

Baboons (n = 5)

Chacma baboon  
Guinea baboon  
Hamadryas baboon  
Olive baboon  
Yellow baboon

Colobus monkey

*Paracolobus*†

Green monkey

Langur

Hanuman langur a.k.a. Southern plains gray langur  
Red-shanked douc  
Sumatran surili  
Thomas’s langur

Macaques

Crab-eating macaque (Cynomolgus monkey)

Mangabey

Sooty mangabey

Snow monkey

##### New World monkeys (Central America + South America)

~100 species

Capuchin monkey  
Howler monkey  
Marmoset  
Saki monkey

Spider monkey  
Squirrel monkey  
Tamarin

### 3) Apes

Lesser apes a.k.a. smaller apes

Gibbons

Great apes a.k.a. Hominids a.k.a. *Family* Hominidae

Bonobos

- *Pan paniscus*
- a.k.a. **pygmy chimpanzee** despite not being diminutive beside a chimp.

Chimpanzees

- *Pan troglodytes*
- a.k.a. **common chimp**

Gorillas

- *Gorilla gorilla*
  - **Western gorilla**
  - **DRC, West Africa**
- *Gorilla beringei*
  - **Eastern gorilla**
  - Critically endangered
- *Gorilla beringei beringei*
  - **Eastern gorilla** subspecies
  - **Virunga Mtns, Rwanda** (n = 880 individuals)

Orangutangs

- *Pongo*
- 3 spp in Borneo, Sumatra, Tapanuli region of Sumatra.

Australopithecines† ('southern ape')

Gracile (slender)

*Australopithecus afarensis*† (**Lucy**) →? *Homo habilis*

*Australopithecus africanus*† →? *Homo habilis*

Robust

*Australopithecus (Paranthropus) robustus*†

*Australopithecus (Paranthropus) boisei*†

Homo

*Homo habilis*†

- Name is coined by **Louis Leaky**. 'Handy man.'
- 2,300,000 – 1,650,000 years ago

*Homo erectus*†

- **Peking man, Java man**
- 2,000,000 – 108,000 years ago (last fossils of **Java Man**)
- *Homo ergaster*† = **African/Asian *Homo erectus***

*Homo sapiens*

*Homo sapiens neanderthalis*

- **Neanderthal man**

*Homo sapiens cromagnonensis*

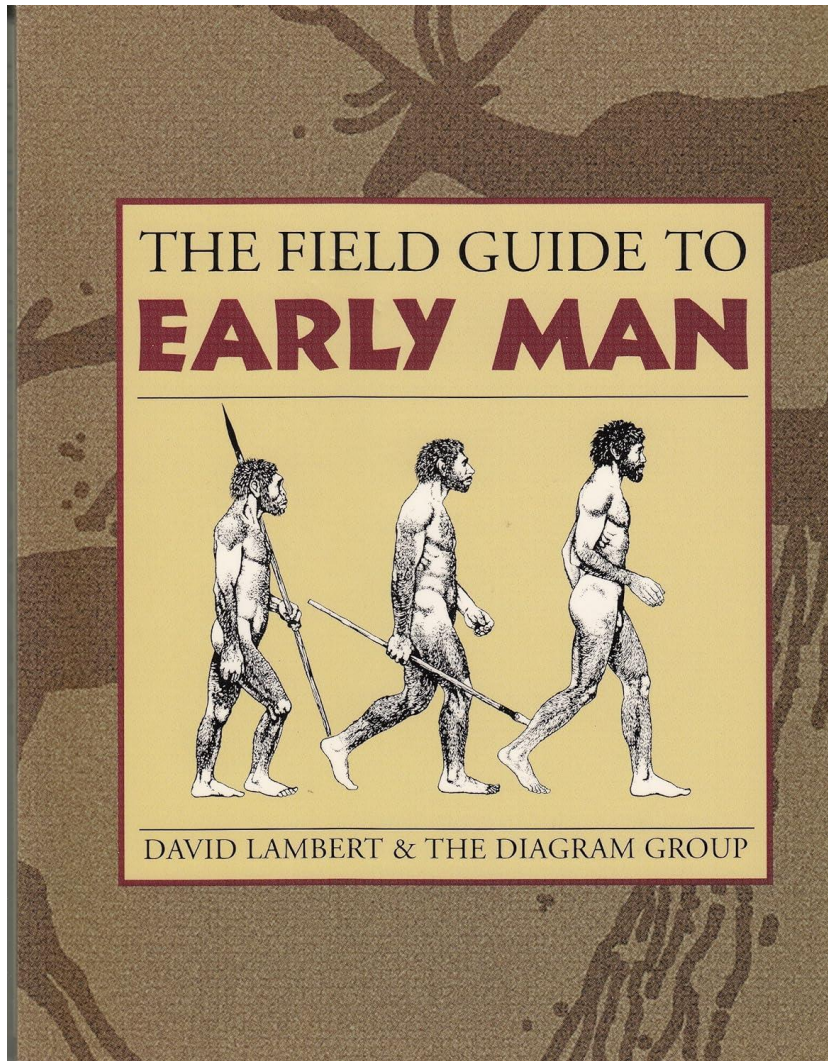
- **Cro-Magnon man** a.k.a. **European Early Modern Humans (EEMH)**
- Currently, considered neither species nor subspecies, so simply EEMH.

*Homo sapiens sapiens*

- That's us.

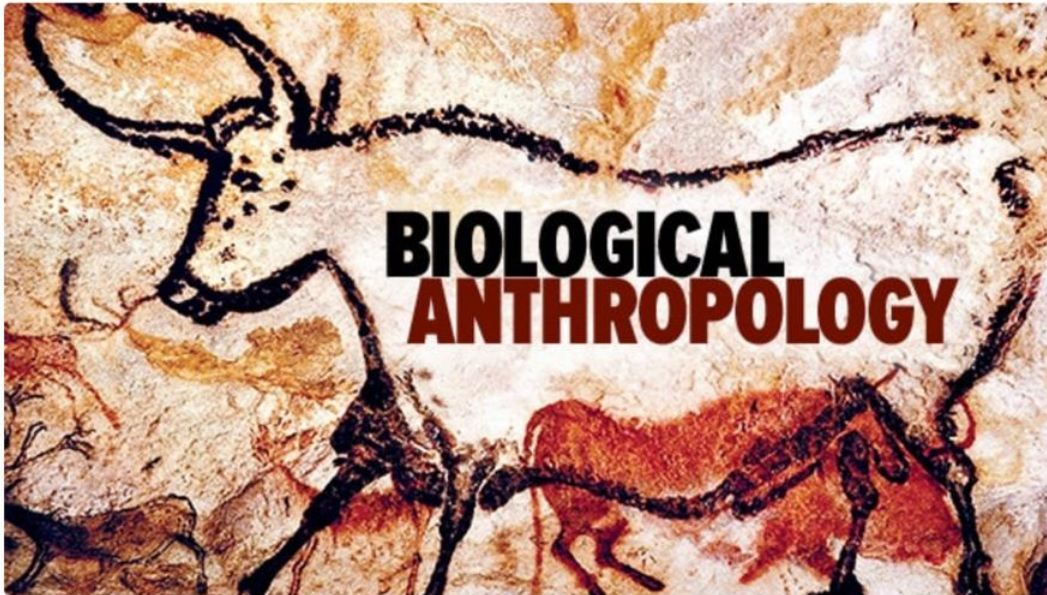
### Education Course Week 2: Primate Taxonomy Lesson

- Summary
  - This is an 11-minute video on the taxonomy of primates. It starts really basic and walks you through all the monkeys and apes and has the Goldilocks amount of details.
- Source
  - **MonkeyWorldOfficial**
    - 10 May 2020
    - <https://www.youtube.com/watch?v=CQFIdh9RacE>



### The Field Guide to Early Man


- Summary
  - This book is a basic guide to early man and his ancestors, that suited me just fine. It has nice drawings of skulls and simulates being there, boots on the ground, digging up the bones of *Homo*.
- Source
  - **Facts on File** is the publisher.
  - 1988
  - Amazon.ca
    - <https://www.amazon.ca/Field-Guide-Early-Man/dp/0816018014>



### *Biological Anthropology: An Evolutionary Perspective*

- Summary
  - This fantastic 24-lecture course goes into great detail on primate behaviour and also touches on classification.
  - **Anthropology** is interested in rituals, language, religion, behaviours ... anything about human culture.
  - **Biological anthropology** adds the dimension of 'time depth.'
  - **Cultural anthropologists** travel to far flung places like say Papua New Guinea to compare different cultures.
- Source
  - The Great Courses
    - You can check out the titles of the 24 lectures on the website.
    - They courses are kinda pricey so I wait until they go on sale.
    - <https://www.thegreatcourses.com/courses/biological-anthropology-an-evolutionary-perspective>
- Lecturer
  - **Dr. Barbara King, PhD**, College of William and Mary
    - She studies primates so she is a **primatologist**. Among other things, she studied baboons in Amboseli National Park in the shadows of Mount Kilimanjaro.

### *Hominidae*

- Summary
  - If you seek detail, you'll find it here in Encyclopedia Britannica.
  -  On the left side is a menu – click on 'Classification.' It would be fair to call the classification of the primates a big hairy terminology mess especially involving the letter 'H' so there are terms like **Hominoidea**, **Hominidae**, and **Homininae**. In fairness to anthropologists, when new bones are dug up, new relationships may be revealed, necessitating a change in the taxonomy.
- Source
  - **Britannica**
    - <https://www.britannica.com/animal/primate-mammal>

# Page 88 – Zoonosis

## Zoonotic Diseases

- Summary
  - This is the CDC page on zoonotic diseases.
- Verbatim
  - animals can sometimes carry harmful germs that can spread to people and cause illness - these are known as **zoonotic diseases** or zoonoses. Zoonotic diseases are caused by harmful germs like viruses, bacterial, parasites, and fungi. These germs can cause many different types of illnesses in people and animals, ranging from mild to serious illness and even death. Animals can sometimes appear healthy even when they are carrying germs that can make people sick, depending on the zoonotic disease.
    - I think their 'parasites' means **protozoa** (think, amoebas) and **worms**.
- Spread
  - Water contaminated with animal feces
    - **Giardia** (this amoeba cousin is found in beaver feces and causes '**Beaver Fever**').
  - Food contaminated with animals feces:
    - Raw milk
    - Undercooked meat / eggs
    - Raw fruit / veggies
  - Direct contact with animal fluids.
    - Saliva
    - Blood
    - Urine
    - Mucous
    - Feces
  - Indirect contact with a surface contaminated by an animal
    - Aquarium
    - Pet habitat
    - Chicken coop
    - Barn
    - Plants
    - Soil
    - Food/water dish of pet
  - Vector
    - Mosquito
    - Tick
    - Flea
- Source
  - **CDC**
    - 1 July 2021
    - <https://www.cdc.gov/onehealth/basics/zoonotic-diseases.html>

## Zoonosis

- Summary
  - The **HIV virus** was initially zoonotic (animal-to-human) then mutated so now it's only human-to-human. Now that is interesting!

- Source
  - <https://en.wikipedia.org/wiki/Zoonosis>

CHAPTER 3 – MEET THE VIRUSES

(page 89)

# Page 90 – Pause for Station Identification

*Principles of Virology Volume 1: Molecular Biology*

- Summary
  - This technical book on viruses is summarized on page 56.

*Principles of Virology Volume 2: Pathogenesis and Control*

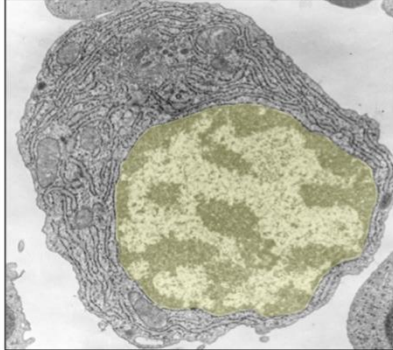
- Summary
  - This is Volume 2.

# Page 91 – Virus versus Cell

Feature:  none  nucleoid  cell wall  pili  flagella  all

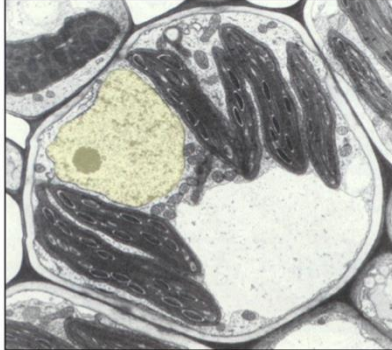
**Eukaryotic Cell Features**

**Animal Cell Electron Micrograph**



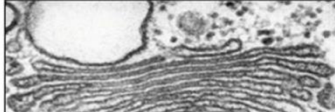

Feature:  none  nucleus  ER  mitochondria  golgi  chloroplast  cell wall  vacuole  all

**Plant Cell Electron Micrograph**



Feature:  none  nucleus  ER  mitochondria  golgi  chloroplast  cell wall  vacuole  all

**Organelles** (click on image to display false colour)

### Cell micrographs

- **Source**
  - Bioninja
  - <https://ib.bioninja.com.au/standard-level/topic-1-cell-biology/12-ultrastructure-of-cells/cell-micrographs.html>
- **Summary**
  - You can **click on the small circles underneath the photographs** to see the parts of the cell. It's nice and simple.

**What is a cell?** Medline Plus. No author, no date

- <https://medlineplus.gov/genetics/understanding/basics/cell/>
- This is a basic explanation of the parts of the cell plus simple diagrams.

**Cell.** Christopher Chow. Encyclopedia Britannica. Last updated 18 October 2022.

- <https://www.britannica.com/science/cell-biology>
- **Summary**
  - This is nicely organized. The menu on the left lets you explore all parts of the cell.
  - Click on 'See all media' for lots of videos and images. It's fairly technical.


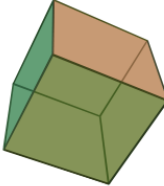
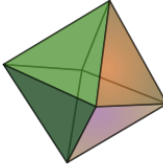
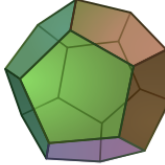
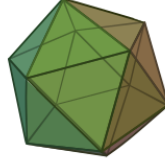
**The Cell: A Molecular Approach.** Geoffrey M. Cooper and Robert E. Hausman. Sinauer Associates Inc; 6th edition (Feb. 1 2013).

- [https://www.amazon.ca/gp/product/1605351555/ref=ppx\\_yo\\_dt\\_b\\_search\\_asin\\_image?ie=UTF8&psc=1](https://www.amazon.ca/gp/product/1605351555/ref=ppx_yo_dt_b_search_asin_image?ie=UTF8&psc=1)
- **Summary**
  - This is a phenomenal textbook of cell biology. Incredible detail. Incredible science.



# Page 92 – Virus geometry


## Geometry

Tetrahedron	Cube	Octahedron	Dodecahedron	Icosahedron
Four faces	Six faces	Eight faces	Twelve faces	Twenty faces
				

### Platonic solid

- Summary
  - The philosopher **Plato** said these were the 5 basic shapes with a characteristic number of '**faces**' (think, surfaces): 4, 6, 8, 12, 20.
  - The one on the far right, with 20 faces, is the **icosa-hedron** and the **capsid** of many viruses have this shape. Think of the capsid as the frame of a tent plus the fabric.
  - The math is crazy.
- Wikipedia
  - [https://en.wikipedia.org/wiki/Platonic\\_solid](https://en.wikipedia.org/wiki/Platonic_solid)

### Platonic solids

- Summary
  -  You can print and assemble the shapes of the five Platonic solids.
- Source
  - **Math is Fun**
    - No author, no date
    - [https://www.mathsisfun.com/platonic\\_solids.html](https://www.mathsisfun.com/platonic_solids.html)

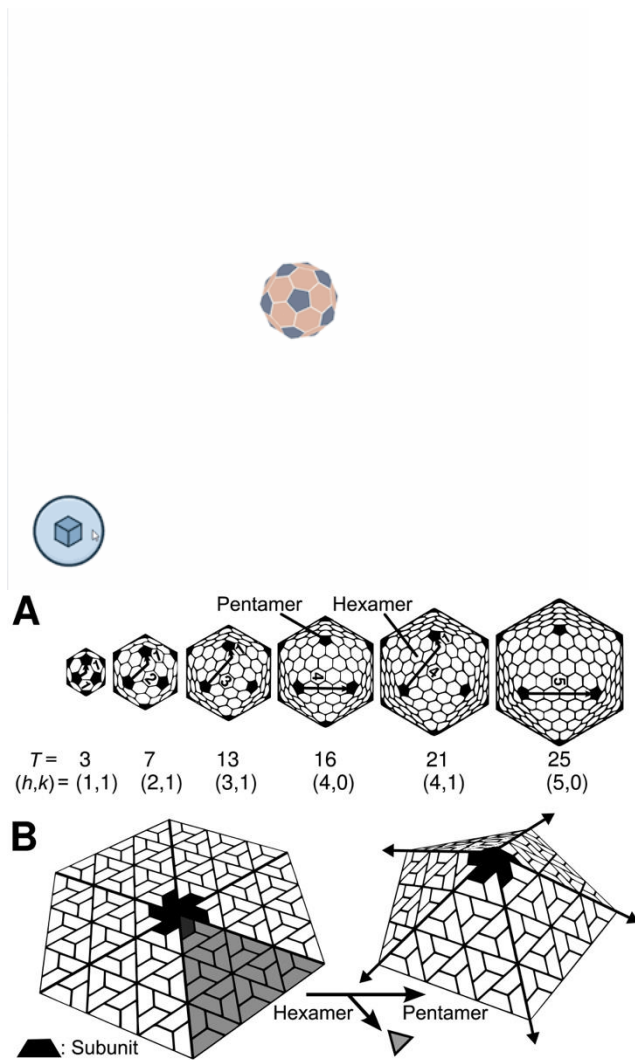
### Virology 2015 Lecture #4: Structure of viruses

- Summary
  - This is a video on the structure of viruses. It's kind of technical but it is pretty easy to follow along and understand.
  - 26m:00s – **Helical symmetry**.
  - 27m:59s – Professor Racaniello winds magnetic beads into a **helical capsid**.
  - 37m:30s – **Icosehedral symmetry**.
- YouTube
  - 2 February 2015
  - 68 minutes long.
  - <https://www.youtube.com/watch?v=MRkcZ6gXiTY>
- Narrator

- Professor Vincent Racaniello
  - He is one of the 5 authors of the book *Principles of Virology* (the previous entry).

### Principles of Virology Volume 1: Molecular Biology

- Summary
  - This technical book on viruses is summarized on page 56 (What is Life?).

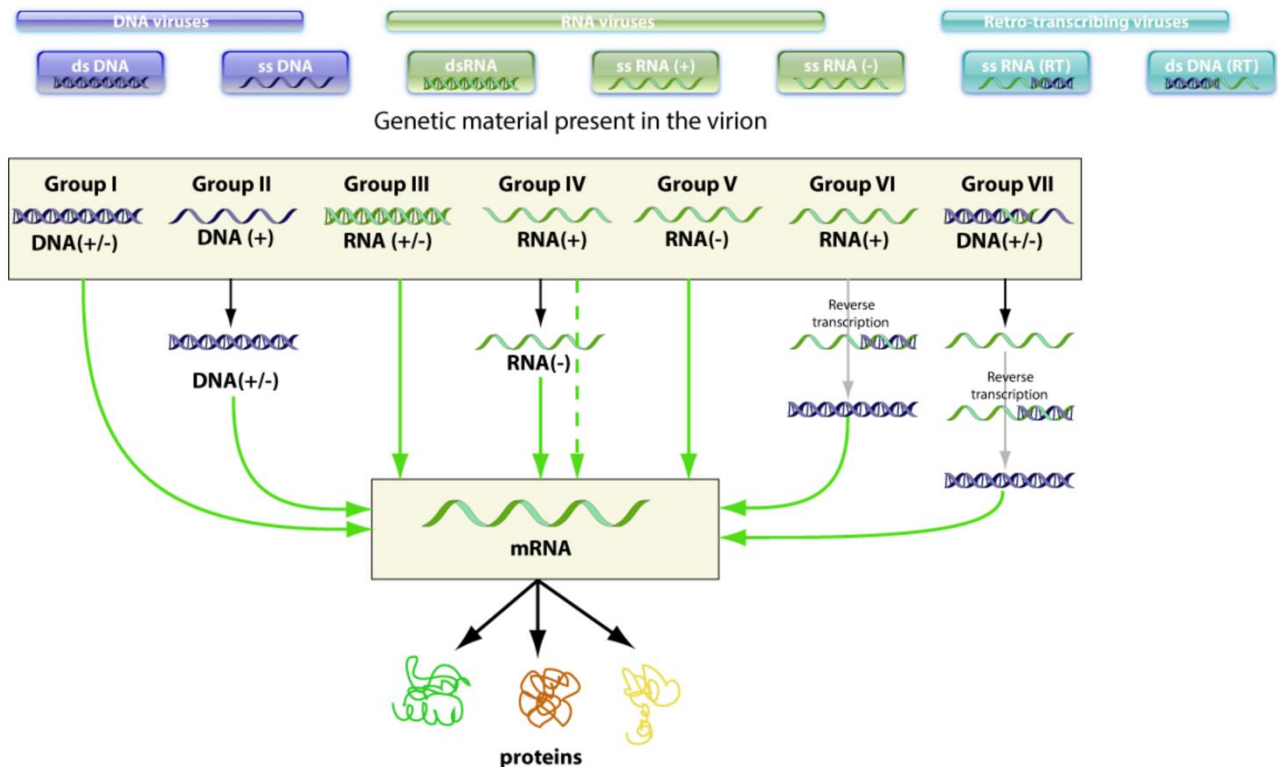


### Capsid

- Summary
  - This describes the deep world of the geometry of viruses that would make Euclid (the Father of Geometry) quiver with excitement.
  - There is an **icosahedral capsid** and **helical capsid**.
    - Icosa-hedron = noun
    - icosa-hedral = adjective.
  - There are also capsid **T-numbers**. Read to your heart's content.
  - I have tried to understand this but I soon got lost.
- Source

- <https://en.wikipedia.org/wiki/Capsid>

## Baltimore classification



### Baltimore classification

- Summary
  - This is David Baltimore's 7 options for virus classification based on the spiral nature of the genetic code.
  - See the 7 rectangles in the 2<sup>nd</sup> row? That's the 7 options. 🖱️ Click on the spiral shape to open a page with the viruses that belong in that group. But you have to put the cursor right overtop the spiral.
- Verbatim
  - The Baltimore classification clusters viruses into families depending on their type of genome.
- Source
  - [ViralZone](https://viralzone.expasy.org/254)
    - No date, no author
    - <https://viralzone.expasy.org/254>



David Baltimore

- Summary
  - That's David Baltimore. He got the Nobel Prize.
  - He's definitely got that 1970's look going on.
- Source
  - [https://en.wikipedia.org/wiki/David\\_Baltimore](https://en.wikipedia.org/wiki/David_Baltimore)

## Page 93 – Bacteriophages

### Some background

- 900 million bacteriophages per ml of seawater of microbial mats. (Don't know where I found that – I think maybe *Principles of Virology*)

### Bacteriophages

- StatPearls. Last updated 26 September 2022.
- Laura M. Kasman - Medical University of South Carolina
- La Donna Porter - Dignity Health - St. Joseph's MC
- <https://www.ncbi.nlm.nih.gov/books/NBK493185/>
- This is short and readable.

### Bacteriophage. Britannica.

- <https://www.britannica.com/science/bacteriophage>
- There is an excellent illustration of the 4 steps when the bacteriophage attacks a bacteria: Landing → Pinning → Tail contraction and penetration → DNA injection.
  - <https://www.britannica.com/science/bacteriophage/images-videos>

*Bacteriophage*. Wikipedia.

- <https://en.wikipedia.org/wiki/Bacteriophage>
- **Click on the top right image then zoom in using the +. You'll see how elaborate the design is, even of this most basic of viruses.**

# Page 94 – Matryoshka virus – From Russia With Love

## Matryoshka virus



*Matryoshka doll*

- **The dolls fit inside each other.** At their 'waist' they can be split apart but the line is hard to see here.
- [https://en.wikipedia.org/wiki/Matryoshka\\_doll](https://en.wikipedia.org/wiki/Matryoshka_doll)

**Russian Cyrillic alphabet**  
(Русский кириллический алфавит)

Uppercase lowercase (*Uppercase lowercase italics*)

А а (А а)	Б б (Б б)	В в (В в)	Г г (Г г)	Д д (Д д)	Е е (Е е)
Ё ё (Ё ё)	Ж ж (Ж ж)	З з (З з)	И и (И и)	Й й (Й й)	К к (К к)
Л л (Л л)	М м (М м)	Н н (Н н)	О о (О о)	П п (П п)	Р р (Р р)
С с (С с)	Т т (Т т)	У у (У у)	Ф ф (Ф ф)	Х х (Х х)	Ц ц (Ц ц)
Ч ч (Ч ч)	Ш ш (Ш ш)	Щ щ (Щ щ)	Ъ ъ (Ъ ъ)	Ы ы (Ы ы)	Ь ь (Ь ь)
Э э (Э э)	Ю ю (Ю ю)	Я я (Я я)			

### Russian alphabet

- Russian: **матрёшка**
- Let's break down the letters:
  - **М**
    - 3<sup>rd</sup> row
  - **а**
    - 1<sup>st</sup> row
  - **Т**
    - 4<sup>th</sup> row
  - **р**
    - 3<sup>rd</sup> row
    - This Russian letter is the same symbol as the Greek letter “rho” which is pronounced “row.” It is also the symbol for density in physics.
    - This is ‘r’ in Mat yoshka.
  - **ё**
    - 2<sup>nd</sup> row
  - **ш**
    - ? row
    - This must be the sh sound?
  - **к**
    - 2<sup>nd</sup> row
    - This Russian letter is the same as the Greek letter kappa, the familiar “k” sound.
  - **а**
    - 1<sup>st</sup> row
- Source
  - [https://en.wikipedia.org/wiki/Russian\\_alphabet](https://en.wikipedia.org/wiki/Russian_alphabet)

*Novel RNA viruses associated with Plasmodium vivax in human malaria and Leucocytozoon parasites in avian disease*

- PLoS Pathogens. 30 December 2019.
  - <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6953888/>

- Authors
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  - 6 Gleneagles Hospital, Kota Kinabalu, Sabah, Malaysia
  - 7 Australian Registry of Wildlife Health, Taronga Conservation Society Australia, Mosman, New South Wales, Australia
  - 8 Kirby Institute for Infection and Immunity, University of New South Wales, Sydney, New South Wales, Australia
  - Umea Universitet, SWEDEN
  - The authors have declared that no competing interests exist.
  - Verbatim
    - These data, confirmed by PCR, are indicative of a novel RNA virus that we term Matryoshka RNA virus 1 (MaRNAV-1) to reflect its analogy to a "Russian doll": a virus, infecting a parasite, infecting an animal.

## Aspergillus virus

### *Mycoviruses in Aspergilli: A Comprehensive Review*

- **frontiers in Microbiology**. [Yes, *frontiers* is lowercase and *Microbiology* upper case.]
- **6 September 2017**.
- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5592211/>
- [Ioly Kotta-Loizou](#)1,\* and [Robert H. A. Coutts](#)2
- 1Department of Life Sciences, Imperial College London, London, United Kingdom
- 2Department of Biological and Environmental Sciences, University of Hertfordshire, Hatfield, United Kingdom
- Edited by: Nobuhiro Suzuki, Okayama University, Japan
- Reviewed by: Daohong Jiang, Huazhong Agricultural University, China; Hiromitsu Moriyama, Tokyo University of Agriculture and Technology, Japan; Michael Norman Pearson, University of Auckland, New Zealand
- Summary

- Remember, *Aspergillus* is the fungus. It gets infected by a virus.
- Verbatim
  - Fungi, similar to all species, are susceptible to viral infection. *Aspergillus* is arguably the most well studied fungal genus because of its medical, ecological and economical significance.

*Discovery and characterization of novel Aspergillus fumigatus mycoviruses.* PLOS ONE. 25 July 2018

- **Jan Zoll**
- **Paul E. Verweij**
- **Willem J. G. Melchers**
- <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0200511>
- Verbatim
  - Two strains were infected with *Aspergillus fumigatus polymycovirus type-1* (AfuPmV-1).
  - Four novel *A. fumigatus* RNA mycoviruses could be identified: two different *Aspergillus fumigatus* narna-like viruses, one *Aspergillus fumigatus* partitivirus, and one *Aspergillus fumigatus* mitovirus

## Chestnut tree fungus



### Chestnut blight

- Those are **cankers** (“kang kers”) on a **chestnut tree**.
- They are caused by a **fungus** a.k.a. *Cryphonectria parasitica* a.k.a. *Chestnut blight*.
- **In botany, a fungal infection of a plant is called a blight.** The Irish potato famine was caused by potato blight.
  - [https://en.wikipedia.org/wiki/Great\\_Famine\\_\(Ireland\)](https://en.wikipedia.org/wiki/Great_Famine_(Ireland))
  - [https://en.wikipedia.org/wiki/Phytophthora\\_infestans](https://en.wikipedia.org/wiki/Phytophthora_infestans)
    - Lotsa pix of infected potatoes.
- The trees **highly susceptible** to the Chestnut blight are:
  - **American chestnut**
  - **Dwarf chestnut**
- Humans also get **canker sores** (usually in the mouth) – usually but they can be caused by stress. They are not caused by the chestnut fungus. Totally different. But the ‘canker’ part implies injury to the tissue, as with the chestnut tree.



- [https://en.wikipedia.org/wiki/Chestnut\\_blight](https://en.wikipedia.org/wiki/Chestnut_blight)

#### American chestnut

- [https://en.wikipedia.org/wiki/American\\_chestnut](https://en.wikipedia.org/wiki/American_chestnut)
- The range (where it lives) of the tree is shown here.

#### *Cryphonectria parasitica*

- Global Invasive Species Database (GISD)
- No date no author
- <http://www.iucngisd.org/gisd/species.php?sc=124>
- Click on the 5<sup>th</sup> image. I used this for my drawing.

#### A Brief Summary of Chestnut Canker Biocontrol

- Timothy McKechnie. The American Chestnut Foundation.
- No date
- There are photos of the cankers on American chestnuts.
- <https://acf.org/ct/news-and-updates/a-brief-summary-of-chestnut-canker-biocontrol/>

#### *Cryphonectria parasitica, the causal agent of chestnut blight: invasion history, population biology and disease control*

- Molecular Plant Pathology. 31 January 2017
- Daniel Rigling, Simone Prospero
- <https://bsppjournals.onlinelibrary.wiley.com/doi/10.1111/mpp.12542>
- This is a very readable summary article.

## The virus that infects the Chestnut tree fungus

### Background info

- Dope
  - The *Hypo-viridae* are viruses purposely introduced into the trees to kill the fungus. Cool.
- CHV1
  - Synonyms
    - CHV1
    - CHV-1
    - Crypho-nectria Hypo-Virus 1
    - Cryphonectria HypoVirus 1
  - NTBCW
    - Canines Herpes Virus (CHV)
  - Tax
    - Family Hypo-viridae
      - Single Genus
        - 4 spp
- Hypo
  - Hypo mean decreased. As in, Hypo-thermia when you get dumped overboard into the freezing ocean.
  - Hypo is a common prefix in human medicine. Hypo-thermia, hypo-thyroidism, hypo-pigmentation. Lots of others.
  - If the virus infects the fungus there is decreased virulence a.k.a. hypo-virulence ... Hypo-viridae. Hence the name of the Virus Family: *Family Hypo-viridae*.

*Occurrence and transmission of mycovirus Cryphonectria hypovirus 1 from dejecta of Thyreophagus corticalis (Acari, Acaridae). Mabrouk Bouneb et al.*

- **Fungal Biology. March 2016**
- Mabrouk Bouneb<sup>a</sup> Tullio Turchetti<sup>b</sup> Roberto Nannelli<sup>a</sup> Pio Federico Roversi<sup>a</sup> Francesco Paoli<sup>a</sup> Roberto Danti<sup>b</sup> Sauro Simoni<sup>a</sup>
- a
- CREA-ABP, Consiglio per la ricerca in agricoltura e l'analisi dell'economia agraria - Research Centre for Agrobiology and Pedology, Via di Lanciola 12/a, 50125 Florence, Italy
- b
- CNR – IPSP, Consiglio Nazionale delle Ricerche – Institute for Sustainable Plant Protection, Via Madonna del Piano 10, Sesto Fiorentino, 50019 Florence, Italy
- Received 8 May 2015, Revised 29 October 2015, Accepted 10 November 2015, Available online 23 November 2015, Version of Record 16 February 2016.
- Corresponding Editor: Paul Birch
- <https://www.sciencedirect.com/science/article/abs/pii/S1878614615002056>
- **Check out the photograph.** Now everything makes sense. A **mite** transfers the virus to the fungus of an infected tree. Then the tree heals.
  - **The mite is the vector.**

*Hypoviridae. Family: Hypoviridae. Chapter Version: ICTV Ninth Report; 2009 Taxonomy Release*

- Nuss, D.L. and Hillman, B.I.
- *International Committee on Taxonomy of Viruses ICTV*
- Just the year, **2009**.
- **There's a table with lots of virus names.**
- **There are photos at the top right** from an electron microscope of **vesicles** in the fungus.
- [https://ictv.global/report\\_9th/RNApos/Hypoviridae](https://ictv.global/report_9th/RNApos/Hypoviridae)

*Mycovirus Cryphonectria Hypovirus 1 Elements Cofractionate with trans-Golgi Network Membranes of the Fungal Host Cryphonectria parasitica*

- **Journal of Virology. July 2006.**
- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1488963/>
- Debora Jacob-Wilk,\* Massimo Turina,† and Neal K. Van Alfen
- Department of Plant Pathology, College of Agricultural and Environmental Science, One Shields Avenue, University of California, Davis, Davis, California 95616
- †Present address: Istituto di Virologia Vegetale, CNR Torino, Strada delle Cacce 73, 10135 Torino, Italy.
- **The upshot of this rather technical article is that the virus replicates in the 'Golgi network' of the fungus.** See page **##92** for details on the Golgi apparatus.

**Page 95 – Rembrandt Tulip-Breaking Virus**

No, I didn't trace the flower. I lovingly and painstakingly drew it.

## Leaf anatomy

### The Leaf

- **John W. Kimball.**
- **Kimball's Biology Pages**
- **25 January 2012**
- <https://www.biology-pages.info/L/Leaf.html>
- <https://www.biology-pages.info>
  - John W. Kimball has retired from a lifetime of teaching biology. A graduate of Harvard College, he began his teaching career at the secondary level, teaching chemistry and biology to students at Phillips Academy, an independent school in Andover, Massachusetts. In 1969, he returned to Harvard to study immunology with the late Professor A. M. Pappenheimer. After receiving his Ph.D. there, he went on to teach introductory biology (in both majors and nonmajors courses) and immunology at Tufts University where he became a tenured professor. In 1982 he returned again to Harvard where he taught immunology and also participated in teaching the introductory course for majors.
- **There is a diagram of the layers of a leaf in cross-section.**

## Flower colors

### The Color of Rhododendron Flowers

- **Benjamin Pecherer**
- **Journal American Rhododendron Society (JARS): JARS v46n4 (Volume 46 number 4). Fall 1992**
- **Virginia Tech University Libraries**
- **This is a summary of the chemistry of flower colors.**
- <https://scholar.lib.vt.edu/ejournals/JARS/v46n4/v46n4-pecherer.htm>
- Verbatim
- **Pure White Flowers:**
  - These contain no anthocyanins; their color is due to the air-filled lacunae, i.e., empty cells. The two yellow flavanols, kampferol galactoside and myricetin-5-methyl ether are present in small amounts. Earlier reports that other pigments are present are due to the inclusion of the blotch and spot colors. For example: *R.* 'Sappho', *R.* 'Jacksonii', *R. taronense*, *R. catawbiense*.  
**Yellow Flowers:** In this group the colors range from yellow green to the deep lemon yellow, and this is due to the varying ratio of the pigment gossypetin/chloroplast. A few other flavanols dihydroquercetin, myricetin, and quercetin as glycosides are present. In the pale greenish-yellow *R. ambiguum* and the yellow *R. lutescens*, the presence of gossypetin is difficult to establish. It is believed that the chloroplasts and the breakdown products are the main causes of the color of these two species.
- **Orange Flowers:**
  - Gossypetin as the 3-rhamnoside is the most frequently occurring pigment. Note that in the yellow group, gossypetin 3-galactoside was the principal component. Carotenoids are encountered for the first

time. As the color deepens the ratio of carotenoid to chlorophyll increases; additionally the ratio of chromoplasts to chloroplasts increases, indicative of a change from green to yellow. It is not certain whether any anthocyanins are present to contribute to the flower color. In the range yellow to orange violet blotches or throat color are never observed, with the exception of *R. 'Sonata'*, *R. dichroanthum* x *R. 'Purple Splendour'*.

- **Pink, Red, Lavender and Purple Flowers:**

- Anthocyanins are responsible for the colors in this group. In but one case, have chloroplasts been found together with the anthocyanins. This combination gives the very dark red-brown or red-black of *R. sanguineum*. Usually it is the chromoplasts that are encountered with the anthocyanins, and depending on their concentration in the epidermal cells, the color will vary from red-orange to pure deep red. The carotenoids that were plentiful in the orange colors are less so here. The main contributions to the color come from three cyanidin glycosides.
- The bluish reds contain small amounts of malvidin and delphinidin and small amounts of flavanols that contribute little to the color.
- In the lavender-purple group, the color is due to cyanidin, malvidin, and paeonidin in the form of their glycosides: chromoplasts are not seen, but the methyl ethers of flavanols are present. The role of carotenoids in this color group has not been clarified, but they must certainly be present. A further demonstration that heavy metals contribute to these colors is shown by in vitro experiments wherein yellow solutions of the flavanols are turned blue on addition of metal ions.
- **In summary**, the above results show that the flower color is the result of combinations of anthocyanins, flavanols, carotenoids, chloroplasts and chromoplasts. The subtle effects of cell acidity and the presence of heavy metals are likely but not precisely demonstrated. The information obtained in this research is of value from two points of view. Firstly, in some cases it confirms the classification of some species, and in others it requires a revision. Secondly, recent research has been able to determine the genes that are responsible for the production of certain pigments. In theory this would be expected to be a basis for plant breeding for specific color objectives. Unfortunately, this type of research is beyond the capabilities of rhododendron hybridizers, and they will have to depend on the old hit and miss methods.

## Tulip viruses

### *The Rembrandt Tulip Mixture*

- **Van Engelen, Inc. Wholesale Flower Bulbs.**
- No date. No author
- <https://www.vanengelen.com/flower-bulbs-index/tulips/single-late/the-rembrandt-tulip-mixture.html>
- Verbatim
- Reminiscent of 17th century Tulipmania varieties afflicted with tulip breaking (mosaic) virus, our *healthy* Rembrandt Tulip Mixture includes flamboyant Carnaval de Rio (white flamed red), Del Piero (white and lavender-pink), Flaming Flag (white and lavender), Grand Perfection (yellow

to ivory flamed red), Helmar, Marilyn and Olympic Flame. No one is allowed to grow the old sort of Rembrandt Tulips that were afflicted with tulip breaking virus any more. Tulip Classes: Giant Darwin Hybrid, Lily Flowering and Parrot. Bulb size: 12 cm/up. May. HZ: 3-8. Height: 18" to 20".

*Great Tulip Book: Semper Augustus.* Norton Simon Museum. No date. No author. No artist.

- <https://www.nortonsimon.org/art/detail/M.1974.08.030.D>
- This is the painting I drew.

*Anthocyanin.* Wikipedia.

- <https://en.wikipedia.org/wiki/Anthocyanin>
- Check out those vibrant purples.

*Characterization of Potyviruses from Tulip and Lily which Cause Flower-Breaking.*

- **Journal of General Virology. 1 May 1993.**
  - <https://www.microbiologyresearch.org/content/journal/jgv/10.1099/0022-1317-74-5-881>
- [Elise L. Dekker<sup>1</sup>, Antonius F. L. M. Derks<sup>2</sup>, Cees J. Asjes<sup>2</sup>, Miriam E. C. Lemmers<sup>2</sup>, John F. Bol<sup>1</sup>, Simon A. Langeveld<sup>1</sup>](#)
  - Affiliations:<sup>1</sup> [Department of Biochemistry, Leiden University, Gorlaeus Laboratories, Einsteinweg 5, 2333 CC Leiden](#)<sup>2</sup> [Bulb Research Centre, Vennestraat 22, PO Box 85, 2160 AB Lisse, The Netherlands](#)
- Summary
  - *Family Poty-viridae*
    - 5 viruses in family
      - *Lily Mottle Virus*
      - *Tulip-Breaking Virus (TBV)*
        - Synonyms
          - *Tulip Breaking Virus (TBV)*
          - *Tulip Break Virus*
          - *Lily Streak Virus*
          - *Lily Mosaic Virus*
      - *Tulip Top-Breaking Virus (TTBV)*
      - *Tulip Band-Breaking Virus*
      - *Rembrandt Tulip-Breaking Virus*
    - *Genus Potyvirus*
  - Verbatim
    - Five viruses causing colour-breaking of tulip flowers were isolated from tulips and lilies. Tulip-breaking virus (TBV), tulip top-breaking virus (TTBV), tulip band-breaking virus, Rembrandt tulip-breaking virus and lily mottle virus were all characterized as potyviruses by serology [What? Serology on a flower? Is that a thing?] and potyvirus-specific PCR. Sequence analysis of amplified DNA fragments spanning a conserved area of the coat protein cistron of potyviruses was performed in order to classify the isolates as distinct viruses or strains. It appears that all tulip-breaking viruses are distinct viruses and TTBV was found to be strain-related to turnip mosaic virus.

*TULIP BREAKING OR MOSAIC.* report on PLANT DISEASE. Department of Crop Sciences University of Illinois of Urbana-Champaign. September 1990. No author.

- <https://ipm.illinois.edu/diseases/rpds/634.pdf>
- Readable history of the fad of buying these streaked tulips.

### Plant Virus Diseases: Ornamental Plants

- J. Engelmann, J. Hamacher, in **Encyclopedia of Virology** (Third Edition), **2008**
- <https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/tulip-breaking-virus>
- Summary
  - Tulips originated in Central Asia.
  - There are 100 species of tulips.
  - There are 20 viruses of tulips.
  - The aphid is the vector for the Tulip Breaking Virus (TBV).
  - The color breaking is due to the accumulation of pigments in the upper epidermis.
- Verbatim
  - Virus Diseases of Liliaceae
  - Tulipa, Lilium
  - Taxonomically, Liliaceae are assigned to the order Liliiflorae of the monocotyledonous plants. We concentrate on virus diseases of the genera Tulipa and Lilium, as they represent large genera with economically very important ornamentals.
  - Tulips originated from Central Asia and include about 100 different species. Tulips are propagated via bulbs, which develop at the base of the bulb of the previous year.
  - More than 20 different viruses are reported to infect tulips, the most important of which are TBV, TNV, and TRV.
  - Tulip breaking virus (TBV) is the most frequently encountered virus in tulips. It is assigned to the genus Potyvirus and can be transmitted by aphids (e.g., Myzus persicae and Aphis fabae) in a nonpersistent manner. [What?] TBV affects color breaking of flowers particularly in late-flowering pink, purple, and red cultivars, while white- and yellow-flowered cultivars are not affected. Breaking symptoms have been described as bars, stripes, streaks, featherings, or flames of different colors on petals (Figure 58). The color variation is caused by local fading, intensification, or accumulation of pigments in the upper epidermal layer after development of the normal flower color. Mottling or striping of the leaves also occurs. The infection causes loss of vigor and poor flower production. TBV played an important role in the Dutch 'tulipomania' in the seventeenth century, in that it increased the value of tulips with decorative flower breaking and led to wild speculations with astronomical prices for one variegated tulip bulb. At that time, the undesirable viral cause of the spectacular flower breaking was not yet known.

### Transmission

- Aphid
  - Myzus persicae
    - Green peach aphid
    - 2 mm
    - Green peach aphid in turn killed by fungus Pandora neoaphidis
  - Verbatim
    - The virus binds inside their piercing mouthparts when the aphid feeds on an infected plant, and is released when a new plant is probed. <http://www.directtransmission.org/tulip-breaking-virus/>
      - Dead link, boo hoo.

### How Dangerous Is The Tulip Breaking Virus? Amsterdam Tulip Museum. 25 October 2017.

- <https://amsterdamtulipmuseumonline.com/blogs/tulip-facts/how-dangerous-is-the-tulip-breaking-virus>
  - [Amsterdam Tulip Museum - 1](#)

- 60% of world's tulips still come from Netherlands.
- 60% of Netherlands land devoted to agriculture. Not sure what % of that is tulips but I sense it's most of it.
- If broken tulip seen, it's immediately discarded so virus wont spread.

*Broken Tulips: The Beautiful Curse*. Amsterdam Tulip Museum. 5 December 2017

- <https://amsterdamtulipmuseumonline.com/blogs/tulip-facts/broken-tulips-the-beautiful-curse>

# Page 96 – Orsay virus – From France with Love

## Orsay virus

*Caenorhabditis elegans*. Wikipedia.

- [https://en.wikipedia.org/wiki/Caenorhabditis\\_elegans](https://en.wikipedia.org/wiki/Caenorhabditis_elegans)
- Summary
  - *C. elegans*, for short.
    - “See ella gans”
  - 1 mm long.
  - Feeds on bacteria.
  - The worm is naturally infected by Orsay virus which is distantly related to noda-viruses.
  - There is a video of it moving.

*Orsay virus*. Wikipedia.

- [https://en.wikipedia.org/wiki/Orsay\\_virus](https://en.wikipedia.org/wiki/Orsay_virus)
  - 2011 – Discovered in the *C. elegans* worm in a rotting apple in Orsay, France.
    - And also a rotting grape in Santeuil, France but not *C. elegans*, rather *C. briggsae*.

*Natural and Experimental Infection of Caenorhabditis Nematodes by Novel Viruses Related to Nodaviruses*

- This is ref. no. 3 in Wikipedia – Orsay virus
- **PLOS Biology**, 25 January 2011
  - Marie-Anne Felix, Institut Jacques Monod, Paris
  - et al
  - <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3026760/>
- Author info
  - Marie-Anne Félix, # 1, \* Alyson Ashe, # 2 Joséphine Piffaretti, # 1 Guang Wu, 3 Isabelle Nuez, 1 Tony Bélicard, 1 Yanfang Jiang, 3 Guoyan Zhao, 3 Carl J. Franz, 3 Leonard D. Goldstein, 2 Mabel Sanroman, 1 Eric A. Miska, 2, \* and David Wang 3, \*
  - Jonathan Hodgkin, Academic Editor
  - 1Institut Jacques Monod, CNRS-University of Paris-Diderot, Paris, France
  - 2Gurdon Institute, University of Cambridge, Cambridge, United Kingdom
  - 3Departments of Molecular Microbiology and Pathology & Immunology, Washington University in St. Louis School of Medicine, St. Louis, Missouri, United States of America
  - Oxford University, United Kingdom

- #Contributed equally.
- Verbatim
  - One representative, stably infected, strain of each nematode species, *C. elegans* JU1580 (isolated from a rotting apple in Orsay, France) and *C. briggsae* JU1264 (isolated from a snail on a rotting grape in Santeuil, France), were selected for detailed analysis.
  - we identified two novel RNA viruses distantly related to known nodaviruses, one infecting specifically *C. elegans* (Orsay virus), the other *C. briggsae* (Santeuil virus).
  - The intestinal apical border [of the worm] showed extensive convolutions and intermediate filament disorganization.
- **Figure 2 H = yellow arrowheads = putative viral particles**
  - On the right of (H) is shown a higher magnification of the intestinal lumen, showing putative viral particles (arrowheads).
    - FYI, the **lumen** is the hollow interior of the gut.

## Feline Distemper virus

### *Feline Panleukopenia virus*

- [https://en.wikipedia.org/wiki/Feline\\_panleukopenia](https://en.wikipedia.org/wiki/Feline_panleukopenia)

*Feline Panleukopenia (Feline Infectious Enteritis, Feline Parvoviral Enteritis)*. Merck Manual – Veterinary Manual.

- <https://www.merckvetmanual.com/generalized-conditions/feline-panleukopenia/overview-of-feline-panleukopenia#v3276621>
- Last full review/revision **Aug 2020** | Content last modified **Oct 2022**
- **Richard A. Squires DVM, PhD**, DACVIM-SAIM, DECVIM-CA, Veterinary Science, College of Public Health, Medical and Veterinary Sciences, [James Cook University](#)

### *Distemper (Panleukopenia) in Cats.*

- [VeterinaryPartner](#) website.
- Date Published: 04/18/2005. Date Reviewed/Revised: 05/12/2022
- **18 April 2005**. Revised **12 May 2022**.
- **Wendy Brooks DVM**
- <https://veterinarypartner.vin.com/default.aspx?pid=19239&id=4952250>

### Summary of above sources

- Names
  - *Feline distemper virus*
    - Out of favor.
  - *Feline Panleukopenia virus (FPV)*
  - *Feline Infectious Enteritis Virus (FIE)*
- Closely related to:
  - *Canine ParvoVirus (CPV) Type 2*
  - *Mink Enteritis Virus*
- Microbio
  - Env ss DNA
- Who does it infect?
  - **Cats**
    - Mostly it infects cats.
    - Basically, affects kittens.
  - **Racoons**



- Tx
  - Shed in all bodily secretions
  - Can be found in feces for 6/52 after recovery
  - Can be transported long distance by fomites such as:
    - Human shoes
    - Human clothing
- Pathophys
  - Destroys cells in bone marrow
  - Cerebellum, retina
    - In very young cats
    - FPV-induced Cerebellar Ataxia, think wobbly kitten
- SS
  - Cats usually < 1y.
  - 40 – 41.7 deg C
  - Anorexia → vomiting +/- diarrhea → sits by water dish but won't drink → extreme dehydration
  - Septic Shock
  - DIC
- Dx
  - Fecal ELISA
- Rx
  - Vigorous fluid therapy
- Proph
  - 1 bleach : 32 water kills in 10 min on surfaces
  - FPV vaccine a.k.a. Feline Distemper Vaccine

## Rabies virus

See pages 100 – 110.

## Chronic bee paralysis virus

*Chronic bee paralysis: A disease and a virus like no other?*

- **Journal of Invertebrate Pathology**
- **11 November 2009**
- <http://www.ask-force.org/web/Bees/Ribiere-Chronic-Bee-Paralysis-2010.pdf>
- **Magali Ribière** a,\*, **Violaine Olivier** b, **Philippe Blanchard** a
- <sup>a</sup> **French Food Safety Agency (AFSSA), Bee Disease Unit**, Les Templiers, Route des Chappes, BP 111, 06902 Sophia-Antipolis, France
- <sup>b</sup> UMR PISC 1272, Route de Saint-Cyr, 78026 Versailles, France<sup>1</sup>
- Verbatim
  - Chronic bee paralysis which was called Paralysis is a rather unusual disease caused by a rather unusual virus. In this review, we explore current knowledge of the disease and its etiological agent. Paralysis is the only common viral disease of adult bees whose symptoms include both behavioural and physiological modifications: trembling and hair loss. The disease often affects the strong colonies of an apiary and thousands of dead individuals are then observed in front of the

hives. Two sets of symptoms have traditionally been described in the existing literature, but nowadays we can define a general syndrome.

#### Spread of Infectious Chronic Bee Paralysis Virus by Honeybee (*Apis mellifera* L.) Feces

- *Apis mellifera* is the Western honey bee.
- Experimentally infected bees → Bee feces can transmit the virus.
- **Applied and Environmental Microbiology. 1 December 2007.**
  - <https://aem.asm.org/content/73/23/7711>
- **Authors:** [M. Ribière](#) [P. Lallemand](#), [A.-L. Iscache](#), [F. Schurr](#), [O. Celle](#), [P. Blanchard](#), [V. Olivier](#), [J.-P. Faucon](#)

#### Chronic Bee Paralysis Virus in Honeybee Queens: Evaluating Susceptibility and Infection Routes

- **Viruses. March 2014**
- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3970145/>
- Authors
  - [Esmaeil Amiri](#),<sup>1</sup> [Marina Meixner](#),<sup>2</sup> [Ralph B uchler](#),<sup>2</sup> and [Per Kryger](#)<sup>1,\*</sup>
  - <sup>1</sup>Department of Agroecology, Aarhus University, 4200 Slagelse, Denmark
  - <sup>2</sup>LLH Bieneninstitut Kirchhain, Erlenstr. 9, 35274 Kirchhain, Germany;

#### CHRONIC BEE PARALYSIS VIRUS (CBPV)

- **Bee Culture – The Magazine of American Beekeeping. 24 May 2017.**
- <https://www.beekeeping.com/chronic-bee-paralysis-virus-cbpv/>
- **Don Coats**
- This article is kind of like a differential diagnosis of weakness in bees:
  - *Chronic Bee Paralysis Virus*
  - *Varroa mites*
    - *Varroa mites* weaken bees. But not part of transmission of virus.

*Chronic bee paralysis virus*. Wikipedia.

- [https://en.wikipedia.org/wiki/Chronic\\_bee\\_paralysis\\_virus](https://en.wikipedia.org/wiki/Chronic_bee_paralysis_virus)

*Western honey bee*. Wikipedia.

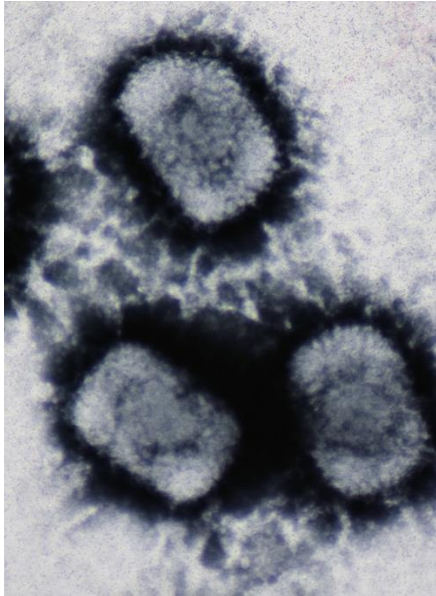
- [https://en.wikipedia.org/wiki/Western\\_honey\\_bee](https://en.wikipedia.org/wiki/Western_honey_bee)

#### Summary - Chronic Bee Paralytic Virus (CBPV)

- *Apis mellifera* a.k.a. Western honey bee
  - General
    - It makes honey.
  - Who is affected?
    - Affects worker honey bees.
      - Viral load
        - $10^{11}$  virus/distended honey sac.
        - $10^{12}$  virus per bee after 5 days of experimentally infected bees
        - $10^{12} - 10^{13}$  virus per bee of naturally infected bees
          - So  $10^{12} = 1$  trillion is a good, safe estimate.
        - $10^{13}$  virus per bee in symptomatic dead bees
        - 'Viral load' is the term used.
        - (J Invert Path – link at bottom)
    - Not the queen, except experimentally (below)

- Experiment
  - $10^{11}$  viruses per queen bee head.
  - Transmission is via trophallaxis
    - = mouth-to-mouth feeding
    - = anus-to-mouth feeding
- Experiment
  - Experimentally infected bees → Bee feces can transmit the virus.
    - *Spread of Infectious Chronic Bee Paralysis Virus by Honeybee (Apis mellifera L.) Feces*
      - **Applied and Environmental Microbiology. 1 December 2007.**
        - <https://aem.asm.org/content/73/23/7711>
      - Authors: [M. Ribière](#), [P. Lallemand](#), [A.-L. Iscache](#), [F. Schurr](#), [O. Celle](#), [P. Blanchard](#), [V. Olivier](#), [J.-P. Faucon](#)
      - *Apis mellifera* is the Western honey bee.
- SS
  - Trembling
  - Crawling
  - Dec flying ability
  - Hair loss
    - *Chronic bee paralysis: A disease and a virus like no other?*
      - <https://pubmed.ncbi.nlm.nih.gov/19909978/>
  - Belly distended with honey.
  - 1000's of dead/crawling bees in front of hive.
- RF
  - *Varroa mites* weaken bees. But not part of Tx.
    - **CHRONIC BEE PARALYSIS VIRUS (CBPV)**
      - **Bee Culture – The Magazine of American Beekeeping. 24 May 2017.**
      - **Don Coats**
      - This article is kind of like a DDX of weakness in bees:
        - *Chronic Bee Paralysis Virus*
        - *Varroa mites*
      - <https://www.beeculture.com/chronic-bee-paralysis-virus-cbpv/>
- Virus
  - ss RNA
  - anisometric
  - Genome
    - Has been sequenced.

Cowpox virus



### Cowpox virus

- That's a photo of 3 cowpox viruses taken by an electron microscope.
- <https://en.wikipedia.org/wiki/Cowpox>

### Cowpox virus

- Gruesome photo.
- Those are cowpox lesions on the arm.
- Caption on webpage: Cowpox lesions on patient's forearm on day 7 after onset of illness. The hemagglutinin gene of the isolate clustered with a Russian cowpox virus strain, and the more distantly, with other cowpox and vaccinia virus strains. The patient's dog had orthopoxvirus-specific antibodies, indicating a possible transmission route.
- Details: Figure 1. Cowpox lesions on patient's forearm on day 7 after onset of illness. A 4-year-old girl from a small farm in eastern Finland was hospitalized in September 2000 because of umbilicated vesicopapules, which developed over the previous 5 days
- <https://en.wikipedia.org/wiki/Cowpox>

### Dairy cattle. Wikipedia.

- [https://en.wikipedia.org/wiki/Dairy\\_cattle](https://en.wikipedia.org/wiki/Dairy_cattle)
- That was the source of my drawing.

### Cowpox in Cattle. Merck Manual – Veterinary Manual.

- Last full review/revision **Feb 2021** | Content last modified **Oct 2022**
- <https://www.merckvetmanual.com/integumentary-system/pox-diseases/cowpox?query=cowpox>
- Paul Gibbs BVSc, PhD, FRCVS, Department of Infectious Diseases and Immunology, College of Veterinary Medicine, University of Florida

### Cowpox Virus Infections in Cats and Other Species. Merck Manual – Veterinary Manual.

- Last full review/revision **Feb 2021** | Content last modified **Oct 2022**

- <https://www.merckvetmanual.com/integumentary-system/pox-diseases/cowpox-virus-infections-in-cats-and-other-species?query=cowpox>
- Paul Gibbs BVSc, PhD, FRCVS, Department of Infectious Diseases and Immunology, College of Veterinary Medicine, University of Florida

**MAMMARY GLAND | Anatomy.** In book: *Encyclopedia of Dairy Sciences* (pp.328-337). December 2011

- [https://www.researchgate.net/publication/291068331\\_MAMMARY\\_GLAND\\_Anatomy](https://www.researchgate.net/publication/291068331_MAMMARY_GLAND_Anatomy)
  - Can DL the pdf from here.
- Stephen C Nickerson – University of Georgia.
- Robert Michael Akers - Virginia Polytechnic Institute and State University

# Page 97 – Special Guest Appearance: JASTU'S Dragonfly

## Stigma

*The pterostigma of insect wings an inertial regulator of wing pitch.* March 1972.

- *Journal of Comparative Physiology A.* 81 (1): 9–22. doi:10.1007/BF00693547.
- Norberg, R. Åke Department of Zoology, University of Göteborg, Göteborg, Sweden
- <https://link.springer.com/article/10.1007/BF00693547>

### Pterostigma

- Wikipedia. <https://en.wikipedia.org/wiki/Pterostigma>
- Semantics
  - Ptero-stigma = singular
  - Ptero-stigmata = plural
- Fcn:
  - Assists in gliding. If there is flutter you cannot glide. It adds weight to the outer wing.
  - Reduces flutter.
    - This is the flutter source.
    - Ref no. 2 in Wik - Pterostigmata
- Verbatim
  - The purpose of the pterostigma, being a heavier section of the wing in comparison to nearby sections, is to assist in gliding. Without the pterostigmata, self-exciting vibrations known as flutter would set in on the wing after a certain critical speed, making gliding impossible. Tests show that with the pterostigmata, the critical gliding speed is increased 10–25% on one species of dragonfly.<sup>[2]</sup>
  - The pterostigma (plural: pterostigmata) is a group of specialized cells in the outer wings of insects, which are often thickened or coloured, and thus

stand out from other cells. It is particularly noticeable in dragonflies, but present also in other insect groups, such as snakeflies, hymenopterans, and megalopterans.[1]

### Religious stigmata

- Etym - stigma
  - Verbatim – **Wik stigmata**
    - **Stigmata** (Ancient Greek: στίγματα, plural of στίγμα *stigma*, 'mark, spot, brand'), in Christianity, are the appearance of bodily wounds, scars and pain in locations corresponding to the crucifixion wounds of Jesus Christ, such as the hands, wrists, and feet.[1]
    - <https://www.britannica.com/topic/stigmata>
      - Britannica is actually ref no. 1 in Wik – stigmata
      - 1<sup>st</sup> sentence in Wik -stigmata is close to verbatim from Britannica.
      - But Britannica does not give the Greek spelling which is why Wikipedia is a consistent winner for thoroughness and or extra bits.
    - <https://en.wikipedia.org/wiki/Stigmata>
  - Verbatim – **Online Etym**
    - stigma (n.)
    - 1590s (earlier *stigma*, c. 1400), "mark made on skin by burning with a hot iron," from Latin *stigma* (plural *stigmata*), from Greek *stigma* (genitive *stigmatos*) "mark of a pointed instrument, puncture, tattoo-mark, brand," from root of *stizein* "to mark, tattoo," from PIE root *\*steig-* "to stick; pointed" (see **stick** (v.)).
    - [https://www.etymonline.com/word/stigma#etymonline\\_v\\_22082](https://www.etymonline.com/word/stigma#etymonline_v_22082)
- Who had stigmata?
  - **St Francis of Assisi**
  - **St. Catherine**
  - **Padre Pio**
    - Some critic who examined him thought it was chemical burns on the hands with the exact same appearance as soldiers with self-inflicted wounds.

## Anatomy and Life cycle of the dragonfly

### External Anatomy

- **ARIZONA DRAGONFLIES** (it's a website)
- **Pierre Deviche**. No date.
- <http://azdragonfly.org/external-anatomy>
- **Abdomen has 10 segments.**
  - **S1 segment** is big.
  - **The rear wings** seem to attach just slightly proximal to the **S1 segment** of the abdomen.

### Dragonfly

- Taxonomy
  - Phylum **Arthropoda**: Class **Insecta**: Order **Odonata**: Infraorder **An-iso-ptera** (not-same-wings)
  - 5900 spp. Way more than I figured.
  - Odonata semantics
    - Verbatim

- **Odonata** is an order of flying insects that includes the dragonflies and damselflies. Like most other flying insects (flies, beetles, Lepidoptera, and Hymenoptera), they evolved in the early Mesozoic era.[1] Their prototypes, the giant dragonflies of the Carboniferous, 325 MYA, are no longer placed in the Odonata but included in the Protodonata or Meganisoptera.
  - Etym odonata
  - Fabricius apparently coined the term *Odonata* from the Ancient Greek *ὀδών* *odón* (Ionic form of *ὀδοῦς* *odoús*) 'tooth' because they have teeth on their mandibles, even though most insects also have toothed mandibles.[3]
  - The word *dragonfly* usually refers to only Anisoptera, but is also sometimes used to refer to all Odonata[4] Odonata enthusiasts avoid ambiguity by using the term *true dragonfly*, [5] or simply *anisopteran*, [6] when referring to just the Anisoptera. The term *warriorfly* has also been proposed.[7] Some 5,900 species have been described in this order.[8]
  - <https://en.wikipedia.org/wiki/Odonata>
- Of note
  - **Dragonfly** is not the same as **damselfly**.
  - Verbatim
    - Dragonflies and damselflies are confused very much as some believe that the damselflies are small dragonflies which grow later on to the bigger size but this is not true as after metamorphosis the dragonflies are fully grown. There are differences between the two insects. Damselflies *hold* their wings while at rest but the dragonflies keep their wings in a *perpendicular* direction while at rest. Hind wing of dragonfly is somewhat broader than the fore wing while in the damselflies both fore and hind wings are similar in shape and size. The eyes in damselflies are apart while in dragonflies the eyes touch each other.
    - Ojai Valley Land Conservancy, Ojai, California
    - <https://ovlc.org/dragonflies-and-damselflies/>
- Body
  - Head
  - Prothorax
  - Thorax
    - 6 legs
  - Abdomen
    - 10 segments
- Physical characteristics
  - wings
    - 2 pairs, *unequal*
      - **An-iso-ptera**
      - **Not-same-wing**
    - strong
    - transparent
    - 6 legs but walk poorly
  - Flight
    - turn **180°** in one body length
    - fly **backwards**
    - hover one minute

- 100 body lengths / sec in  *fwd* flight
- 3 body lengths / sec in  *bkwd* flight
- Avg 10 mph
- Max 34 mph
  - More than 34 mph disputed.
- Life cycle
  - N
    - Egg → larva → pupa (think, chrysalis) → adult
  - Dragonfly
    - Egg → nymph (it's neither pupa nor larva) → adult (imago)
    - Details below,
  - Details
    - **Egg**
      - Laid in plant tissues
      - Shaped like rice grain
      - Size?
      - 1500 eggs in a 'clutch'
    - **Nymph (naiad)**
      - A nymph is NOT a larva. That's apparently because the nymph already resembles the adult.
      - Water stage.
        - Gills in rectum. Hmm.
      - Most of its life.
      - Molts 6 - 15 x, depending on spp.
      - Deadly lower mandible like the  *Alien*  a.k.a.  *mask* .
      - 2 mo – 3 y in small spp
      - 5y in large spp.
      - When it's time to become an adult, this happens:
        - Stops feeding → goes to surface at night → remains stationary with head out of water → adapts to air breathing. AMAZING. Just like a fetus. → climbs up on a reed → metamorphosis to adult → the nymph exoskeleton (exuvia) splits → adult emerges → hemolymph pumped into wings.
    - **Adult (imago)**
      - It's only 5 weeks on average.
  - Source for stages info
    - <https://en.wikipedia.org/wiki/Dragonfly>
- Predators
  - Nymph
    - Ducks
    - Herons
    - News
    - Frogs
    - Water spiders
  - Adult dragonfly
    - Birds
      - Falcons
        - American kestrel
        - Merlin
        - Hobby
        - Amur falcon migrate over Indian Ocean alongside the globe skimmer dragonfly and may eat them 'on the wing'. Wow.
      - Nighthawk
      - swift
      - flycatcher
      - swallows



- Insects
  - Wasps
- Verbatim
  - Although dragonflies are swift and agile fliers, some predators are fast enough to catch them. These include falcons such as the American kestrel, the merlin, and the hobby; nighthawk, swifts, flycatchers and swallows also take some adults; some species of wasps, too, prey on dragonflies, using them to provision their nests, laying an egg on each captured insect. In the water, various species of ducks and herons eat dragonfly larvae and they are also preyed on by newts, frogs, fish, and water spiders. **Amur falcons**, which migrate over the Indian Ocean at a period that coincides with the migration of the globe skimmer dragonfly, *Pantala flavescens*, may actually be feeding on them while on the wing.
  - **Ojai Valley Land Conservancy, Ojai, California**
    - <https://ovlc.org/dragonflies-and-damselflies/>

## Water mite



### Hydrachnidia

- Wikipedia. <https://en.wikipedia.org/wiki/Hydrachnidia>
- Summary
  - Photo
    - The photo is a water mite that infects the dragonfly nymph. You can totally **zoom in** on that image if you click on it.
  - Taxonomy
    - **Class Arachnida** includes **spiders, ticks, scorpions ... and mites.**
  - Weird synonyms with weird spelling
    - **Hydrachnidia**

- Note the weird spelling. It does NOT say, arachnid, even though it is Class Arachnida.
  - **Hydracarina**
- Where it lives
  - It is a parasite of the **dragonfly nymph** ... which makes total sense since it is a *water* mite and the nymph lives in *water*.

### DRAGONFLIES AND DAMSELFLIES – DRAGONFLIES (ANISOPTERA) AND DAMSELFLIES (ZYGOPTERA).

Ojai Valley Land Conservancy.

- No date, no author
- <https://ovlc.org/dragonflies-and-damselflies/>
- Summary
  - Ojai, California
  - Special thanks to **Blake Evernden** (6 years old) who colored the eyes of the water mite.
- Verbatim
  - Dragonflies are affected by three major groups of parasites: water mites, gregarine protozoa, and trematode flatworms (flukes).
  - Water mites, *Hydracarina*, can kill smaller dragonfly larvae, and may also be seen on adults.
    - Okay, fine, it also likes adult dragonflies.

Gregarina, think Amoeba



### Gregarinasina

- <https://en.wikipedia.org/wiki/Gregarinasina>
- The photo was apparently of a live specimen. Okey, dokey.

### Parasites, proteomics and performance: effects of gregarine gut parasites on dragonfly flight muscle composition and function

- **Journal of Experimental Biology, December 2007.**
- <https://pubmed.ncbi.nlm.nih.gov/18055619/>
- **Rudolf J Schilder <sup>1</sup>, James H Marden**
  - **1 Department of Biology**, 208 Mueller Lab, **Pennsylvania State University**, University Park, PA 16802, USA.
- Summary
  - Effects on dragonfly adult:
    - **Dec muscle power output.**
    - **Loss of lipid oxidation in flight mm.**
    - **Metabolic syndrome** similar to those in **mammals**. Hmmm.
  - Verbatim
    - In previous work, we found that dragonflies infected with gregarine gut parasites have reduced muscle power output, loss of lipid oxidation in their flight muscles, and a suite of symptoms similar to mammalian metabolic syndrome.

## Virus

### Dragonfly cyclovirus, a novel single-stranded DNA virus discovered in dragonflies (Odonata: Anisoptera). Kayrna Rosario *et al.* **Journal of General Virology**, 1 June 2011

- <https://www.microbiologyresearch.org/content/journal/jgv/10.1099/vir.0.030338-0>
- Source
  - **Journal of General Virology, 1 June 2011**
    - This is the full article.
      - **Kayrna Rosario *et al.*** – College of Marine Science, Univ South Florida, St. Petersburg FL
  - **Kayrna Rosario<sup>1</sup>, Milen Marinov<sup>2</sup>, Daisy Stainton<sup>2</sup>, Simona Kraberger<sup>2</sup>, Elizabeth J. Wiltshire<sup>2</sup>, David A. Collings<sup>2,3</sup>, Matthew Walters<sup>2</sup>, Darren P. Martin<sup>4</sup>, Mya Breitbart<sup>1</sup>, Arvind Varsani<sup>2,3,5</sup>**
    - Affiliations:<sup>1</sup> [College of Marine Science, University of South Florida, St Petersburg, FL 33701, USA](#)<sup>2</sup> [School of Biological Sciences, University of Canterbury, Ilam, Christchurch 8140, New Zealand](#)<sup>3</sup> [Biomolecular Interaction Centre, University of Canterbury, Ilam, Christchurch 8140, New Zealand](#)<sup>4</sup> [Institute of Infectious Disease and Molecular Medicine, University of Cape Town, Observatory 7925, Cape Town, South Africa](#)<sup>5</sup> [Electron Microscope Unit, University of Cape Town, Rondebosch 7701, Cape Town, South Africa](#)
- **Dragonfly cyclovirus (DfCyV)**
  - **ssDNA**
  - **1741 bp**
    - **Genome** has 48-63% similarity to **human Cyclovirus**.
  - Effect on dragonfly
    - **Genome study** was done in **Tonga!**
    - **Virus** isolated from **dragonfly abdomen** but unclear if native to dragonflies or if it tx from **insect prey** it eats.
    - **Pathologic effect on dragonfly is unknown.**

- Verbatim – abstract
  - Dragonfly cyclovirus (DfCyV), a new species of ssDNA virus discovered using viral metagenomics in dragonflies (family Libellulidae) from the Kingdom of Tonga. Metagenomic sequences of DfCyV were similar to viruses of the recently proposed genus Cyclovirus within the family Circoviridae. Specific PCRs resulted in the recovery of 21 DfCyV genomes from three dragonfly species (*Pantala flavescens*, *Tholymis tillarga* and *Diplacodes bipunctata*). The 1741 nt DfCyV genomes share >95 % nucleotide identity and are classified into 11 subtypes representing a single strain. The DfCyV genomes share 48-63 % genome-wide nucleotide identity with cycloviruses identified in human faecal samples. Recombination analysis revealed three recombinant DfCyV genomes, suggesting that recombination plays an important role in cyclovirus evolution. To our knowledge, this is the first report of a circular ssDNA virus identified in insects, and the data may help elucidate evolutionary links among novel Circoviridae recently identified in animals and environmental samples.
- Verbatim - text
  - Since DfCyV was isolated from dragonfly abdomens that contain the gut and other tissues, the primary host for DfCyV remains unconfirmed. One possibility is that DfCyV infects an insect upon which dragonflies prey. Dragonflies are top predators that feed on many types of insect. Although their diet includes other Odonata species (even conspecific), they usually prey on much smaller insects that are easily chewed in flight (Corbet & Brooks 2008). If the virus originates from the dragonflies' food source, then the prey insect must be widespread in the Kingdom of Tonga. Since dragonflies are not known to have feeding preferences for particular prey species, it is unlikely that identical DfCyV genotypes would be detected in several dragonflies if DfCyV infects their prey. Future studies need to investigate the presence of cycloviruses in other insect species to rule out a dietary source for DfCyV and to confirm that dragonflies are the primary host for this virus.
  - Little is known regarding the potential impact of viral infections on dragonfly populations.

#### Cyclovirus. ViralZone.

- No date, no author
- <https://viralzone.expasy.org/7296>
- 1790 bp
- ssDNA
- Nice image of virus structure.

## Worm

#### When Parasites Invade: A Need for Hosts.

- Nice diagram of the life cycle of the worm.
- Parasite Ecology

- 18 February 2013. No author.
- Their source is **Tim Goater PhD** (page 97 of bibliography, the 2<sup>nd</sup> last source on bullfrogs).
- <https://parasiteecology.wordpress.com/tag/dragonfly/>

- **Trematode Flatworms**

- **Summary**
  - **Cercaria** infects **nymph**
  - **Meta-cercariae** infects **adult dragonfly**.
- **Haematoloechus longiplexus**
  - It's a (**frog**) **lung fluke** that infects the **bullfrog**.
  - This was on **Vancouver Island**. Hmm.
  - Infects the **nymph** and **adult**. Hmm.
  - <https://parasiteecology.wordpress.com/tag/dragonfly/>
- **Life cycle**
  - **Adult worms** in **frog lungs** → **eggs** in **frog saliva/eces** → eggs eaten by **snail (1<sup>st</sup> int. host)** → asexual reproduction → **cercariae** → cercariae infect **dragonfly nymph (2<sup>nd</sup> int. host)** → cercariae *en-cyst* to become → **meta-cercariae** in nymph → meta-cercariae remain in **adult dragonfly** (also the 2<sup>nd</sup> int. host) → dragonfly eaten by **frog** → meta-cercariae *ex-cyst* in frog guts → **immature adult worms** → immature adults go from frog gut to frog lungs → **adult worms** (frog is now the **definitive host**).



*Introduced Bullfrogs and Their Parasites: Haematolechus longiplexus (Trematoda) Exploits Diverse Damselfly Intermediate Hosts on Vancouver Island*

- **The Journal of Parasitology. 1 February 2013.**
- **Colin W. Novak** - Biology Department, Vancouver Island University, Nanaimo, British Columbia, Canada V9R 5S5.
- **Timothy M. Goater** - Biology Department, Vancouver Island University, Nanaimo, British Columbia, Canada V9R 5S5.
- <https://meridian.allenpress.com/journal-of-parasitology/article-abstract/99/1/59/7073/Introduced-Bullfrogs-and-Their-Parasites?redirectedFrom=fulltext>

*DRAGONFLIES AND DAMSELFLIES – DRAGONFLIES (ANISOPTERA) AND DAMSELFLIES (ZYGOPTERA).*  
Ojai Valley Land Conservancy.

- No date, no author
- <https://ovlc.org/dragonflies-and-damselflies/>
- Summary
  - I also mentioned this article with the water mites above.
- Verbatim
  - Dragonflies are affected by three major groups of parasites: water mites, gregarine protozoa, and trematode flatworms (flukes).

- Trematodes are parasites of vertebrates such as frogs, with complex lifecycles often involving a period as a stage called a cercaria in a secondary host, a snail. Dragonfly nymphs may swallow cercariae, or these may tunnel through a nymph's body wall; they then enter the gut and form a cyst or metacercaria, which remains in the nymph for the whole of its development. If the nymph is eaten by a frog, the amphibian becomes infected by the adult or fluke stage of the trematode.
  - **Ojai Valley Land Conservancy, Ojai, California**
    - <https://ovlc.org/dragonflies-and-damselflies/>

## Page 98 – 20 (twenty) viruses of humans

They are in alphabetical order.

### Chickenpox virus

#### Varicella

- Remember the word viremia?
- Verbatim
  - VZV enters the host through the respiratory tract and conjunctiva. It replicates at the site of entry in the nasopharynx and in regional lymph nodes. A primary **viremia** occurs 4 to 6 days after infection and disseminates the virus to other organs, such as the liver, spleen, and sensory ganglia. Further replication occurs in the viscera, followed by a secondary viremia, with viral infection of the skin. Virus can be cultured from mononuclear cells of an infected person from 5 days before to 1 to 2 days after the appearance of the rash.
- <https://www.cdc.gov/vaccines/pubs/pinkbook/varicella.html#:~:text=A%20primary%20viremia%20occurs%204,viral%20infection%20of%20the%20skin.>

*Chickenpox (Varicella) – Transmission.* CDC. 28 April 2021.

- <https://www.cdc.gov/chickenpox/about/transmission.html>

### Cowpox virus

See page 96.

### Coxsackie virus

*Myocarditis.* Mayo Clinic Staff. Mayo Clinic.

- <https://www.mayoclinic.org/diseases-conditions/myocarditis/symptoms-causes/syc-20352539>

### Diagnosis and Treatment of Viral Myocarditis.

- [Jason C. Schultz, MD](#)
- [Anthony A. Hilliard, MD](#)
- [Leslie T. Cooper Jr, MD](#)
- [Charanjit S. Rihal, MD](#)
- **Mayo Clinic Proceedings. 1 November 2009.**
- [https://www.mayoclinicproceedings.org/article/S0025-6196\(11\)60670-8/fulltext#relatedArticles](https://www.mayoclinicproceedings.org/article/S0025-6196(11)60670-8/fulltext#relatedArticles)
- **Figure 4** shows white blood cells in the heart, attacking the invader, which could be the coxsackie virus.
  - “**Lym-po-cytic infiltration**” means lympho-cytes are infiltrating the heart.
  - They are a type of White Blood Cell (WBC) whose job in life is to fight viruses.

## Ebola virus

See page 18.

## Epstein-Bar virus (“Mono”)

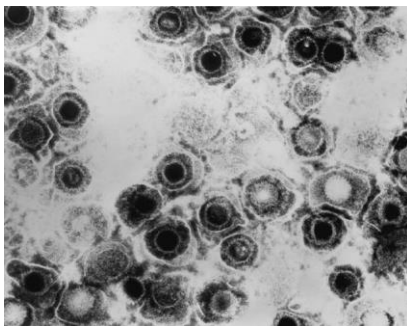
*About Epstein-Barr Virus (EBV).* CDC. 28 September 2020.

- <https://www.cdc.gov/epstein-barr/about-ebv.html>

*monocyte.* National Cancer Institute (NCI).

- No date no author
- <https://www.cancer.gov/publications/dictionaries/cancer-terms/def/monocyte>

## Herpes Simplex Virus (HSV)



*Herpes simplex virus.* Wikipedia.

- [https://en.wikipedia.org/wiki/Herpes\\_simplex\\_virus](https://en.wikipedia.org/wiki/Herpes_simplex_virus)
- There about 30 round-shaped *Herpes Simplex Viruses* (HSV) in that photo from an electron microscope.



*Herpes simplex virus*. World Health Organization (WHO). 10 March 2022.

- <https://www.who.int/news-room/fact-sheets/detail/herpes-simplex-virus>
- Nice layout of the information of HSV-1 versus HSV-2.

## Hepatitis virus

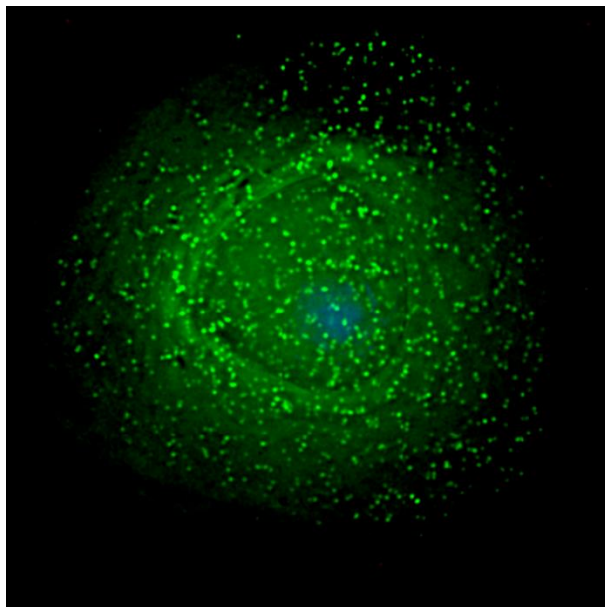
*Hepatitis*. World Health Organization (WHO). 1 September 2019.

- <https://www.who.int/news-room/questions-and-answers/item/hepatitis>
- Basic explanation of Hepatitis A B C D E.

*Viral Hepatitis*. CDC. 28 July 2020.

- <https://www.cdc.gov/hepatitis/abc/index.htm>
- More detailed explanation of Hepatitis A B C D E.

## HIV / AIDS virus



*HIV*

- Photo is a single **macrophage** being positively swarmed by *HIV virus* (green dots).
- <https://en.wikipedia.org/wiki/HIV>

*HIV*. CDC. 30 June 2022.

- <https://www.cdc.gov/hiv/basics/whatishiv.html>

## Measles, Mumps, Rubella (MMR) viruses

### Background

- What are 3 skin rashes of childhood caused by a virus?
  - **Measles**
  - **Mumps** a.k.a. **Rubeola** (“roo bee oh la”)
  - **Rubella** (“roo bell ah”) a.k.a. **German Measles**
- Each is caused by a different virus.
- There is a single vaccine to treat all of them, called **MMR**.

*Measles, Mumps, and Rubella (MMR) Vaccination: What Everyone Should Know.* CDC. 26 January 2021.

- <https://www.cdc.gov/vaccines/vpd/mmr/public/index.html>

## Measles virus



### Measles.

- <https://en.wikipedia.org/wiki/Measles>

*Transmission of Measles.* CDC. 5 November 2020.

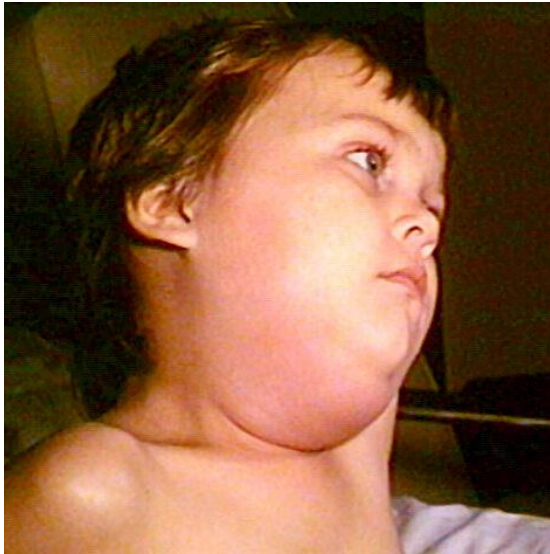
- <https://www.cdc.gov/measles/transmission.html>

### Measles

- **Figure 23.1: images a, b.** **Gruesome photos.**
  - Let there be no doubt that failure to vaccinate against the measles virus can be catastrophic to the brain of a child.
  - This is called **Sub-Acute Sclerosing Pan-Encephalitis (SSPE)**.
- Radiology of Infectious Diseases: Volume 1 pp 515–540. 2015.

- [Shi Qi,](#)
- [CuiYu Jia &](#)
- [Yue Yin](#)
- [https://link.springer.com/chapter/10.1007/978-94-017-9882-2\\_23](https://link.springer.com/chapter/10.1007/978-94-017-9882-2_23)

## Mumps virus



### Mumps

- That is swelling of the **parotid gland** (“par aw tid”) due to the **mumps virus**.
- The parotid gland makes saliva. It’s in your cheek.
- <https://en.wikipedia.org/wiki/Mumps>

*Transmission of Mumps.* CDC. 8 March 2021.

- <https://www.cdc.gov/mumps/about/transmission.html>

## Rubella virus



### Rubella

- <https://en.wikipedia.org/wiki/Rubella>

*Rubella (German Measles, Three-Day Measles) – Transmission.* CDC. 31 December 2020.

- <https://www.cdc.gov/rubella/about/transmission.html>

*Chapter 15: Congenital Rubella Syndrome.* CDC. [Manual for the Surveillance of Vaccine-Preventable Diseases](#). 28 April 2020.

- <https://www.cdc.gov/vaccines/pubs/surv-manual/chpt15-crs.html>
- Authors: Tatiana Lanzieri, MD; Susan Redd; Emily Abernathy, MS; Joseph Icenogle, PhD

*Congenital rubella syndrome.* Wikipedia.

- [https://en.wikipedia.org/wiki/Congenital\\_rubella\\_syndrome](https://en.wikipedia.org/wiki/Congenital_rubella_syndrome)

## Rhino virus

*Cold Versus Flu.* CDC. 29 September 2022.

- <https://www.cdc.gov/flu/symptoms/coldflu.htm>
- Verbatim
  - **What is the difference between a cold and flu?**
  - Influenza (flu) and the common cold are both contagious respiratory illnesses, but they are caused by different viruses. Flu is caused by influenza viruses only, whereas the common cold can be caused by a number of different viruses, including rhinoviruses, parainfluenza, and seasonal coronaviruses. Seasonal coronaviruses should not be confused with SARS-CoV-2, the virus that causes COVID-19. Because flu and the common cold have similar symptoms, it can be difficult to tell the difference between them based on symptoms alone. In general, flu is worse than the common cold, and symptoms are typically more intense and begin more abruptly. Colds are usually milder than flu. People with colds are more likely to have a runny or stuffy nose than people who have flu. Colds generally do not result in serious

health problems, such as pneumonia, bacterial infections, or hospitalizations. Flu can have serious associated complications.

## Smallpox virus

See page 21.

## Varicella Zoster Virus (VSV)

*Shingles (Herpes Zoster)*. CDC. 3 February 2022.

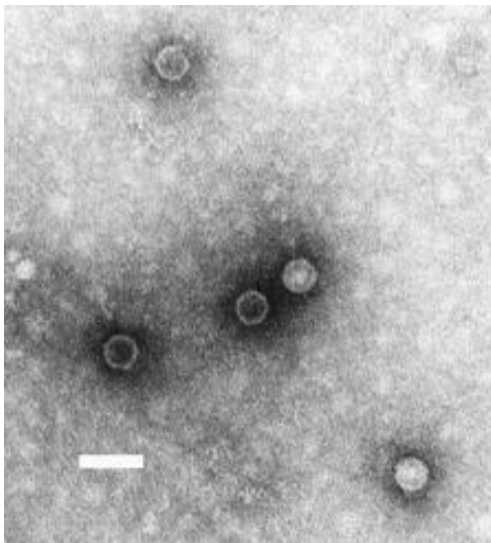
- o <https://www.cdc.gov/shingles/index.html>

## Yellow fever virus

See page 15.

# Page 99 – Polio virus

## Polio virus



*Poliovirus*

- o The **white scale bar** is 50 nm.
- o <https://en.wikipedia.org/wiki/Poliovirus>



*Polio*

- <https://en.wikipedia.org/wiki/Polio>
- This unfortunate chap has **Post-Polio Syndrome**. The muscle in the leg has atrophied due to the fact the spinal cord neurons that are supposed to excite it are dead. The muscle receives no nerve impulses to contract ... so it atrophies (basically shrinks in size).



Iron lung

- That's an iron lung.



A patient inside an iron lung.

- [https://en.wikipedia.org/wiki/Iron\\_lung](https://en.wikipedia.org/wiki/Iron_lung)

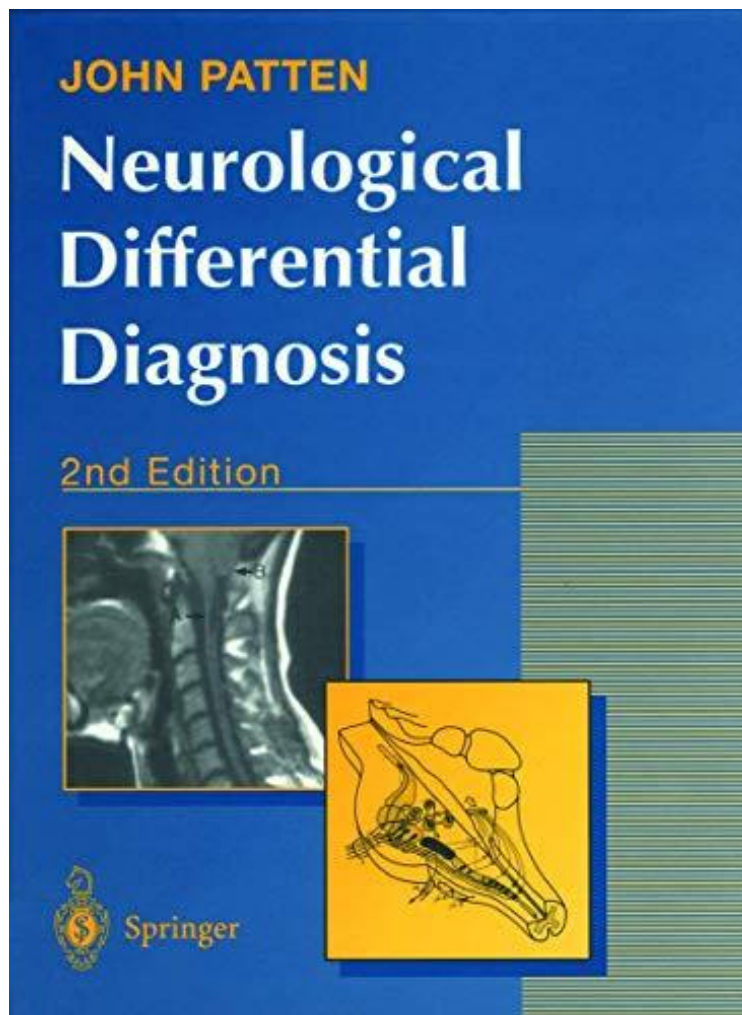
What is Polio? CDC. 11 August 2022.

- <https://www.cdc.gov/polio/what-is-polio/index.htm>
- There is a remarkable photo of ancient Egyptian painting showing a man with a “withered” leg. That is because of the Polio virus. It’s called Post-Polio Syndrome.
- As usual, scads of information from the CDC. Lots of subheadings in the left column.

*Post-Polio Syndrome*. CDC. 23 September 2021.

- <https://www.cdc.gov/polio/what-is-polio/pps.html>
- Verbatim.
  - Post-polio syndrome (PPS) is a condition that can affect polio survivors decades after they recover from their initial poliovirus infection.
  - Unlike poliovirus, PPS is not contagious.

## The Neuro-science explanation of the paralysis caused by the Polio virus



*Neurological Differential Diagnosis*. 2<sup>nd</sup> Edition. 464 pages. John Patten. Springer. 1996.

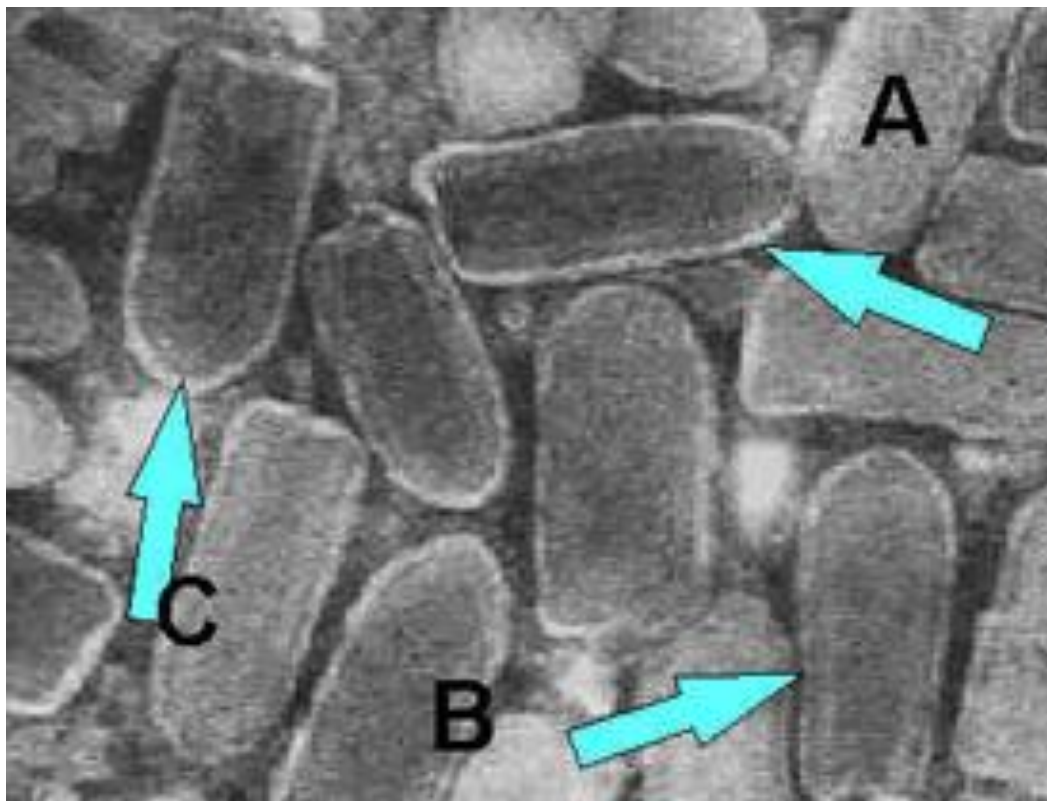
- Summary



- **This is a phenomenal book.** Even if you have zero science background you will learn something. I'm not saying it's not technical. It *is* technical. But it's just so well written that the technical is understandable.
- There are many vignettes. E.g., Betty has a pounding headache. Oh, turns out it's an aneurysm. There are great diagrams.
- **You can Look inside.**
  - <https://www.amazon.ca/Neurological-Differential-Diagnosis-John-Patten/dp/3540199373>
  - <https://www.amazon.com/John-Patten-Neurological-Differential-Diagnosis/dp/B008UBLW01>

## Page 100 – Rabies virus

### Rabies in humans



*Rabies – Electron microscopy*

- Summary
  - The photo shows the bullet shape of the *Rabies virus*.
- Source
  - **CDC**
    - The CDC always has lots of good diagrams and photos.
    - 22 April 2011

- [https://www.cdc.gov/rabies/diagnosis/electron\\_microscopy.html](https://www.cdc.gov/rabies/diagnosis/electron_microscopy.html)

### Rabies

- Summary
  - This is about rabies in *humans*. It's short and technical.
- Verbatim
  - Pain or paresthesias may develop at the site of the bite. Rapidity of progression depends on the viral inoculum and proximity of the wound to the brain. The incubation period averages 1 to 2 months but may be > 1 year.
  - Initial symptoms of rabies are nonspecific: fever, headache, and malaise. Within days, encephalitis (furious rabies; in 80%) or paralysis (dumb rabies; in 20%) develops. Encephalitis causes restlessness, confusion, agitation, bizarre behavior, hallucinations, and insomnia. Salivation is excessive, and attempts to drink cause painful spasms of the laryngeal and pharyngeal muscles (hydrophobia). In the paralytic form, ascending paralysis and quadriplegia develop without delirium and hydrophobia.
- Translation of the above
  - **Paresthesia** ("pair ess thee zee ah") means tingling.
  - **Inoculum** is fancy way of saying how much virus was introduced into you by the rabid animal when it bit you. The more virus, the faster things go bad. The word 'inoculum' is not necessarily bad – it can also refer to the volume of fluid that gets injected into you when you get a vaccine.
  - **Malaise** (mah laze") means you feel blah. It's a French word.
  - **Encephalitis** ("en sef ah light iss") means inflammation of the brain. In this case, the cause of the inflammation is the *rabies virus*.
  - To **hallucinate** is to see and hear things that do not exist.
  - The **laryngeal** ("lah rin jee ul") and **pharyngeal** ("fah rin jee ul") muscles are basically the throat muscles.
- Source
  - Merck Manual
    - Last review/revision Mar 2022 | Modified Sep 2022
    - <https://www.merckmanuals.com/en-ca/professional/neurologic-disorders/brain-infections/rabies>
- Author
  - John E. Greenlee, MD, University of Utah Health

### Rabies in the U.S. and around the world. CDC. 11 June 2019

- <https://www.cdc.gov/rabies/location/index.html>

### Rabies – Epidemiology. Verbatim

- The prevalence of rabies varies by location depending on animal-control effectiveness and immunization programs. The largest number of human deaths annually was recorded during the first half of the 20th century, with an average of 50 documented cases per year. Most were related to rabid-dog exposure. After 1940, when **canine rabies vaccination** programs began, the average number of documented cases declined to two per year. From 2001-2005, 15 cases of human rabies were reported in the United States.
- Translation
  - As the name suggests, **canine rabies vaccination** means dogs get a rabies vaccine.
- Source
  - **Medscape**
    - 16 November 2022.
    - <https://emedicine.medscape.com/article/220967-overview#a7>
- Authors

- Author
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## CDC

- **Early 1900's** 100 **Rabies deaths** / y in **United States**
- **Current** 59,000 **Rabies deaths** / y **globally**
  - **11 June 2019**
  - <https://www.cdc.gov/rabies/location/index.html>
  - **Clicking on these images** give USA data or Global data.



- **Graph – United States**
  - **CDC. 6 April 2020.** <https://www.cdc.gov/rabies/location/usa/index.html>
  - **Deaths**
    - The number of **rabies-related human deaths** in the United States declined during the twentieth century, from more than 100 annually in the early 1900's to just **one or two per year since 1960**. This decline can be attributed to **successful pet vaccination and animal control programs**, public health surveillance and testing, and availability of post-exposure prophylaxis (PEP) for rabies.
  - **Cases**
    - From **1960 to 2018**, **127 human rabies** cases were reported in the United States, with roughly a quarter resulting from dog bites received during international travel. Of the infections acquired in the United States, **70% were attributed to bat exposures**.
- **Graph – Global**
  - **CDC. 29 July 2020.** <https://www.cdc.gov/rabies/location/world/index.html>
    - Each year, rabies causes approximately 59,000 deaths worldwide. Despite evidence that control of dog rabies through animal vaccination programs and elimination of stray dogs can reduce the incidence of human rabies, dog rabies remains common in many countries and **exposure to rabid dogs is still the cause of over 90% of human exposures to rabies and of 99% of human rabies deaths** worldwide. CDC experts in the Poxvirus and Rabies Branch conduct an annual assessment of **individual countries' rabies status worldwide** which considers the presence of wildlife rabies, canine rabies variant (dog rabies), and non-rabies lyssaviruses.

### Old Yeller

- **This is a work of fiction. Travis is the kid. Old Yeller is the dog.**
- The author is **Fred Gipson**.
- I purposely bought a used copy of this book – it's from some old school library where they stamp the book with the date you checked it out.
- **HarperCollins**
  - They publish it.
  - <https://www.harpercollins.com/products/old-yeller-fred-gipsonsteven-polson?variant=32117535899682>

### Old Yeller

- **The cover page here is the one I have in my copy of the book, which I intentionally bought used. Totally old school.**
- [https://en.wikipedia.org/wiki/Old\\_Yeller](https://en.wikipedia.org/wiki/Old_Yeller)

### Coma semantics

- Do you die *of* a coma or *in* a coma?
  - It's a bit word splitty. Something caused you to be in a coma. For example, the *rabies virus* inside the brain. For example, trauma to the brain in car crash. You die of the thing that caused the coma. I'm sure someone could write a 1-page essay on this. Maybe 10 pages.

# Page 101 – Bat Trial #1

## Batilda Johnson

**Echo-location** in bats.

- See page 115.

# Page 102 – Bat Trial #2

## JAWS

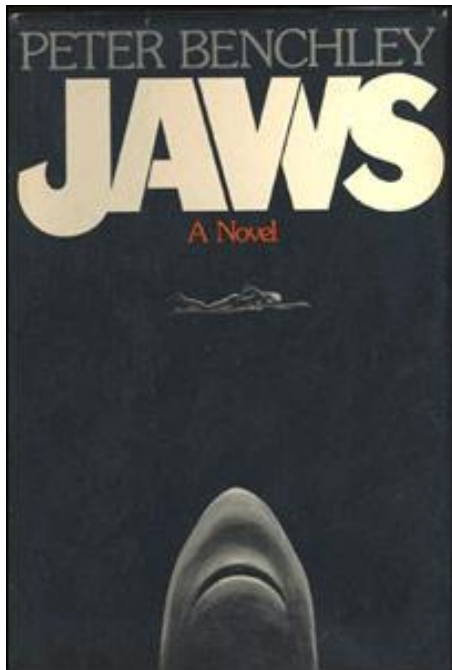
Mini-index

JAWS

International Shark Attack File

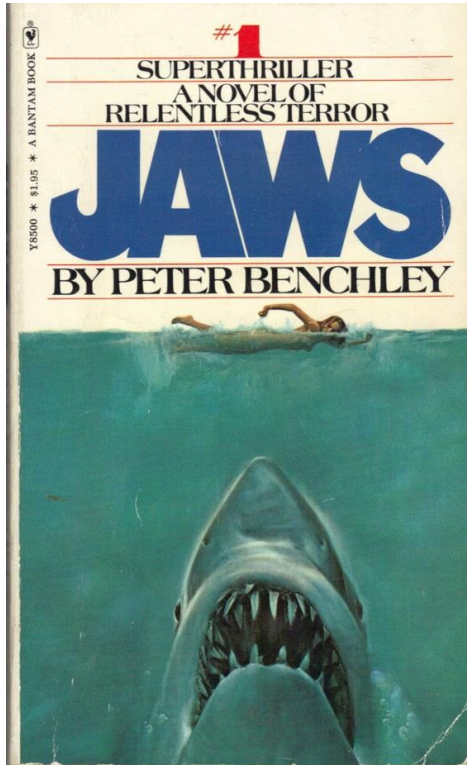
Selfie

JAWS



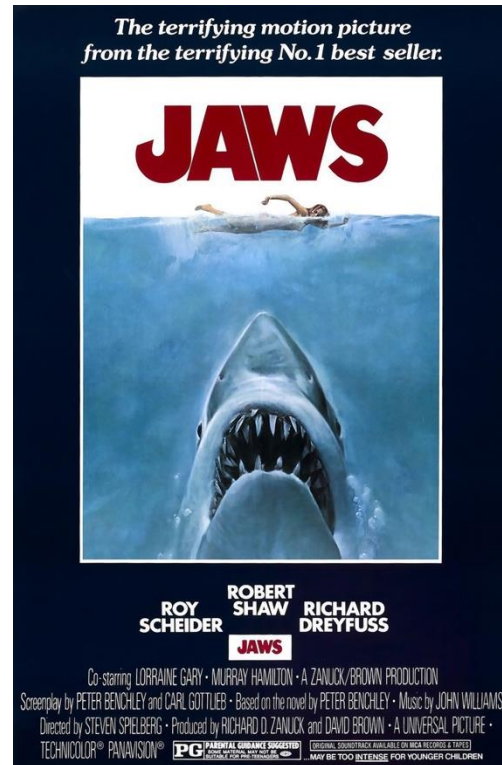
**JAWS** hardcover book by Peter Benchley. 1974

- Hardcover was by Doubleday.
- Feb 1974 = hardback.



**Jaws** softcover by Roger Kastel. Blue letters.

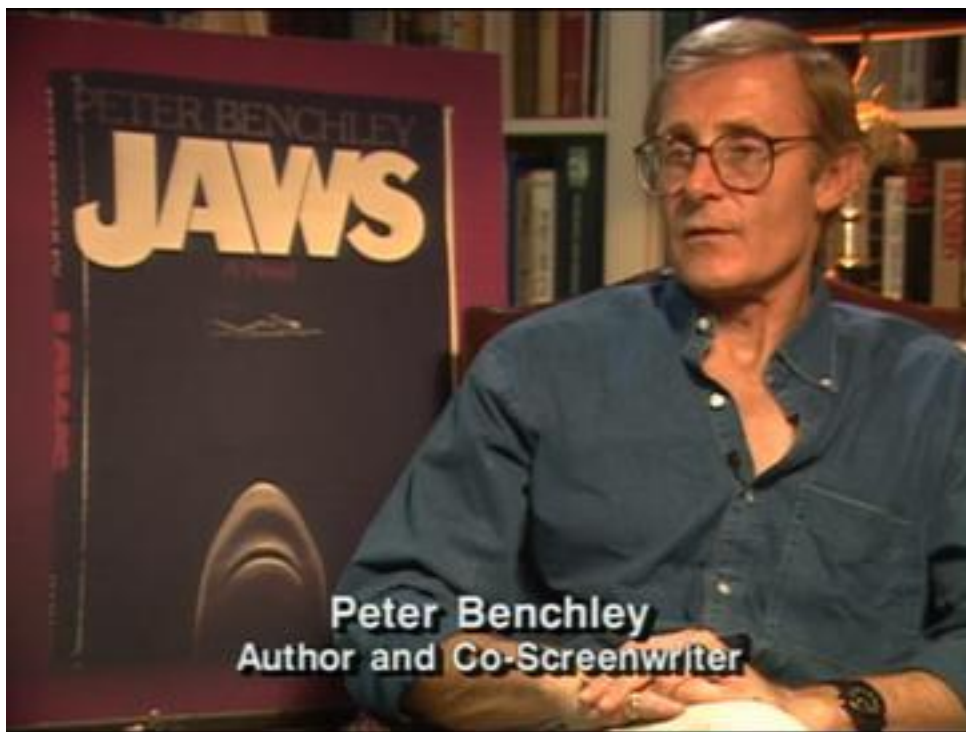
- Paperback by Bantam Books which is owned entirely by Random House which is a subsidiary of Penguin Random House.
- 1975 = softback



**JAWS** movie – Same as book. Red letters.



**THE EMPIRE STRIKES BACK** poster art by **Roger Kastel** (who did the **JAWS** book cover), 1980.

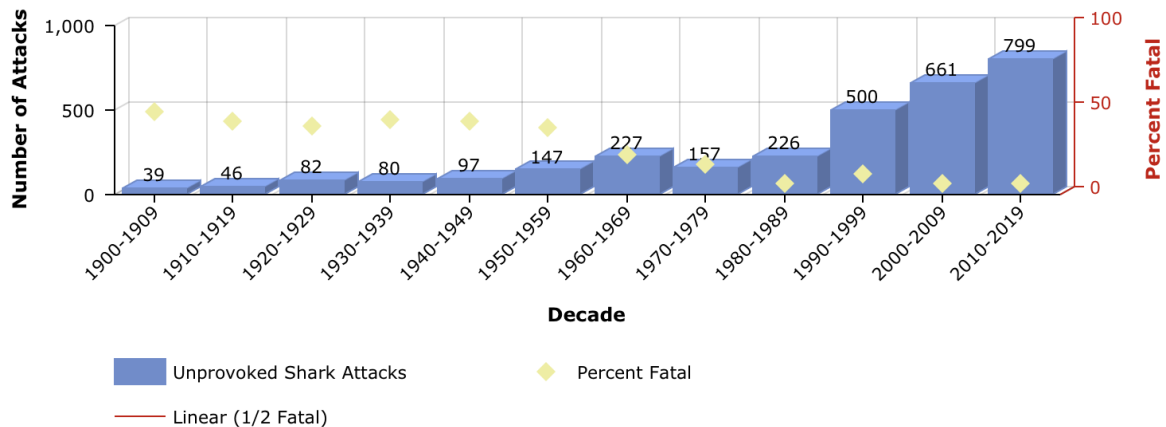


**Peter Benchley** wrote **JAWS** in 1974.

**International Shark Attack File**

# Worldwide Unprovoked Shark Attacks and Rate of Fatality

## 1900-Present



### Fatal shark attacks 1900 – present

- On the graph, if hover cursor over the yellow diamond, the % fatality pops up.
- 2010 – 2019
  - 6.8% fatality rate = 799 attacks x 0.068 fatality rate = 54 deaths over 10 year window = 5 deaths per year.
    - c.f. selfie
      - *The Washington Post* reported in January 2016 that "about half" of at least 27 "selfie related" deaths in 2015 had occurred in India (Wik – selfie deaths)
      - So that means in 2015 there 5x more selfie deaths than shark attack deaths.
        - [https://en.wikipedia.org/wiki/List\\_of\\_selfie-related\\_injuries\\_and\\_deaths#:~:text=From%20January%202008%20to%20July,died%20in%20selfie%20related%20accidents.](https://en.wikipedia.org/wiki/List_of_selfie-related_injuries_and_deaths#:~:text=From%20January%202008%20to%20July,died%20in%20selfie%20related%20accidents.)
    - That's why more likely to die of taking a selfie.
- 2000– 2009
  - 7% fatality rate
- Int Shark Attack File
  - <https://www.floridamuseum.ufl.edu/shark-attacks/trends/fatalities/>

Selfie





Wow. That's for real.

- [https://en.wikipedia.org/wiki/List\\_of\\_selfie-related\\_injuries\\_and\\_deaths#](https://en.wikipedia.org/wiki/List_of_selfie-related_injuries_and_deaths#)

### Jaws – Peter Benchley

- **Peter Benchley**
  - Bio
    - Grew up in **Nantucket** which is where **Captain Ahab** set sail from in **Moby Dick**.
    - After highschool → travels the **world** for a **year** → writes a memoir called **Time and a Ticket** → **US Marine Corps x 6 months** → **White House speechwriter** under **LBJ** (who knew?) → **fledgeling writer** → reads a news report of a **4550 LB Great White Shark (GWS)** → writes **JAWS**.
  - Products
    - **JAWS** novel
      - **1974 February**
        - **Hardcover** by **Doubleday**.
      - **1975**
        - **Paperback** by **Bantam Books** which is **owned entirely by Random House** which is a **subsidiary of Penguin Random House**.
      - **10m copies** → **millionaire Peter Benchley**.
    - **JAWS** movie
      - **1975**.
      - **Steven Spielberg**.
      - **Universal Pictures** released it to **450 theaters**, which was “**exceptionally wide**” at the time.
      - It was also released in **summer**, a traditional **doldrum**, but it did so well it inspired the **summer blockbuster**.
      - **\$470m earnings**.
  - Verbatim (**Animal Attack Files, 4 April 2000**)
    - Author
      - THE author of Jaws said **yesterday** that he would never have written the book if he had known the damage it would do to the reputation of the great white shark.
    - Regret, so to speak
      - "What I now know, which wasn't known when I wrote Jaws, is that there is no such thing as a rogue shark which develops a taste for human flesh."
    - Fishing trawler nets

- "Jaws gave me access to all the scientists and environmentalists and brought me closer to the ocean." He said that because of their fearsome reputation "no one appreciates how vulnerable they are to destruction". He said: "They get caught up in 80-mile fishing lines with thousands of hooks which kill anything, and in nets the size of ten 747s laid wing to wing in the ocean."
- Shark fin soup
  - Benchley is particularly appalled by the Asian delicacy **shark fin soup**. He said: "It's disgusting when you see the slaughter of sharks; when the animal is brought to the surface, has its fins sawn off and is then dropped into the ocean. I've seen the ocean floor littered with the corpses of finless sharks."
- Anthropomorphise
  - But a problem remains. He said: "It's hard to rally people behind sharks. Unlike whales or dolphins, they are hard to anthropomorphise - and they occasionally eat people." However, the fear of sharks seems to outweigh their taste for human flesh. Over the past century, only 74 people have been killed by the eight varieties of sharks - out of 400 in total - that are killers.
- In his own defense
  - "The American media has been trying to get me to apologise for everything from the Sudetenland to the tawny pipit. What I'm doing here is the expression of a sentiment which has been building for 25 years." That's funny.
- Stats
  - Selfie
    - More likely to die from taking a selfie. Awesome. (*NY Post* as per *World Animal Foundation*).
    - *The Washington Post* reported in **January 2016** that "about half" of at least 27 "selfie related" deaths in 2015 had occurred in India (Wik – selfie deaths)
      - [https://en.wikipedia.org/wiki/List\\_of\\_selfie-related\\_injuries\\_and\\_deaths#:~:text=From%20January%202008%20to%20July,died%20in%20selfie%20related%20accidents](https://en.wikipedia.org/wiki/List_of_selfie-related_injuries_and_deaths#:~:text=From%20January%202008%20to%20July,died%20in%20selfie%20related%20accidents).

#### Source

- **Animal Attack Files (AAF)**
  - This is the source for **Boston.com**
  - [http://www.igorilla.com/gorilla/animal/2000/sharks\\_peter\\_benchley.html](http://www.igorilla.com/gorilla/animal/2000/sharks_peter_benchley.html)
- **Boston.com**
  - <https://www.boston.com/culture/entertainment/2015/06/19/why-the-author-of-jaws-wished-he-never-wrote-it/?amp=1>
- [https://en.wikipedia.org/wiki/Peter\\_Benchley](https://en.wikipedia.org/wiki/Peter_Benchley)
- Jaws (novel)
  - [https://en.wikipedia.org/wiki/Jaws\\_\(novel\)](https://en.wikipedia.org/wiki/Jaws_(novel))
- Jaws (film)
  - [https://en.wikipedia.org/wiki/Jaws\\_\(film\)](https://en.wikipedia.org/wiki/Jaws_(film))
- [https://en.wikipedia.org/wiki/Roger\\_Kastel](https://en.wikipedia.org/wiki/Roger_Kastel)
- [https://en.wikipedia.org/wiki/The\\_Empire\\_Strikes\\_Back](https://en.wikipedia.org/wiki/The_Empire_Strikes_Back)
- **World Animal Foundation**
  - <https://worldanimalfoundation.org/advocate/shark-attack-statistics/>
- **Int. Shark Attack File**
  - **Gavin Naylor, Ph.D.**  
Program Director, International Shark Attack File  
Florida Program for Shark Research

- Florida Museum of Natural History – University of Florida  
Gainesville, FL 32611 USA
- <https://www.floridamuseum.ufl.edu/shark-attacks/yearly-worldwide-summary/>
    - This is about *provoked* vs *unprovoked* bites. Hmm.

# Page 103 – Bat Trial #3

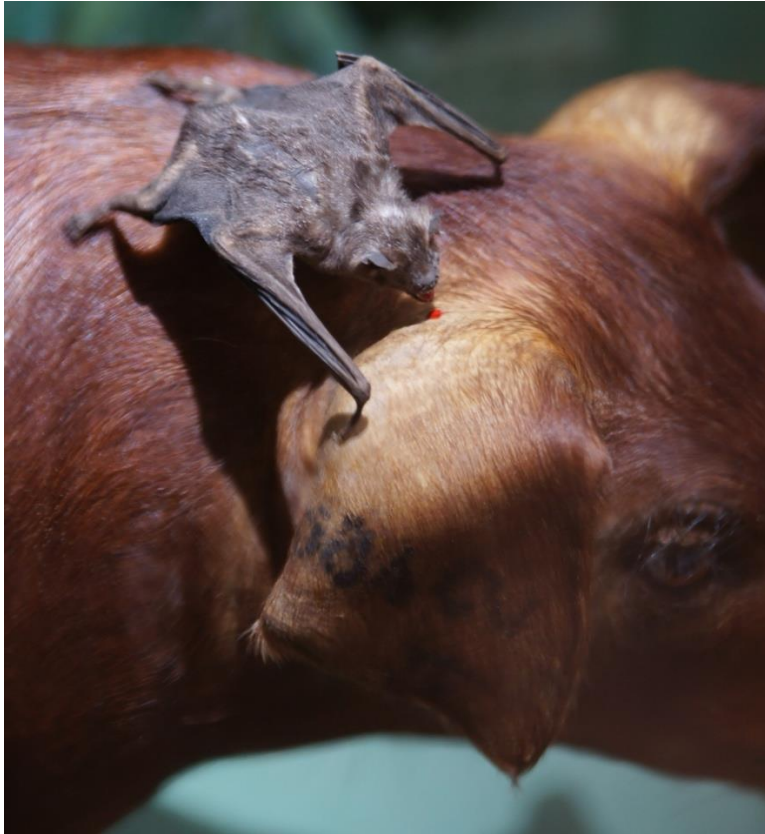
## Vampire bat

### Evolution

*Making a bat: The developmental basis of bat evolution*

- Summary
  - **Bat fossils** apparently found in Eocene 52,000,000 years ago.
- Source
  - Genetics and Molecular Biology
    - 8 Feb 2021
    - <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7879332/>
- Authors
  - [Alexa Sadier](#),<sup>1,\*</sup> [Daniel J. Urban](#),<sup>1,2,\*</sup> [Neal Anthwal](#),<sup>1</sup> [Aidan O. Howenstine](#),<sup>1</sup> [Ishani Sinha](#),<sup>1</sup> and [Karen E. Sears](#)<sup>1</sup>
    - <sup>1</sup>University of California at Los Angeles, Department of Ecology and Evolutionary Biology, Los Angeles, USA.
    - <sup>2</sup>American Museum of Natural History, Department of Mammalogy, New York, USA.
- Associate Editor
  - [Igor Schneider](#)

### Feeding



Vampire bat feeding on pig ear.

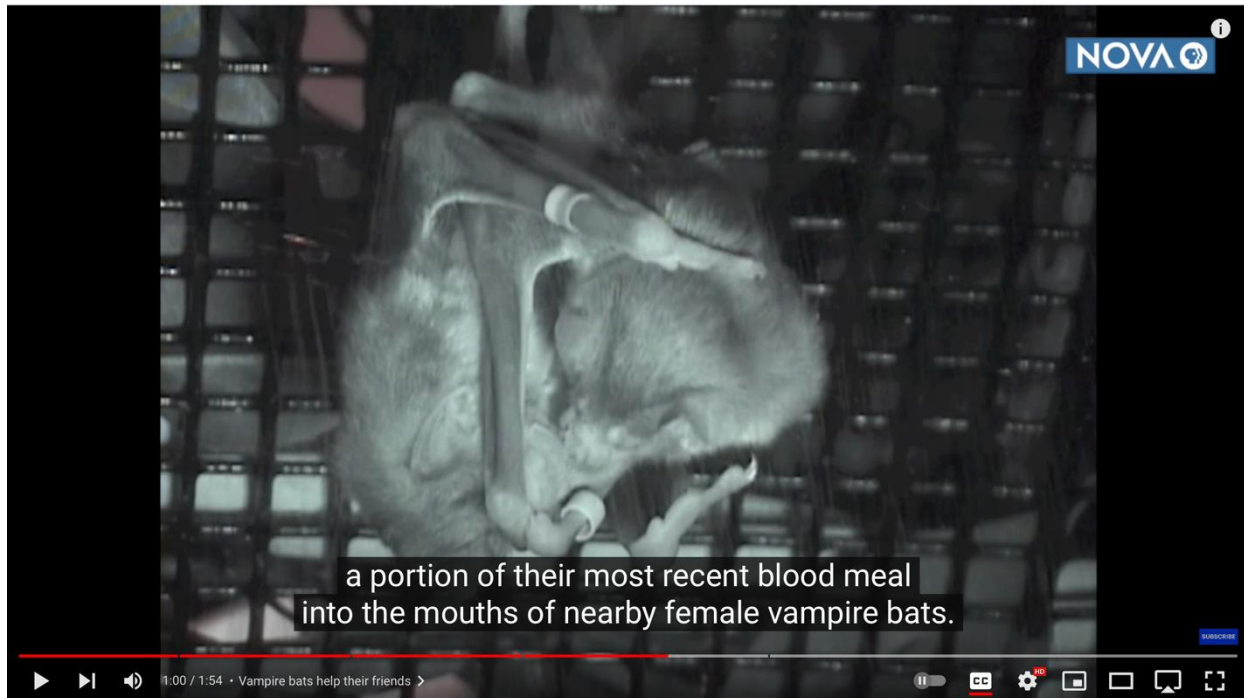
- [https://en.wikipedia.org/wiki/Vampire\\_bat](https://en.wikipedia.org/wiki/Vampire_bat)



Common vampire bat (C) feeding on human scalp (A, B) and cow leg (D).

- [https://en.wikipedia.org/wiki/Vampire\\_bat](https://en.wikipedia.org/wiki/Vampire_bat)

## Regurgitate blood



Female seems to be the who donates. Why not the male?

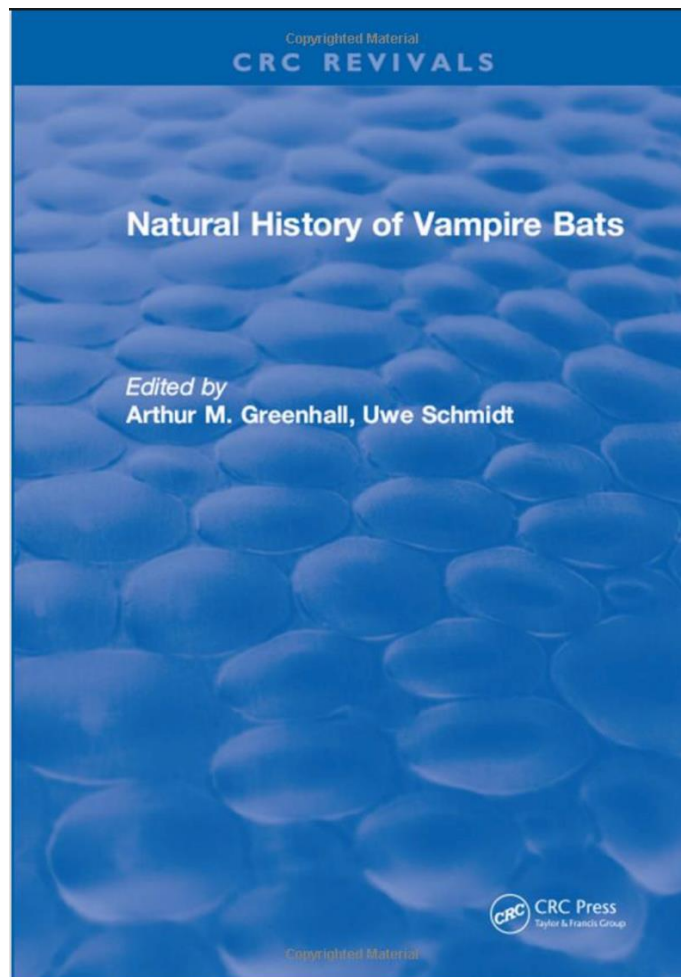
- Source
  - *Vampire Bats Who Share Blood With Their Friends*
    - 2 min video. Super cool.
    - NOVA PBS Official
    - 21 Nov 2016
    - [https://www.youtube.com/watch?v=ADWSG\\_JtcEw](https://www.youtube.com/watch?v=ADWSG_JtcEw)

### Vampire bat

- Semantics
  - Dope
    - 'Vampire' in literature → 'vampire bats' in science lexicon.
    - 1897 – Bram Stoker's *Dracula*.
    - Stake in the heart of the dead seems to have been a real practice in Transylvania as per former bat researcher Micheala Jemison and now does Communications for Bat Conservation International.
  - Verbatim
    - The bats were named after vampires, not the other way around.
    - Vampire mythologies existed in various cultures around the world long before before vampire bats got their name.
    - Former bat researcher Micaela Jemison, who heads up communications for Bat Conservation International, recently traveled to the historic Transylvania region in Romania. "Rather than Dracula, people worried about the dead rising and haunting people," she said, adding that people would open graves and put a stake through the hearts of dead bodies or cover faces, if the corpses were suspected of "causing trouble."

- Vampire bats were first officially described in scientific literature in **1810** and documented by **Darwin in 1839**, but it was the 1897 release of Bram Stoker's *Dracula* that solidified a relationship between vampires and bats in western culture.
  - **PBS**
    - **28 Oct 2016**
    - <https://www.pbs.org/newshour/amp/science/7-things-you-didnt-know-about-vampire-bats>
- Tax
  - N = 3 extant spp.
    - **Common vampire bat**
      - *Desmodus rotundus*
      - Feeds on blood of Mammals, including humans (this is rare, bites (exposed) toes for most part (PBS). Tends to be sleeping.
    - **Hairy-legged vampire bat**
      - *Diphylla ecaudata*
      - Feeds on bird blood.
    - **White-winged vampire bat**
      - *Diaemus youngi*
      - Feeds on bird blood.
- Evolution
  - **52.5 mya** - Bats arise.
    - The oldest known bat fossils date from the early Eocene, approximately 52.5 million years ago; these fossils already bear remarkable morphological similarities with extant bats and when alive the animals were likely capable of powered flight.
      - *Making a bat: The developmental basis of bat evolution*
      - **Genetics and Molecular Biology. 2020.**
        - <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7879332/>
  - **26 mya** - Vampire bats appeared 26 million years ago.
  - Numerous theories for how they split off from 'regular' bats (my term).
    - e.g., Fed and insects that they were attracted to the wounds of animals → and then just fed on the animal wounds themselves.
- Distribution
  - Americas
    - Mexico to Brazil / Argentina / Uruguay / Chile
  - NOT Transylvania.
- Size
  - Common vampire bat
    - 9 cm (3.5") long
    - 18 cm (7") wingspan
    - 25 – 40 g.
      - F 40 g consumes ½ her body weight 20 g.
- CNS
  - **ThermoRc in nose** help locate prey.
    - Seems to involve TRP ion channel.
  - There is a nucleus in the vampire bat brain that is similar in location and histology to the IR Rc nucleus of snakes. Interesting.
  - **Inferior colliculus** is well adapted to detect the breathing of sleeping animals. Wow.
- ENT
  - Dental formula
    - Different for each of the 3 vampire bats. See pix above.
- GI - Diet
  - Hematophagy
    - The 3 species of vampire feed solely on blood.
    - The only mammals that feed exclusively on blood.

- Survives only 2 days without feeding. Very much like your vampire in a movie.
  - A 'donor' bat may regurgitate blood to the starving one.
    - Caveat (Wik- vampire bat): be cautious interpreting the data because it's based on correlation.
- Hunt when fully dark.
- Dope. Whose blood?
  - **Common vampire bat**
    - Saliva contains anti-coagulants.
    - Mammals, including humans. Tends to be sleeping.
    - Cows, pigs, horses (PBS)
      - Horses do sleep standing up so can rapidly escape from predator.
        - <https://www.agriapet.co.uk/hub-agria-blog/2022/sepember/do-horses-sleep-standing-up/>
    - Lands on ground → bounds on all fours to mammal → razor-sharp upper incisors make a 7 mm wide x 8 mm deep cut (they lack enamel thus are permanently sharp. Cool. Can cut fingers even handling a museum skull. Yikes) → “lap up” the blood. (Wik – vampire bat)
      - Ref no. 35, *Natural History of Vampire Bats*, is the source of the enamel and 7 x 8 mm info. But cannot read about this enamel in the Look inside.



Amazon.ca \$300 hardcover! \$85 Kindle (what?)

- This is a 2017 printing but seem to be same book.
- Can Look inside. All these screenshots from amazon.ca.

<https://www.amazon.ca/Natural-History-Vampire-Arthur-Greenhall/dp/1315895811>

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# Natural History of Vampire Bats

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 **CRC Press**  
Taylor & Francis Group  
Boca Raton London New York

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Vampire bat, *Desmodus rotundus* (Photo taken by Uwe Schmidt )

Photo is by **Uwe Schmidt**, one of the **editors**.

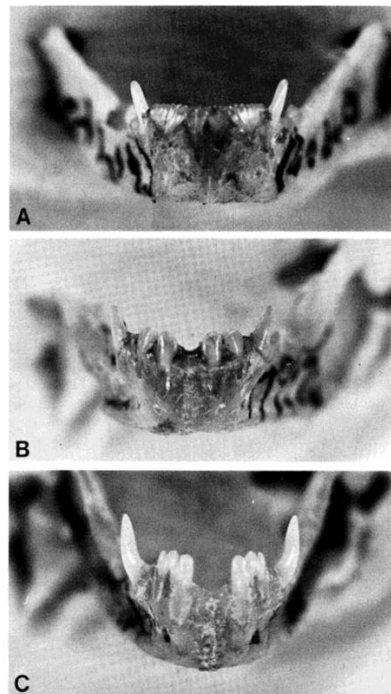


FIGURE 3. Anterior views of mandibles showing incisor teeth: (A) *Diphylla ecaudata*, (B) *Diatemys youngi*, and (C) *Desmodus rotundus*.

(C) Mandible of **Common vampire bat**, *Desmodus rotundus*.

This is from *Natural History of Vampire Bats* that **Merlin Tuttle** write the Intro for.

- Greenhall, Arthur M. (1988) "Feeding Behavior". In: *Natural History of Vampire Bats* (ed. by **A. M. Greenhall** and **U. Schmidt**), pp. 111–132. Boca Raton, FL: CRC Press. ISBN 978-0-8493-6750-2
  - This is Ref no. 36 in Wik – vampire bat, that is the source for the **upper incisor cut**.
  - **Merlin Tuttle** wrote the **Introduction!** (Starting on Page 1)
    - "Known to all, understood by few, the common vampire bat has long remained a mysterious enigma."
    - Culling
      - **8000 bat caves** dynamited / poisoned (in **Trinidad**, I think) bc of a **rabies outbreak** [in **livestock**] in **Trinidad** in the **1930s**.
      - **Poisoned bananas** used to kill **vampire bats** → killed a bunch of **fruit bats**.
    - Stats
      - **Less than 1 bat in a 1000** is a **vampire bat**.
      - **Vampire bat colonies** are **small, easily not noticed** (p2z).
      - Whereas **insectivorous bat** colonies number in **hundreds of thousands** or **millions**.
      - **Vampire bats** adopt **orphans**. Wow.
    - Benefits
      - **70% of bats** (ie NOT **vampire bats**) eat **insects**. Eg mosquitoes
      - **Bats** amy be the most NB 'seed dispersal agents' in the **Amazon**.
  - Bio
    - **Arthur Greenhall** – **BA, MSc, zoologist. US Fish and Wildlife Service.**
  - **Amazon.ca** \$136 hardcover, \$85 Kindle (what?)
    - <https://www.amazon.ca/Natural-History-Vampire-Arthur-Greenhall/dp/0849367506>
  - **Amazon.ca** \$300 hardcover! \$85 Kindle (what?)
    - This is a 2017 printing but seem to be same book.
    - **Can Look inside.**
    - **Biblio.** My suggestion is look inside then rent it for \$16.
    - <https://www.amazon.ca/Natural-History-Vampire-Arthur-Greenhall/dp/1315895811>
  - **Amazon.com** \$105 USD hardcover.
    - **Can rent for \$17 on Kindle. 261 pp. I could do this, I guess.**
    - <https://www.amazon.com/Natural-History-Vampire-Arthur-Greenhall-ebook/dp/B07CYV3PCS>
  - **Cambridge Univ Press.** £109
    - <https://www.cambridge.org/core/journals/oryx/article/natural-history-of-vampire-bats-edited-by-am-greenhall-and-u-schmidt-crc-press-florida-1988-246-pp-hb-10900/8FCA97458B0A875F4559082F78B67127>
  - **Taylor & Francis Group**
    - **Chapter 9 on Feeding Behaviour** is here and it's **21 pages** but only the Abstract and nothing about incisors.
    - <https://www.taylorfrancis.com/books/edit/10.1201/9781351074919/natural-history-vampire-bats-arthur-greenhall>
- **Hair-legged v.p.**
  - **Primarily birds.**
    - **Sleeping chickens (PBS)**
      - **Chickens** sleep **8 hours at night**, kinda like **humans**. Who knew?
      - Sometimes, daytime naps. But if excess sleep in **daytime** can be **seriously ill**.
      - <https://bestfarmanimals.com/why-is-my-chicken-snoozing-lethargic-is-it-dangerous/>
  - **3-4" long**
  - **'Forearm' 2"**
- **White-winged v. b.**
  - **Primarily birds.**

- Sleeping chickens (PBS)
- Female
  - Species not stated (Wik – vampire bat).
  - 40 grams
  - Can consume 20 grams (½ of body weight) of blood in 20 minutes. Wow.
    - That seems to be about 20 ml if 1g/ml.
  - Bat consumes 1 tsp of blood (PBS)
    - I will use this data.
    - 6 tsp = 1 oz = 29.57 ml
    - 1 tsp = 1/6<sup>th</sup> oz = 5 ml
  - c.f. Horse blood volume
    - 500 kg horse x 8% = 40 L blood
    - 500 kg horse x 8% = 40 L blood = 40,000 ml = 8000 tsp = 169 cups = 1353 oz.
- Digestion of blood
  - Can take flight soon after feeding. Flings self into air to take off. Not sure what ‘flings’ means.
  - Stomach and intestines rapidly absorb H<sub>2</sub>O from the blood.
  - Expels urine 2 minutes after feeding.
  - Returns to Roost (RTR) within about 2 hours then spends rest of night digesting the blood. Yum.
- MSK
  - Locomotion
    - It can walk, jump and bound.
      - It has a unique bounding gait.
    - All other bats have lost the ability to walk on land.
    - Ergo: bats lost ability to walk → vampire bat re-acquired this.
- Roosting
  - Live in almost completely dark places.
    - Caves
    - Old wells
    - Hollow trees
    - Buildings
  - N = single digits (eg 9 bats) to 100’s of bats.
    - ie. nowhere close to density of Common bent-wing bat which is 1,000,000.
    - Strong bonds form. Social grooming occurs.
- Coronavirus
  - Yes, the coronavirus has been detected in the common vampire bat.
  - A coronavirus detected in the vampire bat *Desmodus rotundus*
    - Brazilian J Inf Diseases, 2008
    - Dr. Paulo Eduardo Brandão
      - Department of Preventive Veterinary Medicine and Animal Health
      - College of Veterinary Medicine, University of São Paulo
  - Detection of coronavirus in vampire bats (*Desmodus rotundus*) in southern Brazil
    - Full article here.
    - 229E HKU1 NL63 OC43 = these 4 cause Common Cold in humans.
    - 101 bats in Brazil sampled. All were euthanized.
    - AlphaCoV isolated.
      - 229E and NL63 are alphaCoV.
      - I did not get the sense this was in any way related to SARS-CoV-2 (which is Beta CoV).
    - ‘Fecal’ route suspected i.e., fecal-oral I assume.
    - <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8242716/>
- Rabies virus
  - Yes, vampire bats carry the Rabies virus.
- Cats
  - Domestic cat *Felis catus* preys on vampire bat (*Desmodus rotundus*) that itself was preying on goats, pigs, cows, humans.
  - Vampire bat is apparently heavy because just ate so not as agile.

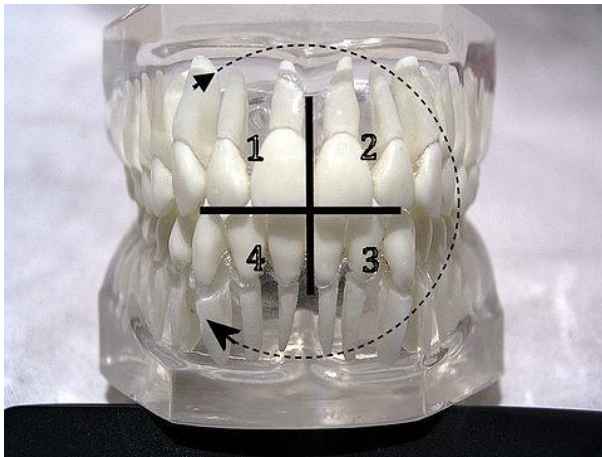
- The vampire bat has cryptic behaviour but not stated what it is.
- There is some odd inference about 'mutual tolerance' between the cat and the vampire bat prey ... like, what, the bats are thankful for the cat?
- Nothing mentioned about virus Tx.
- Source
  - *Domestic cat predation on vampire bats (Desmodus rotundus) while foraging on goats, pigs, cows and human beings*
  - **Applied Animal Behaviour Science** Vol 39: pages 141-150.
    - Abstract only.
    - **February 1994**
    - <https://www.sciencedirect.com/science/article/abs/pii/0168159194901341>
    - Authors
      - [H.Delpietro<sup>a</sup>](#)
      - [F.Konolsaisen<sup>b</sup>](#)
      - [N.Marchevsky<sup>a</sup>](#)
      - [G.Russo<sup>a</sup>](#)
        - <sup>a</sup> National Animal Health Service, Urquiza y Uruguay, 3300 Posadas, Argentina
        - <sup>b</sup> Health Secretary of Paraná State, E. Reboucas 1707, 80230 Curitiba, Brazil
  - Verbatim
    - This paper describes domestic cat (*Felis catus*) predation on vampire bats (*Desmodus rotundus*) foraging on goats, pigs, cows and human beings. The cat captures the bat chiefly at the moment of approaching its prey or when the prey defends itself or after feeding when the weight of the bat's ingesta hinders the bat from escape. Both the cat and the livestock exhibit a mutually beneficial partnership; while the cat increases its chances of capturing the bats, the prey species is attacked less. The attacks of cats on vampire bats were noticed in ecologically different regions, but had two characteristics in common: (1) livestock strongly attacked by vampire bats; (2) livestock spending the night adjacent to the owner's house. Within such a context, cats are efficient vampire predators. In all cases, the differences between the proportion of bitten animals among prey species 'associated with the cat' and the 'nonassociated' ones are evident. Differences were also noticed at the same farm before and after having brought a cat in. Observations regarding the cat and the cryptic behaviour displayed by the vampire while feeding suggest that, in nature, it is feasible that there is a certain kind of association or mutual tolerance between vampires' prey and other vampire bat predators. Our observations are also consistent with De Verteuil and Urich's (1936) remarks, that man is only an alternative prey for the vampire when livestock are very scarce or nonexistent.

#### Source

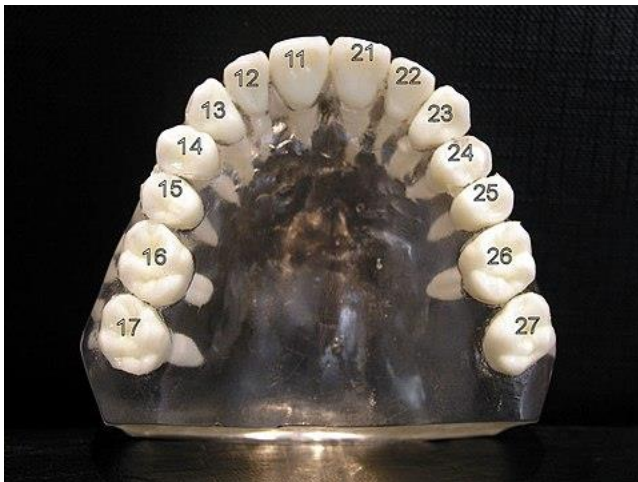
- [https://en.wikipedia.org/wiki/Vampire\\_bat](https://en.wikipedia.org/wiki/Vampire_bat)
- [https://en.wikipedia.org/wiki/Common\\_vampire\\_bat](https://en.wikipedia.org/wiki/Common_vampire_bat)
- [https://en.wikipedia.org/wiki/Hairy-legged\\_vampire\\_bat](https://en.wikipedia.org/wiki/Hairy-legged_vampire_bat)
- [https://en.wikipedia.org/wiki/White-winged\\_vampire\\_bat](https://en.wikipedia.org/wiki/White-winged_vampire_bat)
- PBS
  - *7 things you didn't know about vampire bats*  
<https://www.pbs.org/newshour/amp/science/7-things-you-didnt-know-about-vampire-bats>

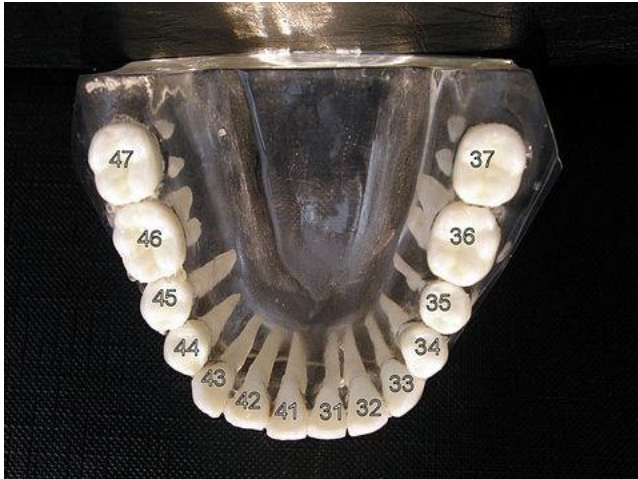
# Page 104 – Bat Trial # Fangs

## Dental formula – humans



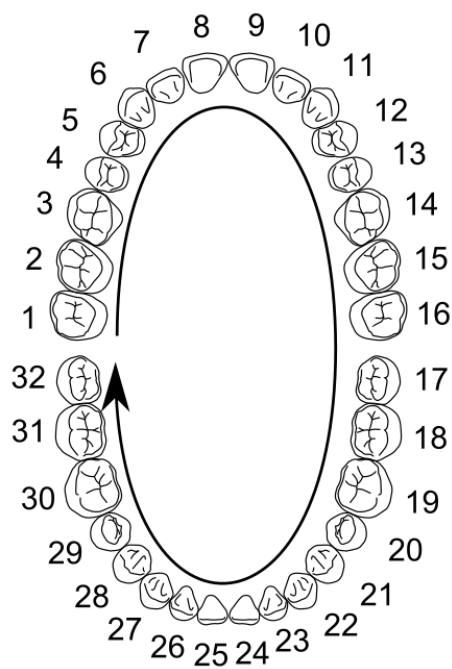
4 quadrants





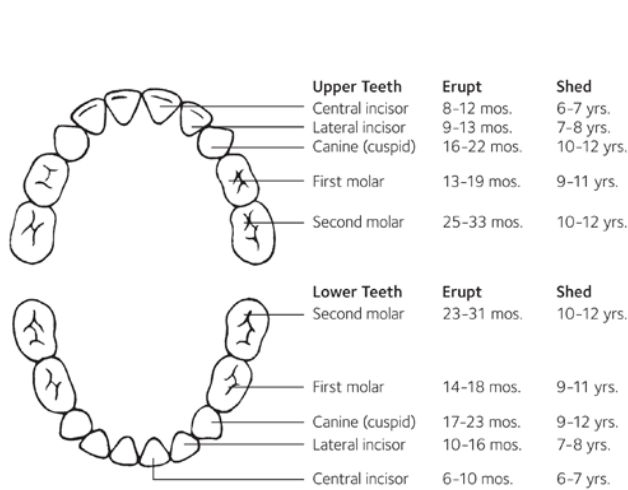
### Dental notation

- This is the numbering system used by dentists.
- Most common system in the world.
- Both links have these images.
- [https://en.wikipedia.org/wiki/Dental\\_notation](https://en.wikipedia.org/wiki/Dental_notation)
- [https://en.wikipedia.org/wiki/FDI\\_World\\_Dental\\_Federation\\_notation](https://en.wikipedia.org/wiki/FDI_World_Dental_Federation_notation)

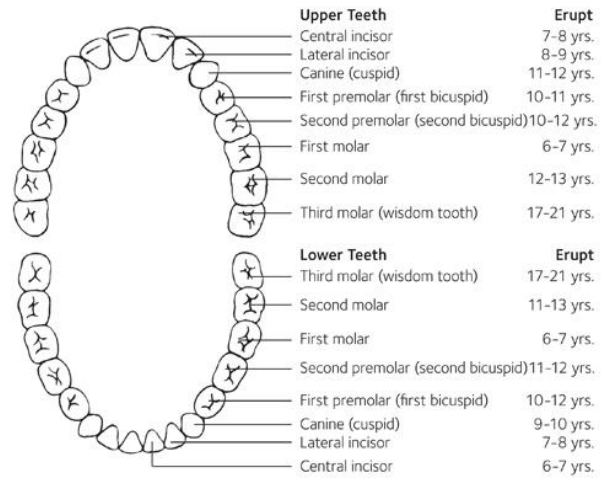


### Universal numbering system a.k.a. American system

- Common in USA.
- [https://en.wikipedia.org/wiki/Universal\\_Numbering\\_System](https://en.wikipedia.org/wiki/Universal_Numbering_System)



**Baby teeth**



**Adult teeth**

- Orientation: Pretend I'm the dentist facing the pt in the chair.
- American Dental Assoc (ADA) has an ad on the page.
- <http://www.mouthhealthy.org/en/az-topics/e/eruption-charts>

**Dental formula – bats**

**Pooled pix**





FIGURE 3. Anterior views of mandibles showing incisor teeth: (A) *Diphyllocaudata*, (B) *Diaemus youngi*, and (C) *Desmodus rotundus*.







**Bone Clones**

- This is apparently the **common vampire bat**.
- <https://boneclones.com/product/vampire-bat-skull-8-to-1-scale-TSBC-333>



**Deviant art** – nothing stated about species.

- See the diastema? It's the David Letterman gap.
  - **The lower incisors are small and bilobed, with a midline diastema.**
- <https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.deviantart.com%2Fm-skirvin%2Fart%2FVampire-Bat-Skull-II-198259262&psig=AOvVaw0RnVdH767GImPglu8YiuDW&ust=1684356263849000&source=images&cd=vfe&ved=0CBQQ3YkBahcKEwio7J6a2vr-AhUAAAAAHQAAAAAQHQ>

**Individual pix**



Dental formula ... this image Wik – common vampire bat

• Dental formula  $\frac{1\ 1\ 2\ 0}{4\ 1\ 3\ 0}$  = 1 incisor + 1 canine + 2 PM + 0 M (Wik – Common vampire bat) IGNORE THIS

• Common v b  $\frac{1\ 1\ 1\ 1}{2\ 1\ 2\ 1}$  = 1 incisor + 1 canine + 1 PM + 1 M = 4 / 4 = 20 (Science Direct) I will use this.

• Hairy legged v b  $\frac{2\ 1\ 1\ 2}{2\ 1\ 2\ 2}$  = 2 incisor + 1 canine + 1 PM + 2 M = 6 / 6 = 26 (Science Direct)

• White-winged v b  $\frac{1\ 1\ 1\ 2}{2\ 1\ 2\ 1}$  = 1 incisor + 1 canine + 1 PM + 2 M = 5 / 5 = 22 (Science Direct)

• **Distinctive incisors.**

- Only seem to be visible when jaw is OPEN.
- Look how angled upwards they are.
- Premolars and molars seem to be a.k.a. cheek teeth.
- Science Direct verbatim

$$I \frac{1}{2} C \frac{1}{1} P \frac{1}{2} M \frac{1}{1} = 20.$$

The **common vampire bat** (*Desmodus rotundus*) (Figs. 11.29 and 11.30) has a dental formula of [the small screenshot just above this paragraph]. This species feeds on the blood of large mammals, such as livestock (Greenhall et al., 1983). The **upper incisors**, and both upper and lower canines, are very large (Fig. 11.30A, C, and D) and the tips of the upper incisors fit into pits in the lower jaw behind the incisors (Fig. 11.30B-D). The **lower incisors** are small and bilobed, with a **midline diastema** (Fig. 11.30D). The **upper cheek teeth** are very small (Fig. 11.30A-B), the **lower cheek teeth** being a little larger and buccolingually compressed.

The **hairy-legged vampire bat** (*Diphylla ecaudata*) specializes in the blood of birds (Greenhall et al., 1984). Chickens are attacked on the legs and in the cloacal regions. *Diphylla* has a dental formula of  $I \frac{2}{2} C \frac{1}{1} P \frac{1}{2} M \frac{2}{2} = 26$ . The upper second incisor is tiny. The upper central incisors are less procumbent than in *Desmodus* or *Diaemus* and rest in larger pits. The crowns of the lower incisors, which are larger than in *Desmodus* and have serrated incisal edges, enclose these pits, so there is no diastema, and the midline symphysis is calcified. Davis et al. (2010) suggested that these features could be related to sucking, rather than lapping, of blood during feeding.

The **white-winged vampire bat** (*Diaemus youngi*) feeds on blood from poultry, pigeons, goats, and cattle (Greenhall and Schutt, 1996). Its dental formula is  $I \frac{1}{2} C \frac{1}{1} P \frac{1}{2} M \frac{2}{1} = 22$ , although the second upper molar is vestigial and may be lost. As in *Desmodus* there is a diastema between the lower central incisors.

<https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/desmodus>



Deviant art – nothing stated about species.

- Common v b  $\begin{array}{l} 1\ 1\ 1\ 1 \\ 2\ 1\ 2\ 1 \end{array} = \frac{1\ \text{incisor} + 1\ \text{canine} + 1\ \text{PM} + 1\ \text{M}}{2\ \text{incisor} + 1\ \text{canine} + 2\ \text{PM} + 1\ \text{M}} = \frac{4}{6} = \frac{20}{6}$  (Science Direct)
- <https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.deviantart.com%2Fm-skirvin%2Fart%2FVampire-Bat-Skull-II-198259262&psig=AOvVaw0RnVdH767GImPglu8YiuDW&ust=1684356263849000&source=images&cd=vfe&ved=0CBQQ3YkBahcK Ewio7J6a2vr-AhUAAAAAHQAAAAAQHQ>

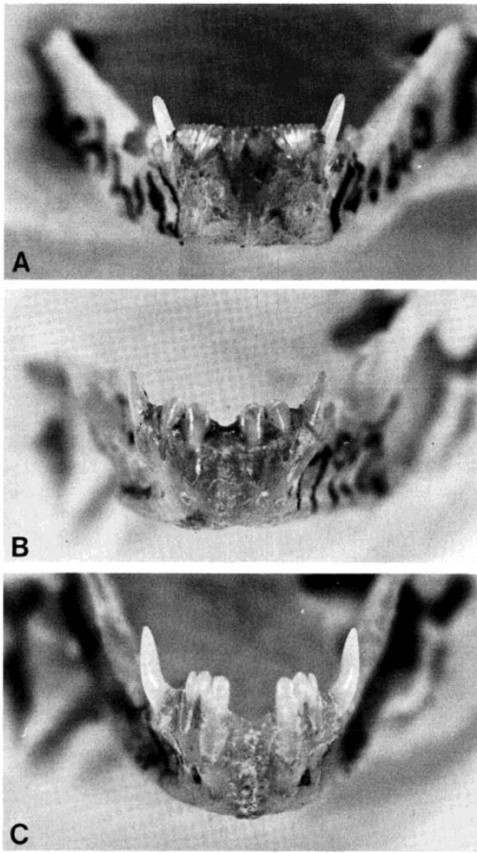


FIGURE 3. Anterior views of mandibles showing incisor teeth: (A) *Diphyllocaudata*, (B) *Diaemus youngi*, and (C) *Desmodus rotundus*.

(C) Mandible of Common vampire bat, *Desmodus rotundus*.

- Common v b  $\frac{1\ 1\ 1\ 1}{2\ 1\ 2\ 1} = \frac{1\ \text{incisor} + 1\ \text{canine} + 1\ \text{PM} + 1\ \text{M} = 4}{2\ \text{incisor} + 1\ \text{canine} + 2\ \text{PM} + 1\ \text{M} = 6} = \frac{4}{6} = \frac{2}{3}$  (Science Direct)
- Can definitely see 2 incisors in (C). It looks like 3 but I think that's the diastema of Incisor #1.
- This is copied from *Natural History of Vampire Bats* that Merlin Tuttle write the Intro for. See Text.



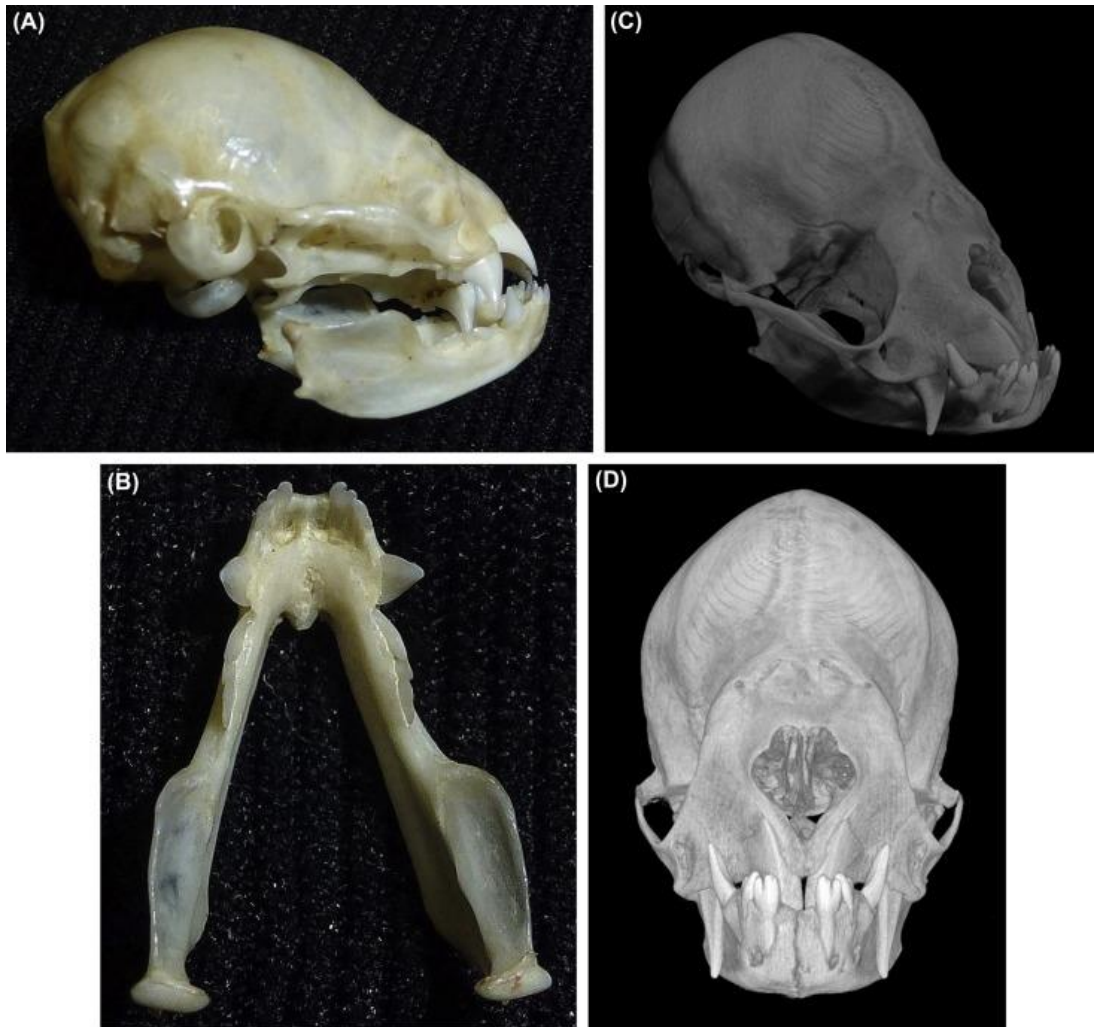
Wik - Vampire bat ... But it's actually a common vampire bat.

- **Incisors** are razor sharp.

- **Common v b**  $\begin{matrix} 1 & 1 & 1 & 1 \\ 2 & 1 & 2 & 1 \end{matrix} = \frac{1 \text{ incisor} + 1 \text{ canine} + 1 \text{ PM} + 1 \text{ M} = 4}{4} = 20$  (Science Direct)  
 $\begin{matrix} 1 & 1 & 1 & 1 \\ 2 & 1 & 2 & 1 \end{matrix} = \frac{2 \text{ incisor} + 1 \text{ canine} + 2 \text{ PM} + 1 \text{ M} = 6}{6}$

- Verbatim of **Wikipedia photo credit**

<b>Description</b>	<b>English:</b> Vampire bat ( <i>Desmodus rotundus</i> ) skeleton, mounted by me, showing the unique dentition.
<b>Date</b>	22 December 2009
<b>Source</b>	Own work
<b>Author</b>	Mokele



Common vampire bat (Science Direct)

- (A) – Can see the awesome incisors.
- (C) – Can see the upper canines and lower canines.
- (D) – Can see the upper canines and lower canines.

- Common v b  $\begin{matrix} 1 & 1 & 1 & 1 \\ 2 & 1 & 2 & 1 \end{matrix} = \frac{1 \text{ incisor} + 1 \text{ canine} + 1 \text{ PM} + 1 \text{ M}}{2 \text{ incisor} + 1 \text{ canine} + 2 \text{ PM} + 1 \text{ M}} = \frac{4}{6} / \frac{4}{6} = \frac{20}{6}$  (Science Direct)



- Vampire bat – specific type not named. It's a resin. (Skulls Unlimited)
- <https://www.skullsunlimited.com/products/replica-vampire-bat>

# Page 105 – Bat Trial #5 Bram Stoker

Bram Stoker's Dracula

# Dracula

This font is **Lucida Blackletter**. It is pretty cool. But in case you can't read that it's **Lucida Blackletter**.



## Abraham “Bram” Stoker

- b. 1847 Dublin
- 1870 – Age 23y – BA from Trinity College, Dublin.
- Plays rugby for Dublin University.
- Becomes a theatre critic for the *Dublin Evening Mail*.
- Marries a local beauty. They have a son.
- Becomes manager of the Lyceum Theatre (still in operation) in London. Wow.



Count Dracula

Historic Personae Dracula

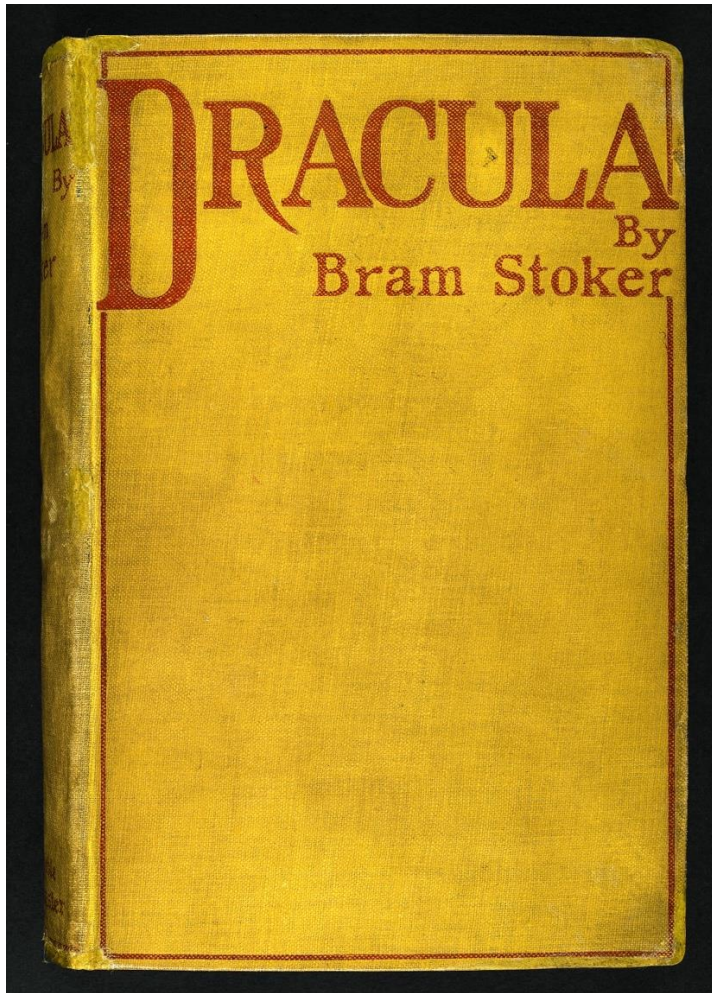
- o Doctor of law home ~~with~~ <sup>to</sup> Seward
- Girl engaged to him Lucy Westenra Schoffellows of Mrs Murray
- o Mad Patient ( <sup>story of petty life - instructed goes for Count follows</sup> up idea with mad cunning.
- o Lawyer ~~with~~ <sup>John Peter Hawkins Esq</sup>
- o His clerk <sup>Jonathan Harker</sup>
- o Franicee of above <sup>Wilhelmina Murray (Coleridge Minnie)</sup>
- o ~~Friend of above~~ <sup>Kate Reed</sup>
- o ~~Friend of above~~ <sup>Count Dracula</sup>
- o A deaf mute woman } <sup>highest servant of</sup> the Count
- o A Silent man } <sup>highest servant of</sup> the Count
- o A Detective <sup>Cotford</sup>
- o A Physical Research Agent <sup>refred Singleton</sup>
- o An Arabian <sup>from Texas</sup>
- o A German Professor <sup>Max Hinderboffel</sup>
- o A Painter <sup>Francis H. Astor</sup>
- o A Texan <sup>Arctus W. Maris</sup>

o makes dinner of 13

secret room - <sup>Mem</sup> ~~closed~~ <sup>like</sup>

Bram Stoker's notes on the Dracula characters. Love it.

- Dracula is the name of the vampire.



*Dracula* – 1<sup>st</sup> Edition. 1897. Bram Stoker is 50 y old.

- Dracula teeth
  - *The mouth, so far as I could see it under the heavy moustache, was fixed and rather cruel-looking, with peculiarly sharp white teeth. These protruded over the lips, whose remarkable ruddiness showed astonishing vitality in a man of his years.* [ He did not specify canine or incisor so we really cannot take issue with him.]
  - Dracula, Chapter 2. Introducing the Count! Jonathan Harker's physical description of Dracula on his first encounter with him at the castle is of a sinister, frightening character. There is also a hint of the supernatural, in the "sharp white teeth" and "astonishing vitality" of Dracula.
    - <https://www.allgreatquotes.com/dracula-quotes-18/>
- Bat references
  - *Between me and the moonlight flitted a great bat, coming and going in great, whirling circles. Once or twice it came quite close, but was, I suppose, frightened at seeing me, and flitted away.*
    - Dracula, Chapter 8. Lucy's best friend Mina, who looks after her friend during the night, notices a bat coming and going outside. Mina is unaware that the bat is Dracula, whose supernatural powers allow him to take on other forms.
  - *Then I caught the patient's eye and followed it, but could trace nothing as it looked into the moonlight sky, except a big bat, which was flapping its silent and ghostly way to the west. Bats usually wheel about, but this one seemed to go straight on, as if it knew where it was bound for or had some intention of its own.*

- Dracula, Chapter 9. Renfield, the patient in the lunatic asylum, becomes agitated and attempts to escape but is caught by the orderlies and Dr. Seward. Just then Renfield looks upwards and Dr. Seward notices a large bat flying above. Renfield suddenly becomes calm and agrees to go back to the asylum. Seward is puzzled, he doesn't realize that the bat is Dracula who can transform into an animal.
- I did not fear to go to sleep again, although the boughs or bats or something flapped almost angrily against the window panes.
  - Dracula, Chapter 11. After Van Helsing covers her room in garlic flowers, Lucy is able to finally get four good nights of sleep.
- I went to the window and looked out, but could see nothing, except a big bat, which had evidently been buffeting its wings against the window.
  - Dracula, Chapter 11. Lucy is still not safe from assault by night in spite of the garlic flowers Van Helsing got for her protection against the supernatural. Dracula comes flapping at her window in the guise of a bat.
- One of those big bats that they call vampires had got at her in the night, and what with his gorge and the vein left open, there wasn't enough blood in her to let her stand up, and I had to put a bullet through her as she lay.
  - Dracula, Chapter 12. **Quincey Morris** tells the others how a **mare** that he was fond of was attacked by a **vampire bat** when he was on the **Pampas**.
    - **Quincey is a rich American from Texas, carries a Bowie knife.**
    - [https://en.wikipedia.org/wiki/Quincey\\_Morris](https://en.wikipedia.org/wiki/Quincey_Morris)
- There was a full moonlight, and I could see that the noise was made by a great bat, which wheeled around, doubtless attracted by the light, although so dim, and every now and again struck the window with its wings.
  - Dracula, Chapter 12. As he and the others watch over the ill Lucy, Dr. Seward heard a dull flapping or buffeting at the window. When he goes to take a loo, he sees that it is a large bat – it is Dracula!
- Can you tell me why in the Pampas, ay and elsewhere, there are bats that come out at night and open the veins of cattle and horses and suck dry their veins, how in some islands of the Western seas there are bats which hang on the trees all day, and those who have seen describe as like giant nuts or pods, and that when the sailors sleep on the deck, because that it is hot, flit down on them and then, and then in the morning are found dead men, white as even Miss Lucy was?
  - Dracula, Chapter 14. **Van Helsing** challenges Dr. John Seward's rigid scientific thinking. He puts the case for believing in vampire bats that suck the blood of other creatures and prey on human beings like Lucy.
- Do you mean to tell me that Lucy was bitten by such a bat, and that such a thing is here in London in the nineteenth century?
  - Dracula, Chapter 14. An incredulous Dr. John Seward to Van Helsing. He cannot seem to believe that there could be vampire bats in modern, 19th century London.

- This vampire which is amongst us...can command all the meaner things, the rat, and the owl, and the bat, the moth, and the fox, and the wolf, he can grow and become small, and he can at times vanish and come unknown.
  - Dracula, Chapter 18. Van Helsing on the supernatural powers Count Dracula has and how he can command all the "meaner" animals at will.
- He can transform himself to wolf...he can be as bat.
  - Dracula, Chapter 18. With his supernatural powers Dracula has the power to change himself into a wolf or bat, says Van Helsing.
- The Count, even if he takes the form of a bat, cannot cross the running water of his own volition, and so he cannot leave the ship. As he dare not change to man's form without suspicion, which he evidently wishes to avoid, he must remain in the box.
  - Dracula, Chapter 25. If the vampire hunters board Dracula's ship by daylight, the Count will be trapped in his box, Jonathan Harker writes. So the group's opportunity will be to get on the boat between sunrise and sunset, Van Helsing suggests.

- <https://www.allgreatquotes.com/dracula-quotes-96/>

- <https://en.wikipedia.org/wiki/Dracula> [book]
- [https://en.wikipedia.org/wiki/Bram\\_Stoker](https://en.wikipedia.org/wiki/Bram_Stoker)

## Horse blood loss

### Advanced Trauma Life Support Classification Scheme: Criteria for Estimating Blood Loss in Humans

Class	Pulse Rate (per min)	Blood Pressure	Central Nervous System Status	Urine Output	Estimation of Blood Loss
I	<100 (horse <40)*	Normal	Mild anxiety	Normal	<15%
II	>100 (horse 40-60)*	Normal	Anxious, agitated	Decreased	15%-30%
III	>120 (horse 60-80)*	Decreased	Confused, delirium	Minimal	30%-40%
IV	>140 (horse >80)*	Decreased/Pulse pressure undetectable	Obtunded, comatose	None	>40%

\* Suggested modified heart rate responses in horses with hemorrhage.

### ATLS for horses

- Source
  - <https://veteriankey.com/internal-hemorrhage-and-resuscitation/>

### Horse Hemorrhagic Shock

- ATLS grades ([veteriankey.com](https://veteriankey.com))
  - I Mild

- II Mild to Moderate
- III Moderate to Severe
- IV Severe
  - High risk for death.
- Horse blood volume
  - Blood volume = 8% of BW
  - Example
    - 500 kg horse x 8% = 40 L blood = 40,000 ml = 169 cups = 1353 oz.
    - Verbatim
      - Blood volume of an adult horse is approximately 8% of body weight, thus a 500kg individual has 40L of blood.
      - [https://www.google.com/url?sa=i&rct=j&q=&esrc=s&source=web&cd=&ved=0CAIQw7AJahcKEwjQpe6DsYn\\_AhUAAAAAHQAAAAAQAg&url=https%3A%2F%2Fwww.jorvet.com%2Fwp-content%2Fuploads%2F2012%2F01%2FEquineTransfusionMedicine.pdf&psig=AOvVaw2aUCejXodmxio\\_lld1Rpp1&ust=1684859524709094](https://www.google.com/url?sa=i&rct=j&q=&esrc=s&source=web&cd=&ved=0CAIQw7AJahcKEwjQpe6DsYn_AhUAAAAAHQAAAAAQAg&url=https%3A%2F%2Fwww.jorvet.com%2Fwp-content%2Fuploads%2F2012%2F01%2FEquineTransfusionMedicine.pdf&psig=AOvVaw2aUCejXodmxio_lld1Rpp1&ust=1684859524709094)
        - This does not want to open.

# Page 106 – Bat Trial #6 99 Dogs

## Vampire bat distribution



Distribution

- As per Wik – vampire bat
  - Americas
    - Mexico to Brazil / Argentina / Uruguay / Chile
- *Present and Potential Future Distribution of Common Vampire Bats in the Americas and the Associated Risk to Cattle*
  - **Map above**
  - <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0042466>

#### List of dog breeds

- Point is, **Human rabies** is caused 99% of the time by rabid dogs, and 1% by rabid bats. But bats seemed to get blamed. **So don't be a douchebag and kill bats.**
- Pages 106 and 107 were the last drawings of the entire book. First I drew in pencil on regular paper, then scanned to 65-pound cardstock, then colored the 99 dogs and 1 bat with MICRON fine-tip markers, then finally gave every dog a name. A few of them are dogs I have known personally – **Butler, Tilly, Niko, Toaster, Jack, Fozzie, Tumbler, Gryfn, Dash** ... to those of you who have gone to the big doghouse in the sky, you are missed.
- [https://en.wikipedia.org/wiki/List\\_of\\_dog\\_breeds](https://en.wikipedia.org/wiki/List_of_dog_breeds)

## Page 107 – Bat Trial #7 99 Dogs

#### List of dog breeds

- [https://en.wikipedia.org/wiki/List\\_of\\_dog\\_breeds](https://en.wikipedia.org/wiki/List_of_dog_breeds)

## Page 108 – Bat Trial #8 Guns, Germs and Steel

### Rabies in bats

#### Bats

- **Bats die in 1 – 3 days of rabies** (pers comm Merlin Tuttle).

#### Rabies in Perspective

- Summary
  - **Rabies transmission from bat to human is exceedingly rare.**
- Source
  - **Merlin Tuttle's Bat Conservation**

- **Merlin Tuttle, PhD** – this man is a legend in the bat community.
- 18 December 2019
- <https://www.merlintuttle.org/rabies-in-perspective/>

## Rabies in dogs and other animals

*Rabies.* Merck Manual – Veterinary Manual. **Charles E. Rupprecht**. VMD, PhD, Lyssa LLC.

- This is about rabies in *dogs, horses, skunks, and other animals*.
- There's a cute, animated **10 minute** video describing the neurological (brain) effect in dogs.
- There is a description of **Furious Rabies** and **Paralytic Rabies** in dogs.
- Last review/revision **Dec 2019** | Modified **Nov 2022**.
- <https://www.merckvetmanual.com/nervous-system/rabies/rabies>

*Rabies in Dogs.* **Charles E. Rupprecht**. VMD, PhD, Lyssa LLC

- This is about rabies in *dogs*.
- **On the left side of the page** are a dozen links to other neurological problems in dogs.
- Last review/revision **Feb 2018** | Modified **Oct 2022**
- <https://www.merckvetmanual.com/dog-owners/brain,-spinal-cord,-and-nerve-disorders-of-dogs/rabies-in-dogs>

## Guns, Germs, and Steel

*Guns, Germs, and Steel*

- Summary
  - *Guns, Germs, and Steel: The Fates of Human Societies* was written by **Jared Diamond**.
  - Chapter 7 and Chapter 11 have a fantastic summary of **zoonotic diseases** (when a bacteria or virus spreads from animals to humans).
  - This book got the **Pulitzer Prize**. It is *amazing*. It takes effort to read but you will be 50 x more informed afterwards. Yeah, not 10 x. More like 50 x.
  - One (of many) questions the book poses is: Why wasn't it the **Incas** who sailed east across the Atlantic Ocean and conquered Spain? Why didn't they have sailing ships and guns and cannons?
  - The level of information is incredible. He goes into nitty gritty detail.
    - What large animals can be domesticated to work on farms? **Cows**? Yes. The **Cape buffalo** in Africa? No, it's violent. **Llamas** in South America? No, they are sketchy. Hence, part of your success as a society (we're talking thousands of years ago) is simply based on whether animals on your continent can be domesticated. Nothing to do with your human talents, per se.
    - Exactly what kind of seeds grew in ancient Mesopotamia?
    - If you develop metallurgy and then make **guns**, you will decimate any civilization you encounter who is even a little bit behind you.
    - That just scratches the surface.
    - You will NEVER get this level of learning anywhere else. Seriously, it's worth the effort.
- Source
  - Amazon.com
    - You can **Look inside**.
    - <https://www.amazon.com/Guns-Germs-Steel-Fates-Societies-ebook/dp/B06X1CT33R>
  - Wikipedia
    - [https://en.wikipedia.org/wiki/Guns,\\_Germs,\\_and\\_Steel](https://en.wikipedia.org/wiki/Guns,_Germs,_and_Steel)

# Page 109 – Bat Trial #9 Dracula

Dracula castle in Romania





That's the castle of **Vlad the Impaler** a.k.a. **Dracula** in Romania. I took that photo in 2023. First you drive the **Transfăgărășan Highway** featured on **Top Gear** (I drove it from north to south), right up a high mountain pass with the freshest air imaginable, then downhill and past a dam, then the castle is a few kilometers past the dam ... and very easy to miss.

- Here's the location on **Google Maps**.
  - <https://www.google.com/maps/place/Poenari+Citadel/@45.360702,24.6432947,14z/data=!4m14!1m7!3m6!1s0x40b347e5a415de31:0xcf922792d921ab7f!2sBran+Castle!8m2!3d45.5149022!4d25.3671637!16zL20vMDJnbXk3!3m5!1s0x474cd881af3bbf57:0x9b4b14bcaba3863e!8m2!3d45.3537043!4d24.6350454!16zL20vMDh5Zzln?entry=ttu>
- There's another 'Dracula' castle called the Bran Castle but that's not the real castle.

## Dracula tomb in Romania



This is where **Vlad the Impaler** is buried ... well, just his body ... he was beheaded. This is the **Snagov Monastery** – it's not too far from the airport in **Budapest**.

- **Google Maps**

- <https://www.google.com/maps/place/%22Snagov%22+Monastery/@44.7295368,26.1731477,17z/data=!3m1!4m6!3m5!1s0x40b2239fa6729929:0xa9d063afae9635c7!8m2!3d44.729533!4d26.175728!16s%2Fq%2F120n34w0?entry=ttu>



That's Vlad the Impaler ... he looks a touch testy. This is outside the monastery.

- Apparently beheading was a very popular method of killing people back in his day. Like, everyone did it. But Vlad did it on a mass scale.



That's inside the monastery.



That's the tomb ... the lady running the place kept scowling at me ... fortunately it was daytime so she could not summon Vlad.

## Page 110 – Bat Trial #10 Reduction to Absurdity

*Reductio ad absurdum* (Latin) = reduction to absurdity (English)

*Global mortality associated with 33 bacterial pathogens in 2019: a systematic analysis for the Global Burden of Disease Study 2019*

- Verbatim
  - **Background**
  - Reducing the burden of death due to infection is an urgent global public health priority. Previous studies have estimated the number of deaths associated with drug-resistant infections and sepsis and found that infections remain a leading cause of death globally. Understanding the global burden of common bacterial pathogens (both susceptible and resistant to antimicrobials) is essential to identify the greatest threats to public health. To our knowledge, this is the first study to present global comprehensive estimates of deaths associated with 33 bacterial pathogens across 11 major infectious syndromes.
  - **Methods**
  - We estimated deaths associated with 33 bacterial genera or species across 11 infectious syndromes in 2019 using methods from the Global

Burden of Diseases, Injuries, and Risk Factors Study (GBD) 2019, in addition to a subset of the input data described in the Global Burden of Antimicrobial Resistance 2019 study. This study included 343 million individual records or isolates covering 11 361 study-location-years. We used three modelling steps to estimate the number of deaths associated with each pathogen: deaths in which infection had a role, the fraction of deaths due to infection that are attributable to a given infectious syndrome, and the fraction of deaths due to an infectious syndrome that are attributable to a given pathogen. Estimates were produced for all ages and for males and females across 204 countries and territories in 2019. 95% uncertainty intervals (UIs) were calculated for final estimates of deaths and infections associated with the 33 bacterial pathogens following standard GBD methods by taking the 2.5th and 97.5th percentiles across 1000 posterior draws for each quantity of interest.

- **Findings**

- From an estimated 13.7 million (95% UI 10.9–17.1) infection-related deaths in 2019, there were 7.7 million deaths (5.7–10.2) associated with the 33 bacterial pathogens (both resistant and susceptible to antimicrobials) across the 11 infectious syndromes estimated in this study. We estimated deaths associated with the 33 bacterial pathogens to comprise 13.6% (10.2–18.1) of all global deaths and 56.2% (52.1–60.1) of all sepsis-related deaths in 2019. Five leading pathogens—*Staphylococcus aureus*, *Escherichia coli*, *Streptococcus pneumoniae*, *Klebsiella pneumoniae*, and *Pseudomonas aeruginosa*—were responsible for 54.9% (52.9–56.9) of deaths among the investigated bacteria. The deadliest infectious syndromes and pathogens varied by location and age. The age-standardised mortality rate associated with these bacterial pathogens was highest in the sub-Saharan Africa super-region, with 230 deaths (185–285) per 100 000 population, and lowest in the high-income super-region, with 52.2 deaths (37.4–71.5) per 100 000 population. *S aureus* was the leading bacterial cause of death in 135 countries and was also associated with the most deaths in individuals older than 15 years, globally. Among children younger than 5 years, *S pneumoniae* was the pathogen associated with the most deaths. In 2019, more than 6 million deaths occurred as a result of three bacterial infectious syndromes, with lower respiratory infections and bloodstream infections each causing more than 2 million deaths and peritoneal and intra-abdominal infections causing more than 1 million deaths.

- **Interpretation**

- The 33 bacterial pathogens that we investigated in this study are a substantial source of health loss globally, with considerable variation in their distribution across infectious syndromes and locations. Compared with GBD Level 3 underlying causes of death, deaths associated with these bacteria would rank as the second leading cause of death globally in 2019; hence, they should be considered an urgent priority for intervention within the global health community. Strategies to address the burden of bacterial infections include infection prevention, optimised use of antibiotics, improved capacity for microbiological analysis, vaccine development, and improved and more pervasive use of available vaccines. These estimates can be used to help set priorities for vaccine need, demand, and development.

- **Funding**

- Bill & Melinda Gates Foundation, Wellcome Trust, and Department of Health and Social Care, using UK aid funding managed by the Fleming Fund.

- **Source**

- **The Lancet**
  - 21 November 2022

- This is the authors: **GBD 2019 Antimicrobial Resistance Collaborators**
- There's about 100 authors
- [https://www.thelancet.com/journals/lancet/article/PIIS0140-6736\(22\)02185-7/fulltext#%20](https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(22)02185-7/fulltext#%20)

### *Bacterial infections the 'second leading cause of death worldwide'*

- Yahoo News
  - 21 November 2022
  - [https://sg.news.yahoo.com/bacterial-infections-second-leading-cause-233009457.html?guccounter=1&guce\\_referrer=aHR0cHM6Ly90LmNvL3BJUkU3TGozYIE&guce\\_referrer\\_sig=AQAAAGjdRFb8uFMz4NMmDJg8qkE0\\_M0K20TnJ5TKInqYMc68Pa61rOKxJbywvjXb1DjpUFWvCZ2yilJu\\_HYhoEEG8MXVMOKRzvm4PM3ptn-7MLDWhg-v6wnHIJr-CbTvk4MI\\_v-GHo179OI0dM44h9rDG5mVrJVpK\\_ffZtY2wcJUkCKE&utm\\_source=Nature+Briefing&utm\\_campaign=bcc3fadf2e-briefing-dy-20221123&utm\\_medium=email&utm\\_term=0\\_c9dfd39373-bcc3fadf2e-43234521](https://sg.news.yahoo.com/bacterial-infections-second-leading-cause-233009457.html?guccounter=1&guce_referrer=aHR0cHM6Ly90LmNvL3BJUkU3TGozYIE&guce_referrer_sig=AQAAAGjdRFb8uFMz4NMmDJg8qkE0_M0K20TnJ5TKInqYMc68Pa61rOKxJbywvjXb1DjpUFWvCZ2yilJu_HYhoEEG8MXVMOKRzvm4PM3ptn-7MLDWhg-v6wnHIJr-CbTvk4MI_v-GHo179OI0dM44h9rDG5mVrJVpK_ffZtY2wcJUkCKE&utm_source=Nature+Briefing&utm_campaign=bcc3fadf2e-briefing-dy-20221123&utm_medium=email&utm_term=0_c9dfd39373-bcc3fadf2e-43234521)
    - Christopher J.L. Murray - Professor; IHME Director; Chair, Department of Health Metrics Sciences, [University of Washington](https://www.healthdata.org/about/christopher-jl-murray).
    - <https://www.healthdata.org/about/christopher-jl-murray>



## CHAPTER 4 - CORONAVIRUS – IT HAS MORE PERSONALITY THAN YOU THOUGHT

Page 111

# Page 112 – Taxonomy #1


## Take-home message

Okay, dear reader, supposed you want to examine the **genetic code** of the *coronavirus*. You have 2 options:

- Option 1 – Examine every single coronavirus that exists.  Proceed to Option 1.
- Option 2 – Chose only from the coronaviruses in this guide.  Proceed to Option 2.

## Option 1


Option 1

- Summary
  - Everything under the sun that coronavirus infects is in the 5 links below. The coronavirus comes in 4 flavors: – Alpha, Beta, Gamma, Delta. Plus a 5<sup>th</sup> that's a catch-all for what's left over.
- Suggestion
  -  Open a new window in your browser. To be clear, a new *window*, not a new *tab*.
    - Apple: Command-N
    - PC: Control-N
  - Now click on each of those 5 links, in order.
  - Now you can see the full array of every animal that coronavirus infects.

- If you are interested in a particular one, click on it, then follow the instructions further below called [NCBI Investigation sequence](#).
- Links
  - *Alpha*
    - <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Tree&id=693996&lvl=3&lin=f&keep=1&srchmode=1&unlock>
  - *Beta*
    - <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Tree&id=694002&lvl=3&lin=f&keep=1&srchmode=1&unlock>
  - *Gamma*
    - <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Tree&id=694013&lvl=3&lin=f&keep=1&srchmode=1&unlock>
  - *Delta*
    - <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Tree&id=1159901&lvl=3&lin=f&keep=1&srchmode=1&unlock>
  - Unclassified
    - <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Tree&id=2664420&lvl=3&lin=f&keep=1&srchmode=1&unlock>
- Source
  - NCBI Taxonomy Browser
    - National Center for Biotechnology Information (NCBI).

## Option 2

### Option 2

-  Click on whichever coronavirus interests you, then follow the instructions further below called [NCBI Investigation sequence](#).

## Bats

These are literally only 5 of dozens of bat coronaviruses.

### *Miniopterus bat coronavirus 1*

- Alpha
- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Tree&id=694000&lvl=3&lin=f&keep=1&srchmode=1&unlock>

### *Pipistrellus bat coronavirus HKU5*

- Beta
- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Tree&id=694008&lvl=3&lin=f&keep=1&srchmode=1&unlock>
- Verbatim

#### *Bat coronavirus P.pyg/GER/9848/2014*

- NCBI
  - [KT894926](#)  
Bat coronavirus P.pyg/GER/9848/2014 isolate 2830 RNA-dependent RNA polymerase (RdRp) gene, partial cds (Fischer, K., et al.)
  - **Attributes**
  - **Nuc Completeness:** partial
  - **Length:** 309
  - **Mol Type:** RNA

- **Host:** *Pipistrellus pygmaeus*
- **Isolate:** feces
- **Geo Location:** Germany
- **Collection Date:** 2013

#### *Rhinolophus Bat Alphacoronavirus strain MJ\_69C*

- Alpha
- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Info&id=1699349&lvl=3&lin=f&keep=1&srchmode=1&unlock>

#### *Rousettus bat coronavirus HKU9*

- Beta
- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Tree&id=694006&lvl=3&lin=f&keep=1&srchmode=1&unlock>

#### *Tylonycteris bat coronavirus HKU4*

- Beta
- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Tree&id=694007&lvl=3&lin=f&keep=1&srchmode=1&unlock>

## Birds

#### *Bulbul coronavirus HKU11*

- Delta
- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Tree&id=574549&lvl=3&lin=f&keep=1&srchmode=1&unlock>

#### *Avian coronavirus*

- Gamma
- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Tree&id=694014&lvl=3&lin=f&keep=1&srchmode=1&unlock>

## Cats

#### *Feline coronavirus*

- Alpha
- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Tree&id=12663&lvl=3&lin=f&keep=1&srchmode=1&unlock>

#### *Acinonyx jubatus coronavirus* (Cheetah)

- Alpha
- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Info&id=263509&lvl=3&lin=f&keep=1&srchmode=1&unlock>

## Dogs



### *Canine coronavirus*

- Alpha
- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Tree&id=11153&lvl=3&lin=f&keep=1&srchmode=1&unlock>

## Hedgehog

### *Hedgehog coronavirus 1*

- Beta
- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Tree&id=1965093&lvl=3&lin=f&keep=1&srchmode=1&unlock>

## Camel

### *Camel coronavirus HKU23*

- Beta
- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Info&id=1699096&lvl=3&lin=f&keep=1&srchmode=1&unlock>

## Pangolin

### *Pangolin coronavirus*

- Beta
- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Info&id=2708335&lvl=3&lin=f&keep=1&srchmode=1&unlock>

## Pig

### *Porcine enteric alphacoronavirus*

- Alpha
- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Info&id=2018513&lvl=3&lin=f&keep=1&srchmode=1&unlock>

### *Porcine epidemic diarrhea virus*

- Alpha
- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Tree&id=28295&lvl=3&lin=f&keep=1&srchmode=1&unlock>

## Mouse

### *Murine coronavirus*

- Beta

- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Tree&id=694005&lvl=3&lin=f&keep=1&srchmode=1&unlock>

## Marine mammals

### *Beluga whale coronavirus SW1*

- Gamma
- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Tree&id=694015&lvl=3&lin=f&keep=1&srchmode=1&unlock>

### *Harbor seal coronavirus 1*

- Alpha
- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Info&id=679171&lvl=3&lin=f&keep=1&srchmode=1&unlock>

### *Bottlenose dolphin coronavirus HKU22*

- Gamma
- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Info&id=1433215&lvl=3&lin=f&keep=1&srchmode=1&unlock>

## Humans

### Full name

### Short name

### *Human coronavirus 229E*

### *HCoV-229E*

- Alpha
- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Tree&id=11137&lvl=3&lin=f&keep=1&srchmode=1&unlock>

### *Human coronavirus NL63*

### *HCoV-NL63*

- Alpha
- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Tree&id=277944&lvl=3&lin=f&keep=1&srchmode=1&unlock>

### *Human coronavirus HKU1*

### *HCoV-HKU1*

- Beta
- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Tree&id=290028&lvl=3&lin=f&keep=1&srchmode=1&unlock>

### *Human coronavirus OC43*

### *HCoV-OC43*

- Beta
- That's "O" as in "Oscar" in OC43.
- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Info&id=31631&lvl=3&lin=f&keep=1&srchmode=1&unlock>

*Severe acute respiratory syndrome coronavirus**SARS-CoV*

- Beta
- This virus is the cause of the **SARS pandemic** of 2003.
- 
- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Tree&id=2901879&lvl=3&lin=f&keep=1&srchmode=1&unlock>

*Middle East respiratory syndrome-related coronavirus*    *MERS-CoV*

- Beta
- This virus is the cause of the **MERS pandemic** of 2012.
- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Tree&id=1335626&lvl=3&lin=f&keep=1&srchmode=1&unlock>

*Severe acute respiratory syndrome coronavirus 2**SARS-CoV-2*

- Beta
- This virus is the cause of the **COVID-19 pandemic** that started in 2019.
- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Info&id=2697049&lvl=3&lin=f&keep=1&srchmode=1&unlock>

## NCBI Investigation Sequence



Let's say you want to look at the genome (genetic code) of the coronavirus that infects the **alpaca**. 🖐️ Follow the steps below.

1 match Begins with

**NCBI Taxonomy Browser**

Entrez PubMed Nucleotide Protein Genome Structure PMC Taxonomy BioCollections

Search for:

Display: 3 levels using filter: [none]

Nucleotide  Protein  Structure  Genome  Popset  SNP  Conserved Domains  GEO Datasets  PubMed Central  
 Gene  HomoloGene  SRA Experiments  LinkOut  BLAST  GEO Profiles  Protein Clusters  Identical Protein Groups  SPARCLE  
 BioProject  BioSample  Assembly  dbVar  Genetic Testing Registry  Host  Viral Host  PubChem BioAssay

Lineage (full): [Viruses](#); [Riboviria](#); [Orthornavirae](#); [Pisuviricota](#); [Pisoniviricetes](#); [Nidovirales](#); [Cornidovirineae](#); [Coronaviridae](#); [Orthocoronavirinae](#)

- [Alphacoronavirus](#) Click on organism name to get more information.
  - [Alphacoronavirus CHB25](#)
    - [Hipposideros pomona bat coronavirus CHB25](#)
  - [Alphacoronavirus HKU33](#)
    - [Tylonycteris bat coronavirus HKU33](#)
  - [Colacovirus](#)
    - [Bat coronavirus CDPHE15](#)
      - [Bat coronavirus CDPHE15/USA/2006](#)
      - [Myotis lucifugus coronavirus](#)
    - [unclassified Colacovirus](#)
      - [Colacovirus sp.](#)
  - [Decacovirus](#)
    - [Bat coronavirus HKU10](#)
      - [Hipposideros bat coronavirus HKU10](#)
      - [Rousettus bat coronavirus HKU10](#)
    - [Rhinolophus ferrumequinum alphacoronavirus HuB-2013](#)
      - [Alphacoronavirus BiMs-AlphaCoV/GS2013](#)
      - [BtRF-AlphaCoV/HuB2013](#)
    - [unclassified Decacovirus](#)
      - [Hipposideros pomona bat coronavirus HKU10-related](#)
      - [Rhinolophus bat coronavirus HKU32](#)
      - [Decacovirus sp.](#)
  - [Duvinacovirus](#)
    - [Human coronavirus 229E](#)
      - [229E-related bat coronavirus](#)
      - [Alpaca respiratory coronavirus](#)
      - [Camel alphacoronavirus](#)
      - [Camel alphacoronavirus Camel229E](#)
    - [unclassified Duvinacovirus](#)
      - [Rousettus aegyptiacus bat coronavirus 229E-related](#)
  - [Luchacovirus](#)
    - [Lucheng Rn rat coronavirus](#)
    - [unclassified Luchacovirus](#)
      - [Alphacoronavirus L232](#)
      - [Alphacoronavirus PLMg1](#)
      - [Alphacoronavirus UKMa1](#)
      - [Alphacoronavirus UKRn3](#)
      - [Coronavirus AcCoV-IC34](#)
  - [Minacovirus](#)
    - [Ferret coronavirus](#)
      - [Ferret enteric coronavirus](#)
      - [Ferret systemic coronavirus](#)
    - [Mink coronavirus I](#)
      - [Mink coronavirus strain WD1127](#)



Click on this link.

- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Tree&id=693996&lvl=3&lin=f&keep=1&srchmode=1&unlock>
- The page above will open.



Click on 'Alpaca respiratory coronavirus'. It's under the heading 'Duvinacovirus' (which is just more classification of coronavirus).

**Alpacac respiratory coronavirus**

Taxonomy ID: 1176035 (for references in articles please use NCBI:taxid:1176035)

current name  
**Alpacac respiratory coronavirus**

NCBI BLAST name: **viruses**  
 Rank: **no rank**  
 Genetic code: [Translation table 1 \(Standard\)](#)  
 Host: human/vertebrates

[Lineage \(full\)](#)  
[Viruses](#); [Riboviria](#); [Orthomavirae](#); [Pisuviricota](#); [Pisoniviricetes](#); [Nidovirales](#); [Cornidovirineae](#); [Coronaviridae](#); [Orthocoronavirinae](#); [Alphacoronavirus](#); [Duvinacovirus](#); [Human coronavirus 229E](#)

[View and Analyze sequences in NCBI Virus](#)  
[ICTV homepage](#)

**External Information Resources (NCBI LinkOut)**

LinkOut	Subject	LinkOut Provider
<a href="#">Show Biotic Interactions</a>	taxonomy/phylogenetic	<a href="#">Global Biotic Interactions</a>

Notes:  
 Groups interested in participating in the LinkOut program should visit the [LinkOut home page](#).  
 A list of our current non-bibliographic LinkOut providers can be found [here](#).

This page will open.

- Click on the 'View and Analyze sequences in NCBI Virus' link about ¾ down the page on the left.

**Explore Virus Data**

Download ▾ Popular Searches: Influenza virus, Dengue virus, Zika virus, Ebola virus, Rotavirus, West Nile virus, MERS coronavirus, SARS-CoV-2 coronavirus

Tabular View Selected Results: 0 [Align](#) [Build Phylogenetic Tree](#)

**New Submitters' Information available**  
 We appreciate the effort from all involved in collecting samples and making sequence data publicly available. In order to facilitate citations and acknowledgements, we are adding information describing submitters, including affiliated organizations or institutions provided during submission. Although table columns may display abbreviated information, complete entries can be viewed by hovering over entries and are available by downloading the metadata table. We are continuing to refine the availability of this information and feedback is appreciated.

Refine Results [Reset](#)

Virus: [Alpacac respiratory coronavirus, taxid:1176035](#)

Accession	Submitters	Organization	Release Date	Isolate	Species	Molecule type	Length	Geo Location	USA
<a href="#">JQ410000</a>	Crossley,...	GTCAllison,...	2012-04-29	CA08...	Huma...	ssRNA(+)	27374	USA	

This page will open.

- Click on 'JQ410000'.

**Nucleotide Details**

[JQ410000](#)  
 Alpacac respiratory coronavirus isolate CA08-1/2008, complete genome (Crossley,B.M., et al.)


**Attributes**  
 Nuc Completeness: complete  
 Length: 27374  
 Mol Type: RNA  
 Host: Vicugna pacos  
 Geo Location: USA  
 Collection Date: 2008

**Submitters Names**  
 Crossley,B.M., Mock,R.B., Callison,S.A., Hietala,S.K.

**Organization (Submitters' Institutional Affiliation)**  
 GTCAllison, LLC

**Affiliation Location**  
 USA

The box at right will open.

-  Click on 'JQ41000' in the box at the far right.



Nucleotide

Nucleotide

Advanced

GenBank ▾

## Alpaca respiratory coronavirus isolate CA08-1/2008, complete genome

GenBank: JQ410000.1

[FASTA](#) [Graphics](#)
Go to: 

**LOCUS** JQ410000 27374 bp RNA linear VRL 29-APR-2012  
**DEFINITION** Alpaca respiratory coronavirus isolate CA08-1/2008, complete genome.  
**ACCESSION** JQ410000  
**VERSION** JQ410000.1  
**KEYWORDS** .  
**SOURCE** Alpaca respiratory coronavirus  
**ORGANISM** [Alpaca respiratory coronavirus](#)  
 Viruses; Riboviria; Orthornavirae; Pisuviricota; Pisoniviricetes; Nidovirales; Coronidovirineae; Coronaviridae; Orthocoronavirinae; Alphacoronavirus; Duvinacovirus; Human coronavirus 229E.  
**REFERENCE** 1 (bases 1 to 27374)  
**AUTHORS** Crossley,B.M., Mock,R.B., Callison,S.A. and Hietala,S.K.  
**TITLE** Identification and characterization of a novel alpaca respiratory coronavirus most closely related to the human coronavirus 229E  
**JOURNAL** Unpublished  
**REFERENCE** 2 (bases 1 to 27374)  
**AUTHORS** Crossley,B.M., Callison,S.A., Mock,R.B. and Hietala,S.K.  
**TITLE** Direct Submission  
**JOURNAL** Submitted (14-JAN-2012) GTCALLISON, LLC, 153 Junction Road, Mocksville, NC 27028, USA  
**FEATURES** Location/Qualifiers  
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 /mol\_type="genomic RNA"  
 /isolate="CA08-1/2008"  
 /host="Vicugna pacos"  
 /db\_xref="taxon:[1176035](#)"  
 /country="USA"  
 /collection\_date="2008"  
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[CDS](#) join(293..12532,12532..20580)  
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This page will open.

- **Now you can view 2 things:**
  - **The proteome** ("pro tee ome" – ome rhymes with home). These are 20 letters that represent the 20 amino acids that make a protein. What you see in the screenshot above are thousands of letters in a specific sequence, starting with **MAC** (highlighted in blue) ... which are the **M**ethionine, **A**lanine, and **C**ysteine. Do not confuse these letters with c, g, a, t.

- **The genome** which is the genetic code of letters c, g, a, t. It is the screenshot below.

ORIGIN

```

1  acttaagtgt  cttatctatc  tatagataga  aaagtcgctt  tttagacttt  gtgtctactc
61  ttctcaacta  aacgaaattt  ttgctacggc  cggcatctct  gatgctggag  tcgtggcgta
121  attgaaattt  catttggggtt  gcaacagttt  ggaataaagt  gctgtgcgct  ctagtctaag
181  ggttctgtgt  tctgtcacgg  gattccattc  tataaacgcc  ttactcgagg  ttctgtctcg
241  tgttgtgtg  gaagcaaagt  tctgtctttg  tggaaaccag  taactgttcc  taatggcctg
301  caaccgtgtg  acacttgccg  tagcaagtga  tactgaaatt  tctgcaactg  gttgctctac
361  tattgcgcta  gccgtccgcc  gctatagcga  ggccgctagc  aatggattta  gagcatgccg
421  atttgtttca  tttggcttgc  atgattgcgt  tgttggcatt  gcaaacgacg  actatgcat
481  gggtttgc  ggttaaccaa  cgttgcctg  caataaatg  aaattttctg  accgtccctt
541  tatgcttctg  ggttgggttg  tttttccaa  ttcaaattac  ctcttggagg  agttttagt
601  tctcttcggt  aagagaggtg  gtgtaaatgt  gacatacact  gaccagtatc  tctgtggcgc
661  cgatggcaaa  cctgtcataa  gtgatgatt  atggcagttt  gttgaccatt  tcggtgaaaa
721  cgaagaatt  atcatcaatg  gtcatactta  cgtttgtgct  tggcttacta  agcgcgaagc
781  tttagattac  aaacgctcaga  acaaccttgc  cattgaagag  attgaatatg  tgcgtggcga
841  tgctttgc  acactacgca  atggttctgt  tcttgaatg  gctaaggaag  tgaagacatc
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1021  tgttcaatgt  acttgtggca  acaagcttgc  gtctgcggt  gattggactg  gttttaaatac
1081  cactgctgt  aatgtgctca  gtaagaaact  gtgtgtgtt  cccggtaatg  ttaaactggt
1141  tgacgctgtg  gttactactc  agcaagctgg  tgttgggtt  aagtactttt  gtggcatgac
1201  tcttaagttt  gttgcaaca  ttgaaggtgt  ctctgtttg  cgagtaatcg  ctgttcagag
1261  tgtggatgga  tttgttctt  ctgctacttt  ttagaggag  gaacatgcta  acagaatgga
1321  tacattctgc  ttcaatgtac  gcaatagcac  tactgatgag  tctcgtttg  ccatgttggg
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1441  cgttgggtt  gatgtttatg  atgacatctt  tgcgtaaaac  aaaccatggt  ttgttcgcaa
1501  ggcctgaagac  attttggcc  cgtgttggc  tgctcttgtt  tctgtgctta  aacagcttaa
1561  agtactaca  ggtgaactta  tgaggtttgc  taagtctatt  tgcagttcag  ctgttgcgt
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1801  tgtaccata  aagcttaagg  gcgttcgccc  aagtgccctt  aaaaacagtt  agtatgcaac
1861  agctgtgtt  ggttccactg  aagaagttaa  atcttcacgt  gttgaacgta  gcactgctgt
1921  acttacaact  gccaaataact  accccaaact  ttcagatgag  ggttatactg  ccgtaattgg
1981  cgatgtggc  factttgtta  gtgatggcga  ctccgctctt  atggccagtc  caaatagtgt
2041  gttgactact  gcagcttata  aaccttgtt  tgcttttaac  gtgaatgta  tgggtactag
2101  acctgaaaa  tttccaacca  ttgtgacttg  tgaaaattta  gactctgccg  ttttatttgt
2161  taatgacaaa  atcactgaat  ttcaattgga  ttgcagtggt  gatgttatg  acaatgaaat
2221  aattgtcaaa  cctaacatca  gcctgtgtgt  tccactttat  gtgagagact  atgttgacaa
2281  atgggatgat  ttttgcagac  aatatagtaa  cgagtcttgg  ttgaagatg  attatagggc
2341  ttttattagc  gttttgatg  ttgctgacgc  tgaatgtaa  gctgcagagt  ctaaggcttt
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2461  atggagtgga  atcattaagg  ctgttagctc  tgttcagac  tggcttaaat  ctttgaatt
2521  aactcttaca  ccagagggtc  tgtttgttac  ttgtgctaag  cgttttaaac  ggttttaaac
2581  cctcttttta  gagccttaca  atgcattttt  agacactgtg  gtttctattg  ttaagattgg
2641  tggtaagct  tttaaaaagt  atgcatttga  caaaccttat  atgtggtat  gtgatcgt
2701  gtgtaaggt  gagcataaaa  cagatgtcga  ctgggttgg  cttatgccac  gtaatgacag
2761  aattaagtct  tttagtactt  ttgaaaatgc  atacttacct  atgtctgacc  caacacattt
2821  tgatattgaa  gaagttgaac  ttcttgatac  ggaatttgtt  gaaccaggtt  gtggtggtat
2881  tttgcatg  atagatgatc  atgtctttta  taaaaggat  gacatttatt  atccatcaaa
2941  tggtaactaaa  atattaccgg  ttgcattttac  taaagccgcc  ggtggtaaag  tttctttctc
3001  tgacgcagta  gaagttaaag  atattccacc  tgcctataga  gttaaacttt  gctttgagtt
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3481  taactcagtt  atgttacagc  tacaattaac  aggcatactc  gacgatgact  atgctatgca
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3661  cactggttt  atggttatg  actacaaatg  tagttgtacc  agtggtagac  tgaagaatc
3721  ggttccctc  ttgttttga  cacctactaa  gaagcgctt  ccctatggt  ctgtctaaa
3781  ttgtaatgca  cctcgtatgt  gtacaattag  gcagttgcaa  ggtactataa  tatttgtgca
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```

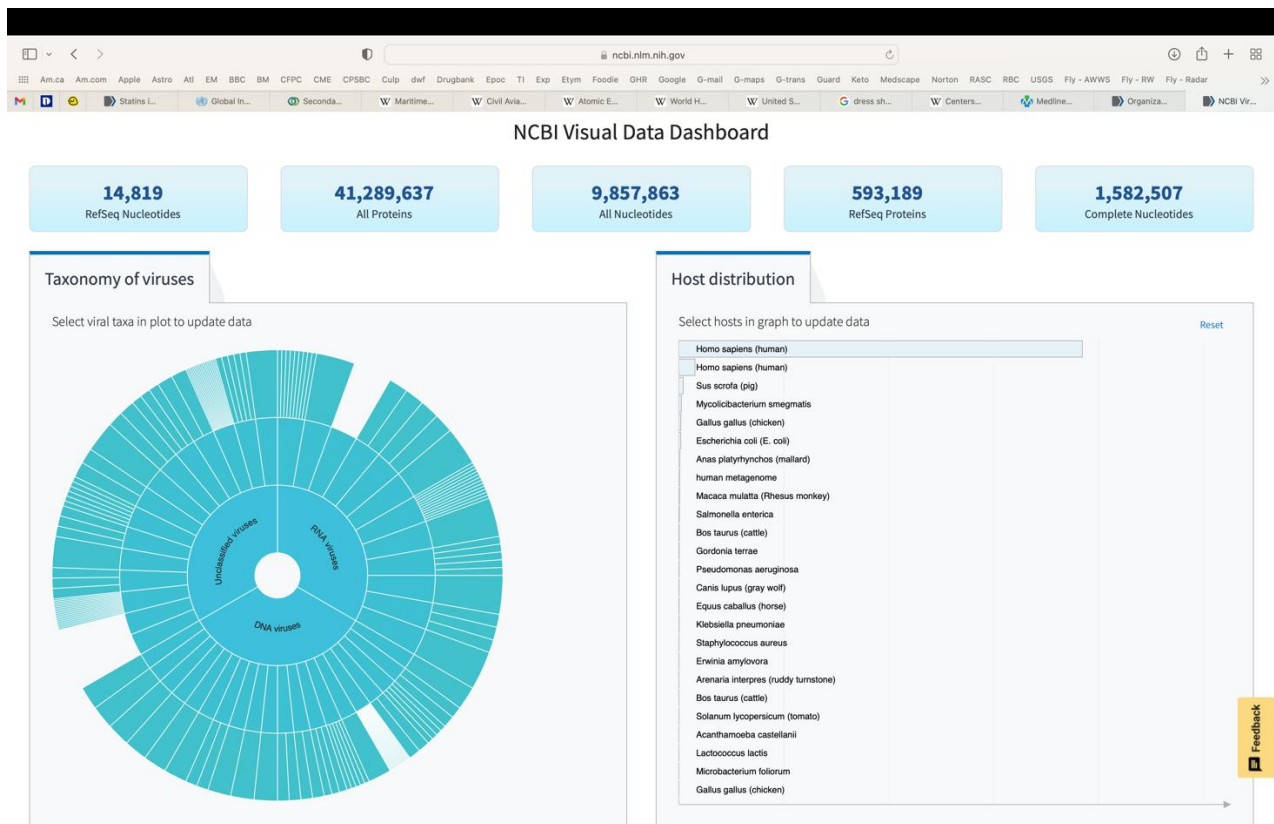
That's the **genetic code** a.k.a. **genome** of the *alpaca coronavirus*. It's a long sequence – about 27,000 letters - of c, g, a, t. It's further down the page.

NCBI

- [Summary](#)



- The **National Center for Biotechnology Information (NCBI)** has a database of the **genetic code of every coronavirus** and thousands of other viruses.
- To make that a bit real, the genetic code for humans contains **19,000** genes (give or take). Each gene is the instructions to make a specific protein. Get it? 19,000 genes code for 19,000 proteins. It's those proteins that make our cells work. For example, insulin is the protein that allows our cells to access glucose (sugar). Is there a genetic code (letters c, g, a, t) for insulin? Yes, in our DNA.
- For coronavirus, it's only **12** genes. It is far simpler than a human.
- These are all synonyms:
  - Genetic code
  - Genome
  - Sequence
  - Base pair sequence
  - Nucleotide sequence
- There is also a database of the **amino acid sequence** of the protein that a particular gene codes for. Restated, proteins are made of amino acids. There are 20 amino acids and they can be arranged into literally billions of different proteins.
- The database is insanely detailed and thorough.
- The NCBI is located in **Bethesda, Maryland, USA**.
- How is the National Center for Biotechnology Information (NCBI) organized?
  - **Computational Biology Branch (CBB)**
    - Genome analysis
    - Structure / function prediction
    - Computer-based analytical tools
  - **Information Engineering Branch (IEB)**
    - Data representation
  - **Information Resources Branch (IRB)**
    - Manages the NCBI computers.
- Why does the URL read like so?
  - [www.ncbi.nlm.nih.gov/Taxonomy/Browser](http://www.ncbi.nlm.nih.gov/Taxonomy/Browser)
  - Because the **National Center for Biotechnology Information (NCBI)** operates under the **National Library of Medicine (NLM)** which operates under the **National Institutes of Health (NIH)** which operates under the **US government**.
- Source
  - <https://www.ncbi.nlm.nih.gov/home/about/>
  - <https://www.ncbi.nlm.nih.gov/home/about/structure/>



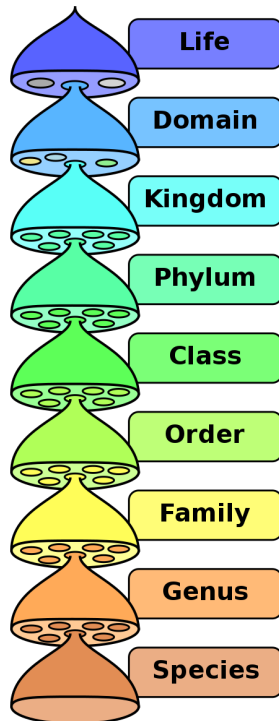
That's the **NCBI** home page of all **viruses**. It's kind of a **DaisyDisk** of viruses.

<https://www.ncbi.nlm.nih.gov/labs/virus/vssi/#/>

# Page 113 – Taxonomy #2

## Sock Drawers

Realm

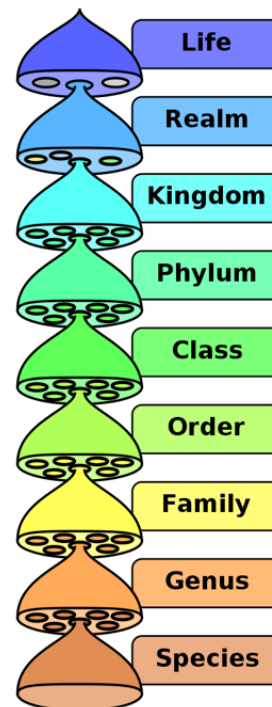


This is how Life is classified.

Notice the Domain.

This is page 86 of *Hidden Zoo*.

[https://en.wikipedia.org/wiki/Kingdom\\_\(biology\)](https://en.wikipedia.org/wiki/Kingdom_(biology))



This is how *viruses* are classified.

**Realm** replaces Domain.

This is page 113 of *Hidden Zoo*.

[https://en.wikipedia.org/wiki/Realm\\_\(virology\)](https://en.wikipedia.org/wiki/Realm_(virology))

## Realm

- Summary

- The diagram on the right is the way that virologists classify viruses. It's similar to that for animals (page 86) except that Domain is replaced by **Realm**. There are 6 Realms of viruses. Realm is only seen when considering viruses.
- The naming of viruses is confusing because it's so heavily infused with Latin.

- Verbatim

In virology, realm is the highest taxonomic rank established for viruses by the International Committee on Taxonomy of Viruses (ICTV), which oversees virus taxonomy. Six virus realms are recognized and united by specific highly conserved traits:

- Adnaviria, which contains archaeal filamentous viruses with A-form double-stranded (ds) DNA genomes encoding a unique alpha-helical major capsid protein;
- Duplodnaviria, which contains all dsDNA viruses that encode the HK97-fold major capsid protein;
- Monodnaviria, which contains all single-stranded DNA (ssDNA) viruses that encode a HUH superfamily endonuclease and their descendants;
- Riboviria, which contains all RNA viruses that encode RNA-dependent RNA polymerase and all viruses that encode reverse transcriptase;

- *Ribozyviria*, which contains hepatitis delta-like viruses with circular, negative-sense ssRNA genomes;
  - *Varidnaviria*, which contains all dsDNA viruses that encode a vertical jelly roll major capsid protein.
- Source
    - [https://en.wikipedia.org/wiki/Realm\\_\(virology\)](https://en.wikipedia.org/wiki/Realm_(virology))

## ICTV

Q - Who comes up with all these virus names?

A - A bunch of virologists from the International Committee on Taxonomy of Viruses (ICTV)



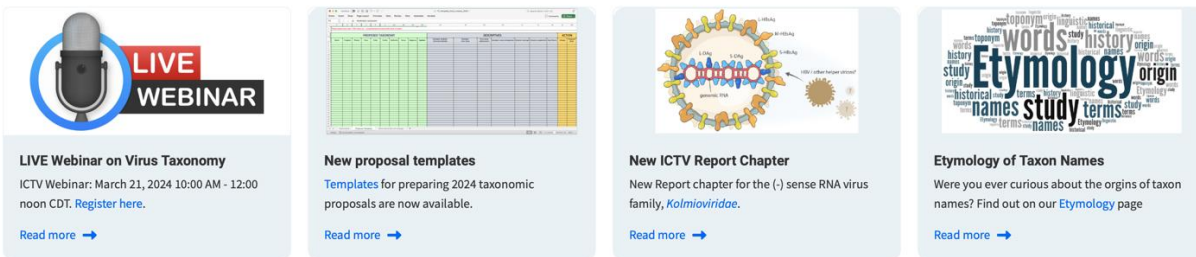
### What's in a name?

- I sent the above drawing (from page 113) to the International Committee on Taxonomy of Viruses (ICTV) and they replied, saying it was slightly off the mark. In reality, the process is like this:
  - The virologist who discovered the virus gets the honor of *naming* it.
  - The ICTV *approves* the stuff like Genus and species.

## Official Taxonomic Resources



## News



### International Committee on Taxonomy of Viruses: ICTV

- Summary
  - This is the home page of the **International Committee on Taxonomy of Viruses (ICTV)**. It's a very sciencey kind of page that beckons sciencey types to explore.
  - **The ICTV classifies viruses. They don't store the genetic code information – see the NCBI stuff on page 112 for that that.**
  - 🖐️ If you click on the **ICTV Taxonomy Browser** at the top left, you can do some serious exploring. My own results are just below.
- Source
  - **International Committee on Taxonomy of Viruses (ICTV)**
    - <https://ictv.global>



ENHANCED BY Google



Home Information Taxonomy Files Discussions Study Groups Meetings ICTV Report Login/Join

– Realm: <i>Riboviria</i>	2 kingdoms, 2 families, 4 genera	history
– Kingdom: <i>Orthornavirae</i> Realm: <i>Riboviria</i>	5 phyla, 2 families, 1 genus	history
+ Phylum: <i>Duplornaviricota</i> Kingdom: <i>Orthornavirae</i>	3 classes	history
+ Phylum: <i>Kitrinoviricota</i> Kingdom: <i>Orthornavirae</i>	4 classes	history
+ Phylum: <i>Lenarviricota</i> Kingdom: <i>Orthornavirae</i>	4 classes	history
+ Phylum: <i>Negarnaviricota</i> Kingdom: <i>Orthornavirae</i>	2 subphyla	history
– Phylum: <i>Pisuviricota</i> Kingdom: <i>Orthornavirae</i>	3 classes	history
– Class: <i>Duplopiviricetes</i> Phylum: <i>Pisuviricota</i>	1 order	history
– Order: <i>Durnavirales</i> Class: <i>Duplopiviricetes</i>	4 families	history
+ Family: <i>Amalgaviridae</i> Order: <i>Durnavirales</i>	2 genera	history
+ Family: <i>Hypoviridae</i> Order: <i>Durnavirales</i>	1 genus	history
+ Family: <i>Partitiviridae</i> Order: <i>Durnavirales</i>	5 genera, 15 species	history
+ Family: <i>Picobirnaviridae</i> Order: <i>Durnavirales</i>	1 genus	history
– Class: <i>Pisoniviricetes</i> Phylum: <i>Pisuviricota</i>	3 orders	history
– Order: <i>Nidovirales</i> Class: <i>Pisoniviricetes</i>	8 suborders	history
– Suborder: <i>Abnidovirineae</i> Order: <i>Nidovirales</i>	1 family	history
+ Family: <i>Abyssoviridae</i> Suborder: <i>Abnidovirineae</i>	1 subfamily	history
– Suborder: <i>Arnidovirineae</i> Order: <i>Nidovirales</i>	4 families	history
+ Family: <i>Arteriviridae</i> Suborder: <i>Arnidovirineae</i>	6 subfamilies	history
+ Family: <i>Cremegaviridae</i> Suborder: <i>Arnidovirineae</i>	1 subfamily	history
+ Family: <i>Gresnaviridae</i> Suborder: <i>Arnidovirineae</i>	1 subfamily	history
+ Family: <i>Olifoviridae</i> Suborder: <i>Arnidovirineae</i>	1 subfamily	history
– Suborder: <i>Cornidovirineae</i> Order: <i>Nidovirales</i>	2 subfamilies, 5 genera, 26 subgenera, 46 species	history
– Family: <i>Coronaviridae</i> Suborder: <i>Cornidovirineae</i>	2 subfamilies	history
+ Subfamily: <i>Letovirinae</i> Family: <i>Coronaviridae</i>	1 genus	history
+ Subfamily: <i>Orthocoronavirinae</i> Family: <i>Coronaviridae</i>	4 genera	history
– Suborder: <i>Mesnidovirineae</i> Order: <i>Nidovirales</i>	2 families	history

### Taxonomy Browser

- Summary

- **Coronavirus!** It was *Where's Waldo* but I found them.

- Realm **Riboviria**:
- Kingdom **Ortho-rna-virae**:
- Phylum **Pisuviricota**:
- Class **Pisoni-viricetes**:
- Order **Nido-virales**:
- SubOrder **Cornido-virineae**:
- Family **Corona-viridae**:
- Genus **Alpha/Beta/Delta/Gamma-coronavirus**

- Do not confuse this with the **Baltimore classification** which is based on the spiral shape of the genetic code. See page 92.

- Source

- **ICTV**
  - <https://ictv.global/taxonomy>

Taxonomic Rank	Name	Order	Class	Phylum	Number of Taxa	History
Family	Amalgaviridae	Order: Durnavirales			2 genera	history
Family	Hypoviridae	Order: Durnavirales			1 genus	history
Family	Partitiviridae	Order: Durnavirales			5 genera, 15 species	history
Family	Picobirnaviridae	Order: Durnavirales			1 genus	history
Class	Pisoniviricetes	Phylum: Pisuviricota			3 orders	history
Order	Nidovirales	Class: Pisoniviricetes			8 suborders	history
Suborder	Abnidovirineae	Order: Nidovirales			1 family	history
Family	Abyssoviridae	Suborder: Abnidovirineae			1 subfamily	history
Suborder	Arnidovirineae	Order: Nidovirales			4 families	history
Family	Arteriviridae	Suborder: Arnidovirineae			6 subfamilies	history
Family	Cremegaviridae	Suborder: Arnidovirineae			1 subfamily	history
Family	Gresnaviridae	Suborder: Arnidovirineae			1 family, 2 subfamilies, 5 genera, 26 subgenera, 4 species	history
Family	Olfoviridae	Suborder: Arnidovirineae				history
Suborder	Cornidovirineae	Order: Nidovirales			1 family	history
Family	Coronaviridae	Suborder: Cornidovirineae			2 subfamilies	history
Subfamily	Letovirinae	Family: Coronaviridae			1 genus	history
Subfamily	Orthocoronavirinae	Family: Coronaviridae			4 genera	history
Genus	Alphacoronavirus	Subfamily: Orthocoronavirinae			14 subgenera	history
Genus	Betacoronavirus	Subfamily: Orthocoronavirinae			5 subgenera	history
Genus	Deltacoronavirus	Subfamily: Orthocoronavirinae			3 subgenera	history
Genus	Gammacoronavirus	Subfamily: Orthocoronavirinae			3 subgenera	history
Suborder	Mesnidovirineae	Order: Nidovirales			2 families	history

And here are Genus **Alpha Beta Delta Gamma**

- Same link as above.
  - <https://ictv.global/taxonomy>

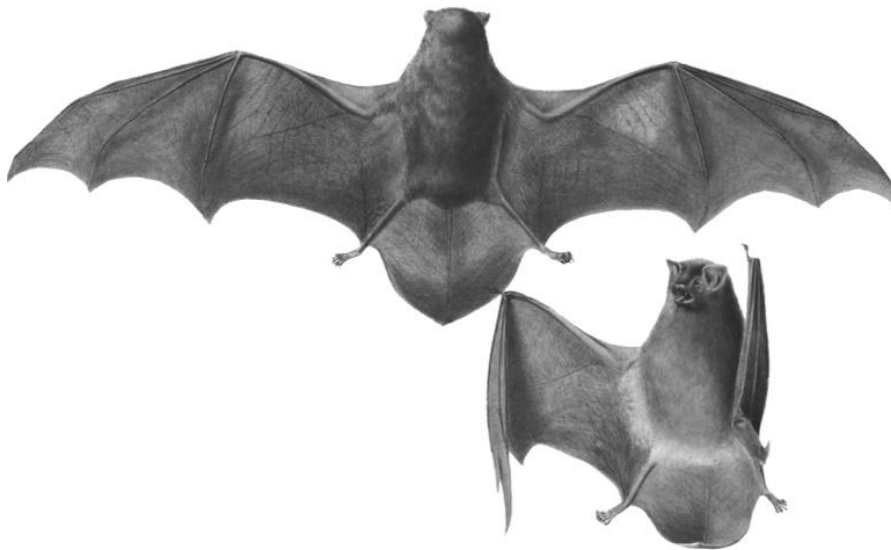
*The species Severe acute respiratory syndrome-related coronavirus: classifying 2019-nCoV and naming it SARS-CoV-2*

- Summary
  - This paper describes how the coronavirus of the COVID pandemic was classified and named by the **Coronaviridae** (“corona vy rid day”) **Study Group of the ICTV**.
- Verbatim
  - The present outbreak of a coronavirus-associated acute respiratory disease called coronavirus disease 19 (COVID-19) is the third documented spillover of an animal coronavirus to humans in only two decades that has resulted in a major epidemic. The *Coronaviridae* Study Group (CSG) of the International Committee on Taxonomy of Viruses, which is responsible for developing the classification of viruses and taxon nomenclature of the family *Coronaviridae*, has assessed the placement of the human pathogen, tentatively named 2019-nCoV, within the *Coronaviridae*.
- Source
  - nature microbiology
    - Volume 5, pages 536–544 (2020)
    - 2 March 2020
    - <https://www.nature.com/articles/s41564-020-0695-z>
- Authors
  - **Coronaviridae Study Group** of the International Committee on Taxonomy of Viruses (ICTV)
    - Alexander E. Gorbalenya
    - Susan C. Baker
    - Ralph S. Baric
    - Raoul J. de Groot
    - Christian Drosten
    - Anastasia A. Gulyaeva
    - Bart L. Haagmans

- Chris Lauber
- Andrey M. Leontovich
- Benjamin W. Neuman
- Dmitry Penzar
- Stanley Perlman
- Leo L. M. Poon
- Dmitry V. Samborskiy
- Igor A. Sidorov
- Isabel Sola
- John Ziebuhr

# Page 114 – Coronavirus Zoo: Common bent-wing bat

## Common bent-wing bat



### Common bent-wing bat

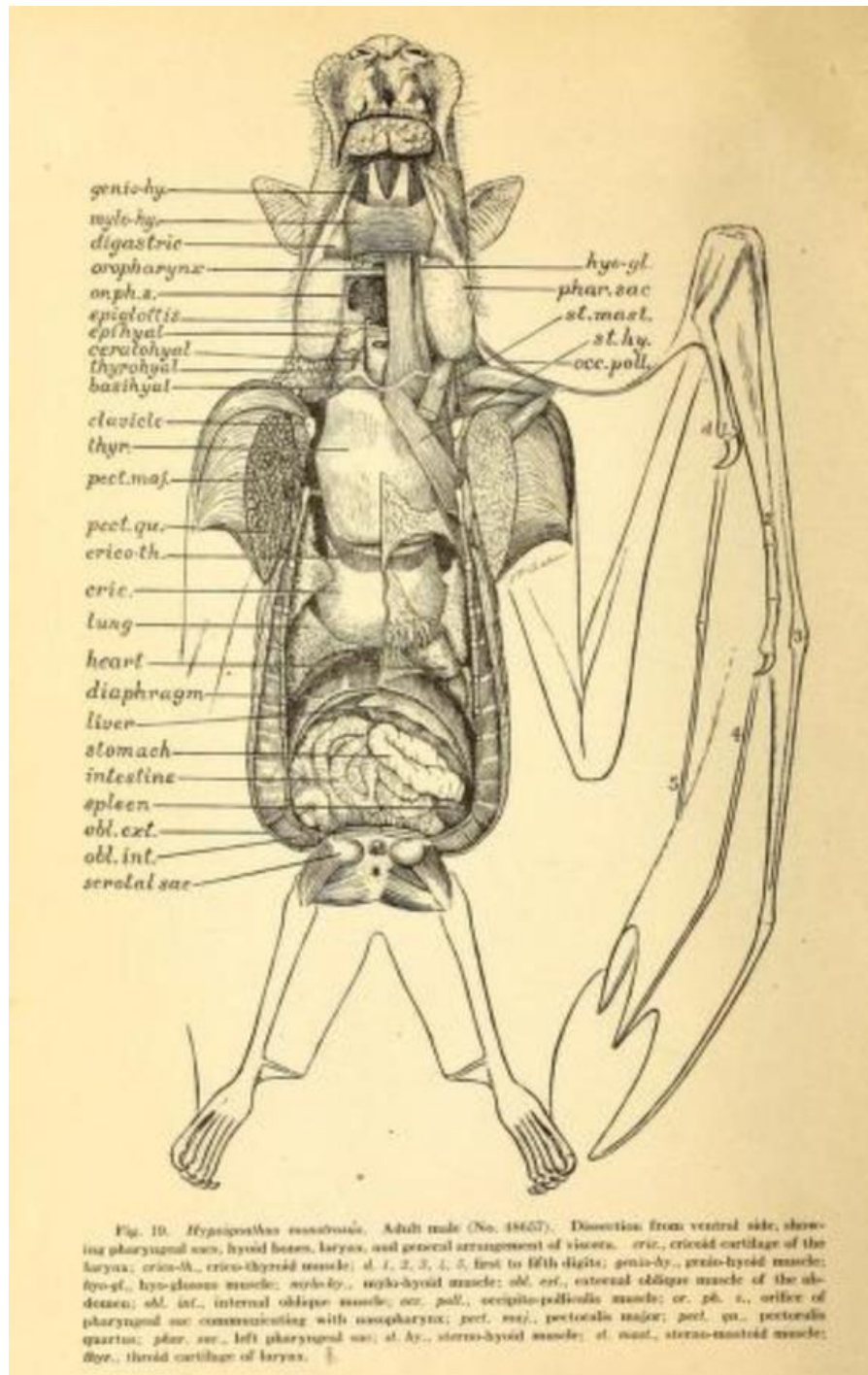
- Names
  - Common bent-wing bat
  - Schreiber's bat
    - It is named after the **Austrian naturalist Carl Franz Anton Ritter von Schreibers** (what a name).
  - *Miniopterus schreibersii*
    - It is common for the species of an animal to be named after the person who discovered it. And then the letter 'i' is added for good measure.
    - **Genus and species are always in italics.**
- Source
  - [https://en.wikipedia.org/wiki/Common\\_bent-wing\\_bat](https://en.wikipedia.org/wiki/Common_bent-wing_bat)



*Miniopterus bat coronavirus 1*

- For technical details on the genome (genetic code) see page 112.

## Bat lungs



Yup, bats have 2 lungs, just like us.

- This drawing is about 1/3 down the page. The *lung* label is on the left side.

- It's a **hammer-headed bat**, which has a bizarre looking head.
- <https://en.wikipedia.org/wiki/Megabat>

## Bat skeleton

### *Skeleton of a bat*

- Summary
  - There is a drawing of a bat skeleton with the bones labelled, and an impressive description of all the bones.
- Source
  - **Merriam Webster – Visual Dictionary Online**
    - <https://www.visualdictionaryonline.com/animal-kingdom/flying-mammal/bat/skeleton-bat.php>



Nothing labelled here, but you can compare the two sides.  
<https://en.wikipedia.org/wiki/Bat>



**That's a bat skull.**


- You can buy real or replica skulls from **Skulls Unlimited**. I've bought a few from them.
- <https://www.skullsunlimited.com/pages/search-results-page?q=bat>



This is a perfect demonstration of the digits (fingers) in an **Egyptian fruit bat** in **Israel**. I have numbered them the same as they are in humans.

- #1 Thumb – claw, sticking up like a hitchhiker.
- #2 index – short
- #3 middle – long, it reaches to the most distant part of the wing
- #4 ring – long
- #5 pinky – long
- [https://en.wikipedia.org/wiki/Egyptian\\_fruit\\_bat](https://en.wikipedia.org/wiki/Egyptian_fruit_bat)

*Morphology of the axial skeleton of seven bat genera (Chiroptera: Phyllostomidae)*

- Summary
  - This is a technical description of the bones of the bat **axial skeleton** which basically means the bones of the skull, spine and chest. Think of it as the axis of the body.
  - The arms (wings) and legs are considered appendages so they form the **appendicular skeleton** (“app en dick you lar”). Not described in this paper.
  -  Click on the figures to show the black and white photos. Figure 6 shows the ribs attached to the spine.
- Vertebrae number is variable among the several bat species examined
  - The vertebrae are the bones of the spine.
  - **Cervical** 7
  - **Thoracic** 11 to 13
  - **Lumbar** 4 to 7
  - **Sacral** Fused
  - **Caudal** 0 to 1 to 3 to 6
- Verbatim
  - *Axial skeleton*. All species analyzed have seven cervical vertebrae, while the number of elements is variable in other types of vertebrae, specifically 11-13 thoracic, 4-7 lumbar, sacral vertebrae fused into a single bone (the sacrum), and 0, 1, 3 to 6 caudal vertebrae. Phyllostomidae is one of the families of bats where the only vertebral fusion observed is the sacrum, three other locations of vertebral fusions are found in other families.
- Source
  - Proceedings of the Brazilian Academy of Sciences
    - Anais da Academia Brasileira de Ciências
    - 2017
    - [https://www.scielo.br/scielo.php?script=sci\\_arttext&pid=S0001-37652017000502341](https://www.scielo.br/scielo.php?script=sci_arttext&pid=S0001-37652017000502341)
- Authors
  - The authors are from [Argentina](#).
  - PABLO J. GAUDIOSO
  - M. MÓNICA DÍAZ
  - RUBÉN M. BARQUEZ
    - Programa de Investigaciones de Biodiversidad Argentina. Fundación Miguel Lillo (MMD), Miguel Lillo 205, 4000, Tucumán, Argentina

**Roosting bats**



### Bat roosts

- Summary
  - This is nicely written and easily understood. It describes the **maternity roosts** used by female bats, and **hibernation roosts** used in the winter. It also describes how the **white-nose fungus** grows on hibernating bats.
  - 🖐️ If you click on the 'About Bats' tab you are led to lots of links to learn about bats. Check out the one called '*A year in the life of a bat*' which is rather charming.
  - I used this site as the source of my image of roosting bats. Thank you **Bat Conservation Trust!!!**
- Source
  - **Bat Conservation Trust**
    - They are based in the UK.
    - I used this site as the source of my image of roosting bats. Thank you!!
    - <https://www.bats.org.uk/about-bats/where-do-bats-live/bat-roosts/roosts-in-trees>

Stamp



That's the stamp.

- You can see it in Wikipedia.
  - [https://en.wikipedia.org/wiki/Common\\_bent-wing\\_bat](https://en.wikipedia.org/wiki/Common_bent-wing_bat)
- You can buy it from these stamp vendors:
  - [colnect](https://colnect.com/en/stamps/stamp/647096-Schreiberss_Long-fingered_Bat_Miniopterus_schreibersii-Bats-Romania)
    - [https://colnect.com/en/stamps/stamp/647096-Schreiberss\\_Long-fingered\\_Bat\\_Miniopterus\\_schreibersii-Bats-Romania](https://colnect.com/en/stamps/stamp/647096-Schreiberss_Long-fingered_Bat_Miniopterus_schreibersii-Bats-Romania)
  - [StampWorld](https://www.stampworld.com/en/stamps/Romania/Postage%20stamps/2010-2019?year=2016)
    - <https://www.stampworld.com/en/stamps/Romania/Postage%20stamps/2010-2019?year=2016>
- This is other stamp designs by the artist, [Victor Telibaşa](https://www.wopa-plus.com/en/stamps/product/pid=18859).
  - <https://www.wopa-plus.com/en/stamps/product/pid=18859>
  - By the way, that S with a squiggle is called the S-cedilla. I just found that out 5 seconds ago.
    - 
    - [https://en.wikipedia.org/wiki/\\$#:~:text=S%2Dcedilla%20\(majuscule%3A%20\\$,%2C%20Turkish%2C%20and%20Turkmen%20alphabets.](https://en.wikipedia.org/wiki/$#:~:text=S%2Dcedilla%20(majuscule%3A%20$,%2C%20Turkish%2C%20and%20Turkmen%20alphabets.)

# Page 115 – Soprano pipistrelle & Japanese house bat

## Soprano pipistrelle



*Soprano pipistrelle*

- **Pipistrello** is Italian for 'bat.' 🖐️ Listen to an Italian say it: <https://en.wiktionary.org/wiki/pipistrello>
- [https://en.wikipedia.org/wiki/Soprano\\_pipistrelle](https://en.wikipedia.org/wiki/Soprano_pipistrelle)

### *Bat coronavirus P. pyg.*

- For technical details on the genome (genetic code) see page 112.

Echolocation 55 KiloHertz (KHz)


Not Secure — www.bio.bris.ac.uk/research/bats/britishbats/batpages/sopranopipi.htm

Am.ca Am.com Apple Astro Atl EM BM BBC CFPC Culp dwf Epoc Exp Etym GG GHR Google G-images G-mail G-maps G-trans Guardian Harvard Medscape Nature Parkhurst RASC RBC

Guitar Mak... The Inner... Genesis... Stamp cat... Chinese ru... Rhinolph... Google Se... Rhinolph... Bat(20070... Cl Soprano Pi...

### Echolocation Calls

The echolocation call of soprano pipistrelles has both a frequency modulated and a continuous frequency component.

To listen to the call of the soprano pipistrelle click here 

Size of sound file: 16.6 KB

For details of how the echolocation calls were recorded [click here](#).

Average values for a soprano pipistrelle echolocation call, as given by Vaughan *et al.* (1997), are listed below:

Interpulse interval: 81.0 ms  
 Call duration: 5.7 ms  
 Minimum frequency: 54.1 kHz  
 Maximum frequency: 64.7 kHz

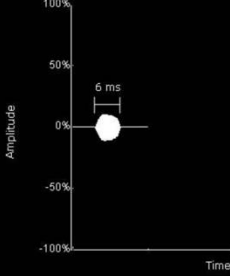
The power spectrum on the left shows that the maximum power of the call is at a frequency of approximately 55.5 kHz.

Kalko (1995) found four stages to the foraging behaviour of pipistrelles: search flight, approach flight, capture and retrieval of prey. Changes in the echolocation call were correlated with these changes in flight behaviour. There is a shallow-modulated component in the echolocation call during search phase which may enable better detection of prey. This shallow-modulated component is not found in the echolocation call during the approach phase. During the approach phase a steep frequency-modulated call is used to assess the distance to the prey item. In this phase the pulse interval and duration decrease as the target is approached. During the terminal phase steep frequency-modulated calls are used to locate the prey item precisely. Again, the pulse interval and duration decrease as the target is approached. The information contained in the call per unit time is increased through the use of a high call repetition rate. By altering the duration of the echolocation call, pipistrelles are able to avoid overlap between emitted signals and returning echos. Using a call with a duration of 6-10 ms, Kalko (1995) suggests that pipistrelles should be able to detect prey at a minimum distance of 1.12-1.70 m.

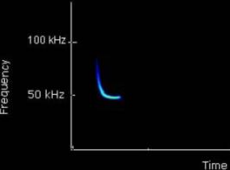
Kalko & Schnitzler (1993) studied search flight echolocation of *Pipistrellus* species. During the search phase echolocation type corresponded to habitat type. Where obstacles were greater than 5m away from the bat the call was less than 15 kHz in width. In cluttered habitats and when the bats were turning the call was more than 15 kHz in width. Prey was only detected when there was no overlap between the emitted call and the received echo.

The soprano pipistrelle emits two types of social calls; a complex song-like call when at the mating roost and in the foraging habitat, and a cheep-like call during flight (Pfalzer & Kusch, 2003).

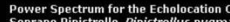
**Wave Form for the Echolocation Call of the Soprano Pipistrelle, *Pipistrellus pygmaeus***



**Spectrogram for the Echolocation Call of the Soprano Pipistrelle, *Pipistrellus pygmaeus***



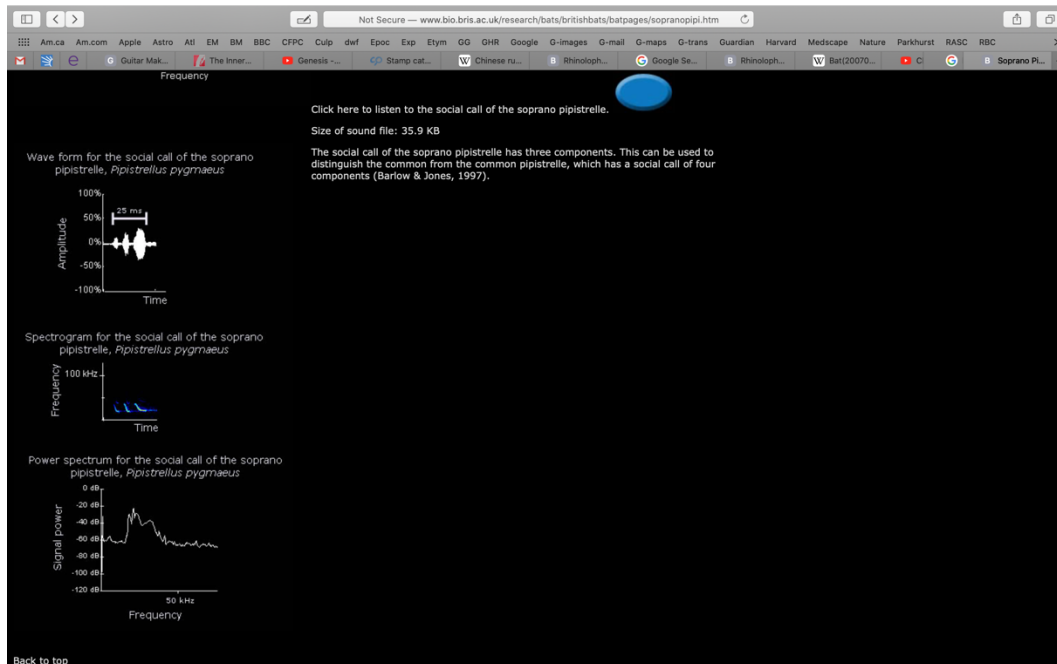
**Power Spectrum for the Echolocation Call of the Soprano Pipistrelle, *Pipistrellus pygmaeus***




Open the link below then click on the blue oval to hear the **Soprano pipistrelle echolocation**.

- See the **single pulse** in both graphs? That's what you heard.
- **Source**
  - **Bat Ecology and Bioacoustics Lab, University of Bristol**
    - <http://www.bio.bris.ac.uk/research/bats/britishbats/batpages/sopranopipi.htm>





Click on the blue oval to hear the **Soprano pipistrelle – social call**.

- This is the same page as above.
- See the **3 pulses** in both graphs? That's what you heard.

## Moth evasion strategies

### Early erratic flight response of the lucerne moth to the quiet echolocation calls of distant bats

- **Summary**
  - **Moth options to escape from the bat are:**
    - Turn away.
    - Zig-zag.
    - Freeze i.e., cease flight.
      - Passively drop to ground ... I guess the equivalent of an aircraft stall, kinda sorta.
      - This is a last-ditch effort.
- **Verbatim**
  - Nocturnal insects have evolved ultrasound-sensitive hearing in response to predation pressures from echolocating insectivorous bats. Flying tympanate moths take various evasive actions when they detect bat cries, including turning away, performing a steering/zigzagging flight and ceasing flight. In general, infrequent ultrasonic pulses with low sound intensities that are emitted by distant bats evoke slight turns, whereas frequent and loud ultrasonic pulses of nearby bats evoke erratic or rapid unpredictable changes in the flight path of a moth. Flight cessation, which is a freezing response that causes the moth to passively dive (drop) to the ground, is considered the ultimate last-ditch evasive behaviour against approaching bats where there is a high predation threat. Here, we found that the crambid moth *Nomophila nearctica* never performed passive dives in response to frequent and loud ultrasonic pulses of >60 dB sound pressure level (SPL) that simulated the attacking echolocation call sequence of the predominant sympatric insectivorous bat *Eptesicus fuscus*, but rather turned away or flew erratically, regardless of the temporal structure of the stimulus. Consequently, *N. nearctica* is likely to survive

predation by bats by taking early evasive action even when it detects the echolocation calls of sympatric bats hunting other insects at a distance. Since **aerially hawking** bats can track and catch erratically flying moths after targeting their prey, this early escape strategy may be common among night-flying tympanate insects.

- Source
  - PLOS ONE
    - This journal is published by the **Public Library of Science (PLOS)**.
      - More info here: [https://en.wikipedia.org/wiki/PLOS\\_One](https://en.wikipedia.org/wiki/PLOS_One)
    - 20 August 2018
    - <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0202679>
- Author
  - **Roy Nakano**
    - Department of Biological Sciences, University of Toronto Scarborough, Toronto, Ontario, Canada
    - Division of Fruit Production and Postharvest Science, **Institute of Fruit Tree and Tea Science**, National Agriculture and Food Research Organization, Tsukuba, Ibaraki, Japan
      - **Is that not a cool name for an institute?**
  - **Andrew C. Mason**
    - Department of Biological Sciences, University of Toronto Scarborough, Toronto, Ontario, Canada

### *Tiger Moth Jams Bat Sonar*

- Summary
  - **A moth may make clicks of its own to confuse bat but this is not definitive.**
- Verbatim
  - In response to sonar-guided attacking bats, some **tiger moths** make ultrasonic clicks of their own. The lepidopteran sounds have previously been shown to alert bats to some moths' toxic chemistry and also to startle bats unaccustomed to sonic prey. **The moth sounds could also interfere with, or "jam," bat sonar, but evidence for such jamming has been inconclusive.** Using ultrasonic recording and high-speed infrared videography of bat-moth interactions, we show that the palatable tiger moth *Bertholdia trigona* defends against attacking big brown bats (*Eptesicus fuscus*) using ultrasonic clicks that jam bat sonar. Sonar jamming extends the defensive repertoire available to prey in the long-standing evolutionary arms race between bats and insects.
- Source
  - Science
    - 2009
    - <https://www.science.org/doi/10.1126/science.1174096>
- Authors
  - **Aaron J. Corcoran** - Department of Biology, Wake Forest University, Winston-Salem, NC
  - **Jesse R. Barber** - Department of Fish, Wildlife and Conservation Biology, Colorado State University, Fort Collins, CO
  - **William E. Conner** - Department of Biology, Wake Forest University, Winston-Salem, NC

### *Evolutionary escalation: the bat-moth arms race*

- Summary
  - **This paper says 'arms race' is a bit of a misnomer because it's not a direct showdown of bats and moths. More accurately, bats evolve to better capture all insects. And moths evolve to better escape all predators.**
  - This is technical but very readable and understandable.
  - There is a rather interesting glossary.

- Verbatim glossary
  - **Aerial hawking**
    - The capture of airborne prey on the wing. Considered to be the predominant means of prey capture in most bats.
  - **Chordotonal organs**
    - Sensory structures specific to insects and crustaceans that contain stretch receptors and are dispersed throughout the body. Most chordotonal organs are proprioceptors, meaning that they detect and encode information about the position or movement of the animal's own body parts.
  - **Feeding buzz**
    - After laryngeal-echolocating bats detect airborne prey, they increase their echolocation call rate dramatically over the course of their attack, culminating in a feeding buzz (>>90 calls s<sup>-1</sup>).
  - **Phonotaxis**
    - The act of moving in response to sound. Positive phonotaxis refers to movement towards sound, such as when female crickets walk towards a singing male, whereas negative phonotaxis refers to movement away from sound, such as when a flying cricket flies away from an echolocating bat.
  - **Stridulatory organ**
    - A structure on an animal that is used to produce sound by rubbing one part against another. Often these consist of a series of ridges, called the file, and a single protrusion that is scraped against the file to produce sound.
  - **Substrate gleaning**
    - The capture of prey from terrestrial surfaces, e.g. vegetation or the ground. Although long known to be a means by which bats take prey, its prevalence has been underestimated.
  - **Tymbal**
    - A thin area of insect cuticle buckled by muscular action to produce sound. In tiger moths, tymbals are located on the ventral surface of the thorax and can be unstriated (producing two clicks per muscular contraction and relaxation cycle) or striated (producing multiple clicks per cycle).
  - **Tympanum**
    - A very thin region of insect cuticle forming a membrane that oscillates in response to sound waves. The tympanum is usually backed up by air sacs and is innervated either directly or indirectly by a chordotonal organ that transduces the movement of the tympanum into neural activity.
- Source
  - Journal of Experimental Biology
    - 1 June 2016
    - <https://jeb.biologists.org/content/219/11/1589>
- Author
  - **Hannah M. ter Hofstede** - Department of Biological Sciences, Dartmouth College, Hanover, NH, USA
  - **John M. Ratcliffe** - Department of Biology, University of Toronto Mississauga, Mississauga, ON, Canada

Mystery source I cannot remember

- Summary
  - **Moth actions are dictated by bat efforts:**
    - Low sound intensity by bat → slight turn by moth.

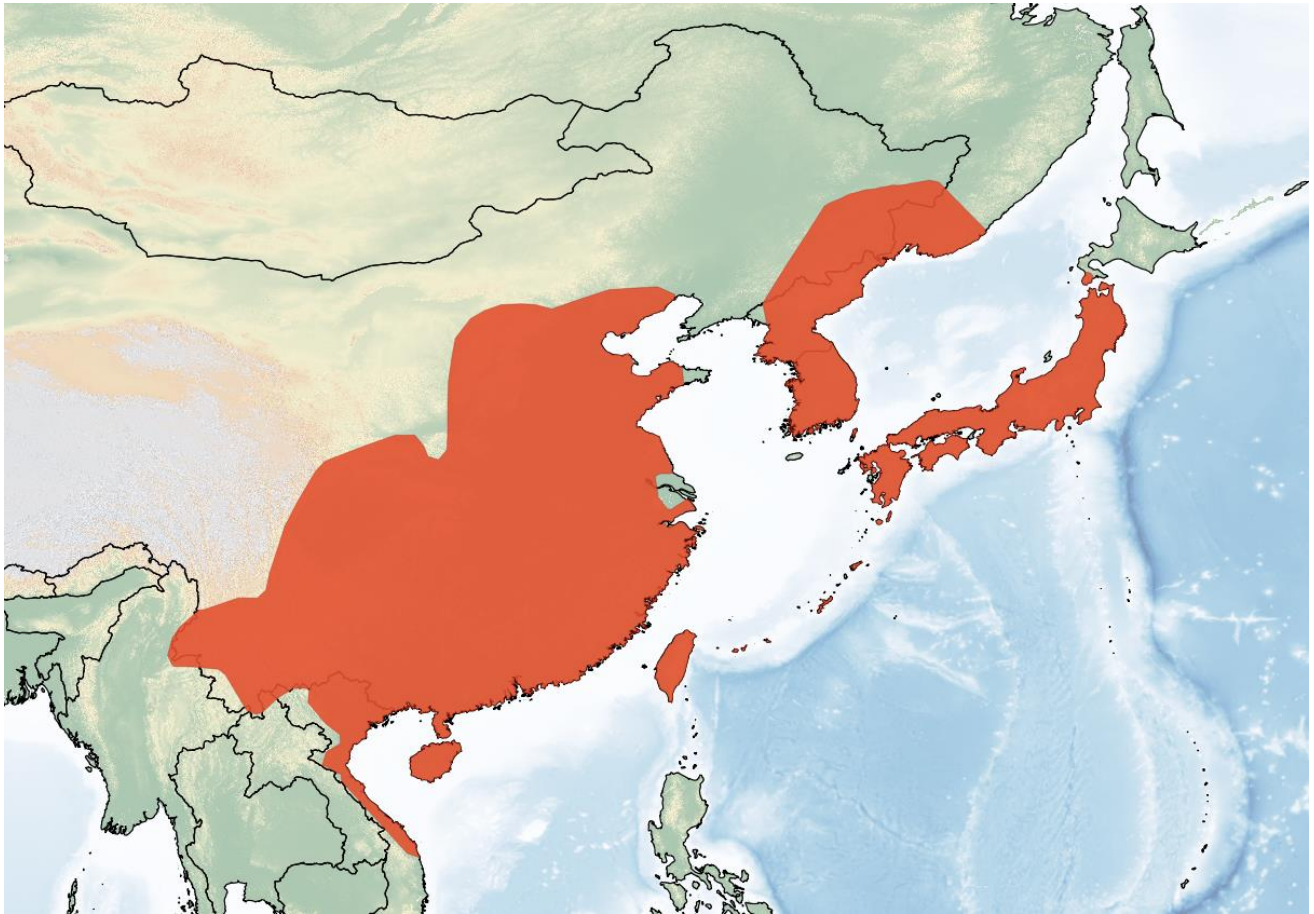
- Loud and frequent sound intensity by bat → rapid, unpredictable turns by moth.
- Source
  - Where are you from?

## Japanese house bat



*Japanese house bat*

- Names
  - Japanese house bat
  - Japanese pipistrelle
  - *Pipistrellus abramus*
- Stats
  - 1" - 2" long
  - 1.3" wingspan
- Diet
  - Things that fly
    - Moths
    - Flies
    - Hymeno-ptera
      - Wasps, bees, ants
    - Caddisflies
  - Do these fly?
    - Beetles
    - Hemi-ptera (a.k.a. true bugs)
      - Aphids
      - Bed bugs
- [https://en.wikipedia.org/wiki/Japanese\\_house\\_bat](https://en.wikipedia.org/wiki/Japanese_house_bat)



The Japanese house bat lives in Japan plus places in south east Asia.

- [https://en.wikipedia.org/wiki/Japanese\\_house\\_bat](https://en.wikipedia.org/wiki/Japanese_house_bat)

*Pipistrellus bat coronavirus HKU5*

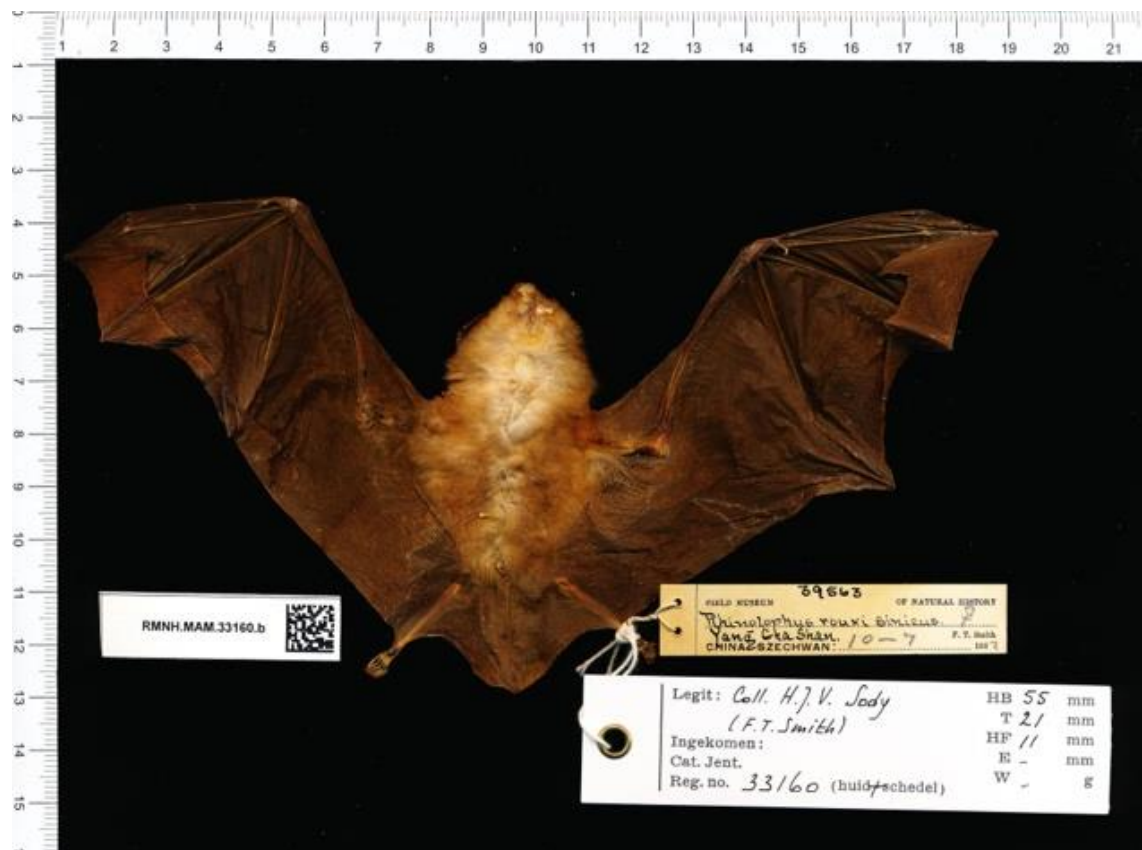
- For technical details on the genome (genetic code) see page 112.

# Page 116 – Chinese rufous horseshoe bat versus Wuhan Institute of Virology

Chinese rufous horseshoe bat

**rufous (adj.)**

- "of a dull red color, reddish-brown," 1781, from **Latin rufus** "red, reddish, tawny, red-haired," from an Osco-Umbrian cognate of Latin **ruber** "red" (from PIE root **\*reudh-** "red, ruddy"). Mostly in names or descriptions of birds or other animals; sometimes frowned upon in early use as just a French word for "reddish." Related: *Rufulous*.
- Online Etymology Dictionary
  - <https://www.etymonline.com/search?q=rufous>



*Chinese rufous horseshoe bat*

- **This bat is sorta reddish.**
- [https://en.wikipedia.org/wiki/Chinese\\_rufous\\_horseshoe\\_bat](https://en.wikipedia.org/wiki/Chinese_rufous_horseshoe_bat)



The Chinese rufous horseshoe bat range is China, India, Nepal, and Vietnam.

- [https://en.wikipedia.org/wiki/Chinese\\_rufous\\_horseshoe\\_bat](https://en.wikipedia.org/wiki/Chinese_rufous_horseshoe_bat)



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Bat Flash! COVID-19 Coronavirus Leads to More Premature Scapegoating of Bats

- Chinese rufous horseshoe bat (*Rhinolophus sinicus*) ... catching a moth in flight.
  - See how big the beige **moth** is?
- <https://www.merlintuttle.org/2020/01/30/wuhan-coronavirus-leads-to-more-premature-scapegoating-of-bats/>

## Discovery of a rich gene pool of bat SARS-related coronaviruses provides new insights into the origin of SARS coronavirus

- Summary
  - Purpose
    - This highly technical 2017 paper speculates about SARS-CoV origins. Take note, this is the coronavirus that caused the SARS pandemic of 2003.
  - Materials & Methods
    - 5-year surveillance (April 2011 – October 2015) of a bat cave in Yunnan province.
    - They looked at horseshoe bats of Genus *Rhinolophus* but they don't say species.
    - 602 alimentary specimens. ("al im en tar ee"). This means specimens from the gut.
      - Anal swabs
      - Feces
    - Pan-CoV RT-PCR
      - This looks for a 440 base pair sequence that is conserved in all known Genus Alpha and Genus Beta.
  - Which bats? (n = 64 samples)
    - *Rhinolophus sinicus*
      - Chinese rufous horseshoe bat
      - 57 / 64 bats.
        - This is based on amplification of the **Cytb gene** or **ND1 gene**.
    - The other 7 / 64 were from:
      - *Rhinolophus affinis*
        - Intermediate horseshoe bat
      - *Rhinolophus ferru-me-quinum*
        - Greater horseshoe bat
        - [https://en.wikipedia.org/wiki/Greater\\_horseshoe\\_bat](https://en.wikipedia.org/wiki/Greater_horseshoe_bat)
      - *Aselliscus stoliczkanus*
        - Stoliczka's trident bat
        - [https://en.wikipedia.org/wiki/Stoliczka%27s\\_trident\\_bat](https://en.wikipedia.org/wiki/Stoliczka%27s_trident_bat)
  - Results
    - They identify 11 new SARSr-CoV strains which are highly diverse in:
      - S gene
      - ORF3 gen
      - ORF8 gene
    - Sequential recombination events of these 11 strains may have led to SARS CoV.
      - This occurred prior to spillover to an intermediate host.
    - Some strains with different S proteins could bind to human ACE2 Receptor.
- Verbatim
  - A large number of SARS-related coronaviruses (SARSr-CoV) have been detected in horseshoe bats since 2005 in different areas of China. However, these bat SARSr-CoVs show sequence differences from SARS coronavirus (SARS-CoV) in different genes (S, ORF8, ORF3, etc) and are considered unlikely to represent the direct progenitor of SARS-CoV. Herein, we report the findings of our 5-year surveillance of SARSr-CoVs in a cave inhabited by multiple species of horseshoe bats in Yunnan Province, China. The full-length genomes of 11 newly discovered SARSr-CoV strains, together with our previous findings, reveals that the SARSr-CoVs circulating in this single location are highly diverse in the S gene, ORF3 and ORF8. Importantly, strains with high genetic similarity to SARS-CoV in the hypervariable N-terminal domain (NTD) and receptor-binding domain (RBD) of the S1 gene, the ORF3 and ORF8 region, respectively, were all discovered in this cave. In addition, we report the first discovery of bat SARSr-CoVs highly similar to human SARS-CoV in ORF3b and in the split ORF8a and 8b. Moreover, SARSr-CoV strains from this cave were more closely related



- to SARS-CoV in the non-structural protein genes ORF1a and 1b compared with those detected elsewhere. Recombination analysis shows evidence of frequent recombination events within the S gene and around the ORF8 between these SARSr-CoVs. We hypothesize that the direct progenitor of SARS-CoV may have originated after sequential recombination events between the precursors of these SARSr-CoVs. Cell entry studies demonstrated that three newly identified SARSr-CoVs with different S protein sequences are all able to use human ACE2 as the receptor, further exhibiting the close relationship between strains in this cave and SARS-CoV. This work provides new insights into the origin and evolution of SARS-CoV and highlights the necessity of preparedness for future emergence of SARS-like diseases.
- Increasing evidence has been gathered to support the bat origin of SARS coronavirus (SARS-CoV) in the past decade. However, none of the currently known bat SARSr-CoVs is thought to be the direct ancestor of SARS-CoV. Herein, we report the identification of a diverse group of bat SARSr-CoVs in a single cave in Yunnan, China. Importantly, all of the building blocks of SARS-CoV genome, including the highly variable S gene, ORF8 and ORF3, could be found in the genomes of different SARSr-CoV strains from this single location. Based on the analysis of full-length genome sequences of the newly identified bat SARSr-CoVs, we speculate that the direct ancestor of SARS-CoV may have arisen from sequential recombination events between the precursors of these bat SARSr-CoVs prior to spillover to an intermediate host. In addition, we found bat SARSr-CoV strains with different **S proteins** that can all use the receptor of SARS-CoV in humans (**ACE2**) for cell entry, suggesting diverse SARSr-CoVs capable of direct transmission to humans are circulating in bats in this cave. Our current study therefore offers a clearer picture on the evolutionary origin of SARS-CoV and highlights the risk of future emergence of SARS-like diseases.
  - We have carried out a five-year longitudinal surveillance (April 2011 to October 2015) on SARSr-CoVs in bats from a single habitat in proximity to Kunming city, Yunnan province, China, which was mainly inhabited by horseshoe bats. A total of 602 alimentary specimens (anal swabs or feces) were collected and tested for the presence of CoVs by a Pan-CoV RT-PCR targeting the 440-nt RdRp fragment that is conserved among all known  $\alpha$ - and  $\beta$ -CoVs.
  - Host species identification by amplification of either *Cytb* or *ND1* gene suggested that most (57/64) of the SARSr-CoV positive samples were from *Rhinolophus sinicus*, while the remaining 7 samples were from *Rhinolophus ferrumequinum*, *Rhinolophus affinis* and from *Aselliscus stoliczkanus* which belongs to the family *Hipposideridae*.
  - Source
    - PLOS Pathogens
      - 30 November 2017
      - <https://journals.plos.org/plospathogens/article?id=10.1371/journal.ppat.1006698>
  - Authors
    - Ben Hu

- Lei-Ping Zeng
- Xing-Lou Yang
- Xing-Yi Ge
- Wei Zhang
- Bei Li
- Jia-Zheng Xie
- Xu-Rui Shen
- Yun-Zhi Zhang
- Ning Wang
- Dong-Sheng Luo
- Xiao-Shuang Zheng
- Mei-Niang Wang
- Peter Daszak
- Lin-Fa Wang
- Jie Cui
- **Zheng-Li Shi**
  - She is the virologist '**Bat Woman**' from China. Description below.

### *How China's 'Bat Woman' Hunted Down Viruses from SARS to the New Coronavirus*

- Summary
  - This article is a kind of mini-biography of **Chinese virologist Shi Zhengli** a.k.a. **Bat Woman** at the **Wuhan Institute of Virology (WIV)**. She is the epitome of a tireless scientist.
- Source
  - Scientific American
    - 1 June 2020
    - <https://www.scientificamerican.com/article/how-chinas-bat-woman-hunted-down-viruses-from-sars-to-the-new-coronavirus1/>

## Wuhan Institute of Virology (WIV) experiments

### *Morphometry of SARS-CoV and SARS-CoV-2 particles in ultrathin plastic sections of infected Vero cell cultures*

- Summary
  - This science lab in Germany measured the size of the coronavirus in vero cell cultures (which are 'immortal' cells).
- Materials & Methods
  - 1. Cell culture
    - **Vero E6 cells** = African green monkey kidney epithelial cells.
      - Incubation
        - Cultivated in flasks containing:
          - 10% fetal bovine serum.
          - 1% L-glutamine
        - 1 day of incubation at 37 C.
      - Fixation
        - Then fixed in glutaraldehyde.
  - 2. Microtome
    - Fixed Vero cells centrifuged.
    - Then ultrathin sections.
      - Ultramicrotome
        - Model = UC7
        - **Leica Microsystems**, Germany

- Diamond knife
      - 45 deg
      - Diatome, Switzerland
- 3. Electron microscopy
  - The method was **electron tomography**.
  - Model = Tecnai Spirit, Thermo Fisher Scientific
  - Slices
    - I get the sense the virus is embedded in plastic sections that are 150 – 180 nm thick.
  - Virus
    - Virus particles were 'randomly selected.'
    - Particle shrink 2ary to electron beam.
  - Diameter
    - See bar graph.
  - Magnification
    - 135,000 x
      - Via side-mounted CCD camera.
  - Spikes
    - Number
      - Counted manually.
      - Scatter plot of Spikes per virion
    - n = 32 median for SARS-CoV.
    - n = 25 median for SARS-CoV-2.
      - This info is in the paragraph directly above the scatter plot.
    - Length
      - 23 nm long.
  - Diameter
    - Basically, the 100 nm histogram bar is the most common for both SARS-CoV and SARS-CoV-2.
      - Technically, 99 nm median as per the article.
  - Verbatim
    - Size of virus particle profiles was measured in images of ultrathin sections (65, 85, 110 nm) and in tomograms of thicker (150-180 and 200-250 nm) plastic sections.
- Source
  - Nature Scientific Reports
    - 10 Feb 2021
    - <https://www.nature.com/articles/s41598-021-82852-7>
- Author
  - Michael Laue – Advanced Light and Electron Microscopy, Centre for Biological Threats and Special Pathogens 4 (ZBS 4), Robert Koch Institute, Berlin, Germany

### Electron Tomography - Overview

- Summary
  - This is a description of **electron tomography**, which is basically using an electron microscope to digitally slice tissues and create a 3D image.
- Source
  - WORMATLAS
    - This science organization is devoted to the worm *C. elegans*.
- Author
  - Their information is adapted from:
    - Hall, D.H. and Rice, W.J. 2015. Electron tomography methods for *C. elegans*. Methods Mol. Biol. **1327**: 141-58
    - Hall, D.H., Hartweig, E. and Nguyen, K.C.Q. 2012. Modern electron microscopy methods for *C. elegans*. Methods Cell Biol. **107**: 93-149



### Rotary Microtome Section

- Summary

- A micro-tome is a glorified meat slicer. It is indispensable in a science lab for cutting tissue into super-thin slices that can then be put on a glass slide and examined under a microscope.
- At the 47 second mark of this video you can see the thin slice that will be viewed with a microscope.

- Source

- Abnova
  - YouTube
  - <https://www.youtube.com/watch?v=KnMdSgd5mts>

# Page 117 – Intermediate horseshoe bat & Egyptian fruit bat (flying fox)

## Intermediate horseshoe bat

*Rhinolophus affinis* - Intermediate horseshoe bat

- <http://www.bio.bris.ac.uk/research/bats/China%20bats/rhinolophusaffinis.htm>
- No info on this page. No author, no date.
- **The Darwin Initiative Center for Bat Research**, University of Bristol
  - <http://www.bio.bris.ac.uk/research/bats/China%20bats/>
    - I had to truncate the link above to get to this.
    - Cool logo.

*Intermediate horseshoe bat*

- [https://en.wikipedia.org/wiki/Intermediate\\_horseshoe\\_bat](https://en.wikipedia.org/wiki/Intermediate_horseshoe_bat)

*Rhinolophus affinis bat coronavirus HKU2-related*

- NCBI.
- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Info&id=2691595&lvl=3&lin=f&keep=1&srchmode=1&unlock>

**Egyptian fruit bat** a.k.a. **Flying fox** a.k.a. **Dog-faced fruit bat**



Egyptian fruit bat omg too cute

- *Rousettus aegyptiacus*
- It's obvious here to see:
  - Humerus
  - Carpals
  - Metacarpals
  - Thumb
  - Index
  - Middle
  - Ring
  - Pinky
- [https://en.wikipedia.org/wiki/Egyptian\\_fruit\\_bat](https://en.wikipedia.org/wiki/Egyptian_fruit_bat)

*MAMMALIAN SPECIES* No. 611, pp. 1-9, 3 figs.

*Rousettus aegyptiacus*. By **Gary G. Kwiecinski** and **Thomas A. Griffiths**

Published **5 May 1999** by the **American Society of Mammologists**

- <https://academic.oup.com/mspecies/article/doi/10.2307/3504411/2600764>
- My data is from here. They spell it *Rousettus aegyptiacus*.
- Verbatim
  - Frequent squabbling occurred, especially if a bat was shuffled out of position and then attempted to regain its former place.
  - Heart rate, determined by telemetry (5 adult males, 5 days), paralleled basal diurnal values and peak nocturnal values of oxygen consumption and body temperature (Noll, 1979a). Average resting heart rate was  $248 \pm 3$  beats/min during the daytime resting period and  $444 \pm 5$  beats/min during the night activity period.
  - NOLL, U. G. **1979a**. *Body temperature, oxygen consumption, nor-adrenaline response and cardiovascular adaptations in the flying fox, Rousettus aegyptiacus*. **Comparative Biochemistry and Physiology**, 63A:79-88.

*Rousettus aegyptiacus* bat coronavirus 229E-related isolate 5425

- [Rousettus aegyptiacus bat coronavirus 229E-related](#)
  - Click this link.
- **NCBI**
  - [MN611517](#)
  - *Rousettus aegyptiacus* bat coronavirus 229E-related isolate 5425, complete genome (Li,B., et al.)
  - **Attributes**
  - **Nuc Completeness:** complete
  - **Length:** 27619
  - **Mol Type:** RNA
  - **Host:** *Rousettus aegyptiacus*
  - **Geo Location:** Kenya
  - **Collection Date:** 2018-03
  - **Publications**
  - **PubMed:** [1 publication](#)
  - **Submitters Names**
    - Li,B., Si,H.R., Zhu,Y., Yang,X.L., Anderson,D.E., Shi,Z.L., Wang,L.F., Zhou,P.
    - **Bat Lady**, I think.
  - **Organization (Submitters' Institutional Affiliation)**
    - Center for Biosafety Mega-Science, Chinese Academy of Sciences, CAS Key Laboratory of Special Pathogens, [Wuhan Institute of Virology](#)
  - **Affiliation Location** [China](#)

# Page 118 – Lesser bamboo & Vampire bat

**Baby bat**



*Common pipistrelle*

That's a baby. omg, too cute. That thing that looks like a spike is the thumb (digit #1).

- [https://en.wikipedia.org/wiki/Common\\_pipistrelle](https://en.wikipedia.org/wiki/Common_pipistrelle)



Baby - size of paperclip

- Species not stated
- <https://www.thedodo.com/tiny-bat-rescue-uk-1970408126.html>

Reproduction



- Yes, the mothers make **milk**.
- Usually one baby.
  - <https://www.britannica.com/list/5-surprising-facts-about-bats>



Common pipistrelle

- *Pipistrellus pipistrellus*
- Nursing baby? Yes. They do drink mother's milk.
- <https://www.durhambats.co.uk/vbrv-scheme/>

## Viruses in bats

### Bats as Viral Reservoirs

- **David T.S. Hayman, BVM, PhD**
  - Molecular Epidemiology and Public Health Laboratory, Infectious Disease Research Centre, Hopkirk Research Institute, Massey University, Palmerston North 4442, [New Zealand](#);
  - **Annual Review of Virology. 2016**
  - Vol. 3:77-99 (Volume publication date September 2016)
  - <https://www.annualreviews.org/doi/10.1146/annurev-virology-110615-042203>
- Summary
  - **This is pretty technical.**

## Vampire bat

**Nucleotide Details** ✕

KU552072  
Bat coronavirus/4292/2013/Desmodus rotundus/Brazil RNA-dependent RNA polymerase gene, partial cds (Asano,K.M., et al.)

**Attributes**  
**Nuc Completeness:** partial  
**Strain:** 4292  
**Length:** 572  
**Mol Type:** RNA  
**Host:** Desmodus rotundus  
**Geo Location:** Brazil  
**Collection Date:** 2013

**Publications**  
**PubMed:** 1 publication

**Submitters Names**  
Asano,K.M., Hora,A.S., Scheffer,K.C., Fahl,W.O., Iamamoto,K., Mori,E., Brandao,P.E.

**Organization (Submitters' Institutional Affiliation)**  
Instituto Pasteur, Virology

**Affiliation Location**  
Brazil

## Genome

- [https://www.ncbi.nlm.nih.gov/labs/virus/vssi/#/virus?SeqType\\_s=Nucleotide&VirusLineage\\_ss=Bat%20coronavirus%2F4292%2F2013%2FDesmodus%20rotundus%2FBrazil,%20taxid:1868636](https://www.ncbi.nlm.nih.gov/labs/virus/vssi/#/virus?SeqType_s=Nucleotide&VirusLineage_ss=Bat%20coronavirus%2F4292%2F2013%2FDesmodus%20rotundus%2FBrazil,%20taxid:1868636)
  - **Genome screenshot above**
- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Info&id=1868636&lvl=3&lin=f&keep=1&srchmode=1&unlock>
  - Location in Genus **Alpha**

# Page 119 – Chinese bulbul

## Chinese bulbul

*Bulbul coronavirus HKU11*  
**NCBI.**

- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Tree&id=574549&lvl=3&lin=f&keep=1&srchmode=1&unlock>



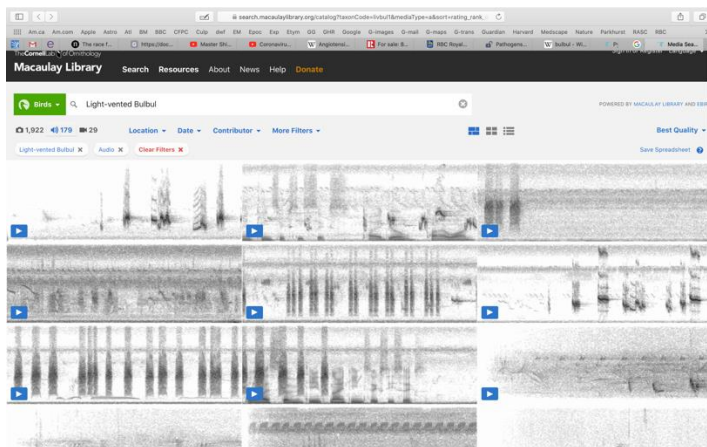
### Chinese bulbul a.k.a. light-vented bulbul

- White patch on **nape** (back of neck) and **sides** of head.
- **China, Taiwan, Vietnam**
  - **Frequently seen in Shanghai.**
- [https://en.wikipedia.org/wiki/Light-vented\\_bulbul](https://en.wikipedia.org/wiki/Light-vented_bulbul)

# The Cornell Lab of Ornithology

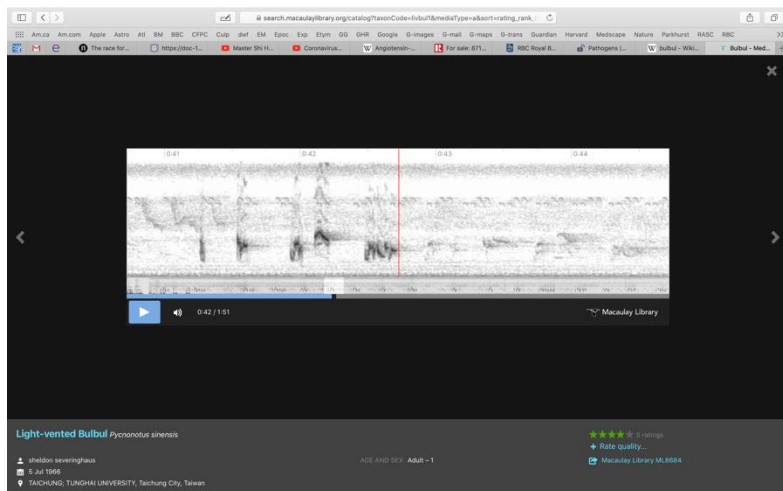
## Cornell Laboratory of Ornithology

- Details in text.
- <https://birdsoftheworld.org/bow/species/livbul1/cur/introduction>
- <https://www.birds.cornell.edu/home/>
  - This is the homepage.



## Cornell Laboratory of Ornithology

- The **file below** is **top row middle** on this page
- [https://search.macaulaylibrary.org/catalog?taxonCode=livbul1&mediaType=a&sort=rating\\_rank\\_desc&\\_hstc=65717809.e7644874b21b6cea26c92d6614b00f19.1588450708894.1588450708894.1588450708894.1&\\_hssc=65717809.1.1588450708894&\\_hsfp=4135581470#\\_ga=2.170815072.1906014796.1588450708-691831375.1588450708](https://search.macaulaylibrary.org/catalog?taxonCode=livbul1&mediaType=a&sort=rating_rank_desc&_hstc=65717809.e7644874b21b6cea26c92d6614b00f19.1588450708894.1588450708894.1588450708894.1&_hssc=65717809.1.1588450708894&_hsfp=4135581470#_ga=2.170815072.1906014796.1588450708-691831375.1588450708)



Amazingly a Chinese bulbul recorded on 5 July 1966 at 5 a.m, Taichung City, Taiwan

- Same link as above.
  - [https://search.macaulaylibrary.org/catalog?taxonCode=livbul1&mediaType=a&sort=rating\\_rank\\_desc&\\_hstc=65717809.e7644874b21b6cea26c92d6614b00f19.1588450708894.1588450708894.1588450708894.1&\\_hssc=65717809.1.1588450708894&\\_hsfp=4135581470#\\_ga=2.170815072.1906014796.1588450708-691831375.1588450708](https://search.macaulaylibrary.org/catalog?taxonCode=livbul1&mediaType=a&sort=rating_rank_desc&_hstc=65717809.e7644874b21b6cea26c92d6614b00f19.1588450708894.1588450708894.1588450708894.1&_hssc=65717809.1.1588450708894&_hsfp=4135581470#_ga=2.170815072.1906014796.1588450708-691831375.1588450708)



Chinese bulbul recording above.

- Taiwan
  - Taipei
  - N coast
  - Taichung City
    - W coast

### bulbul

- Genus *delta* (*Genus Deltacoronavirus*)
  - Bulbul
    - *Bulbul coronavirus HKU11*
      - Chinese bulbul (white-vented bulbul) (light-vented bulbul)
        - *Pycnonotus sinensis*

- It's a bird, specifically a **passerine** (= toes facilitate perching = 3 forward, 1 back).
    - **Songbird.**
    - 150 spp of bulbul.
    - White patch on nape (back of neck) and sides of head.
    - **China, Taiwan, Vietnam**
      - Frequently seen in **Shanghai.**
  - [https://en.wikipedia.org/wiki/Light-vented\\_bulbul](https://en.wikipedia.org/wiki/Light-vented_bulbul)
- **Song**
  - Common song is a ringing series of four notes, “wee-wee-der-wee.” (**Cornell**)

#### Source

- **Cornell Laboratory of Ornithology**
  - **Chinese bulbul**
  - <https://birdsoftheworld.org/bow/species/livbul1/cur/introduction>

# Page 120 – *Gallus gallus* a.k.a. The Chicken that Coronavirus beat the crap out of

#### *Infectious Bronchitis Virus*

- **Gamma**
- **NCBI**
- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Tree&id=11120&lvl=3&lin=f&keep=1&srchmode=1&unlock>

#### *Infectious Bronchitis in Poultry*

- **Summary**
  - There are photos of wrinkled egg shells and an infected chicken windpipe (trachea) (“tray kee ah”).
- **Verbatim**
  - Infectious bronchitis virus (IBV) is an avian gammacoronavirus that only causes disease in chickens, although the virus has also been found in pheasants and peafowl, which may be subclinically infected.
- **Source**
  - **MERCK MANUAL – Veterinary Manual.**
    - **Mark W. Jackwood**, PhD, Poultry Diagnostic and Research Center, Department of Population Health, College of Veterinary Medicine, University of Georgia
    - Last review/revision **Oct 2019** | Modified **Oct 2022**
    - [https://www.merckvetmanual.com/poultry/infectious-bronchitis/infectious-bronchitis-in-poultry?gclid=CjwKCAiAy\\_CcBhBeEiwAcoMRHG0NFGq5ku6kQWyHDV7wJycooyZqqBP5DsyNsv\\_SFntIGmVIM1jZR0CEE0QAvD\\_BwE&qclsrc=aw.ds](https://www.merckvetmanual.com/poultry/infectious-bronchitis/infectious-bronchitis-in-poultry?gclid=CjwKCAiAy_CcBhBeEiwAcoMRHG0NFGq5ku6kQWyHDV7wJycooyZqqBP5DsyNsv_SFntIGmVIM1jZR0CEE0QAvD_BwE&qclsrc=aw.ds)

### Chicken

- There are weird taxonomic instances where the Genus and species are the same.
  - The **chicken** is *Gallus gallus*.
  - The **wolverine** is *Gulo gulo*.
- Lots of photos. You can also listen to a rooster crowing.
- <https://en.wikipedia.org/wiki/Chicken>

### Old MacDonald Had a Farm

- There's a painting of the guy who wrote the song. He does not even remotely resemble a farmer.
- There is a 1927 recording of the song.
- [https://en.wikipedia.org/wiki/Old\\_MacDonald\\_Had\\_a\\_Farm](https://en.wikipedia.org/wiki/Old_MacDonald_Had_a_Farm)

### Old MacDonald Had A Farm - The Countdown Kids | Kids Songs & Nursery Rhymes

- This is an animated version for kids, with words and lyrics.
- The Countdown Kids. YouTube. 10 November 2020.
- <https://www.youtube.com/watch?v=RobT920n0qA>

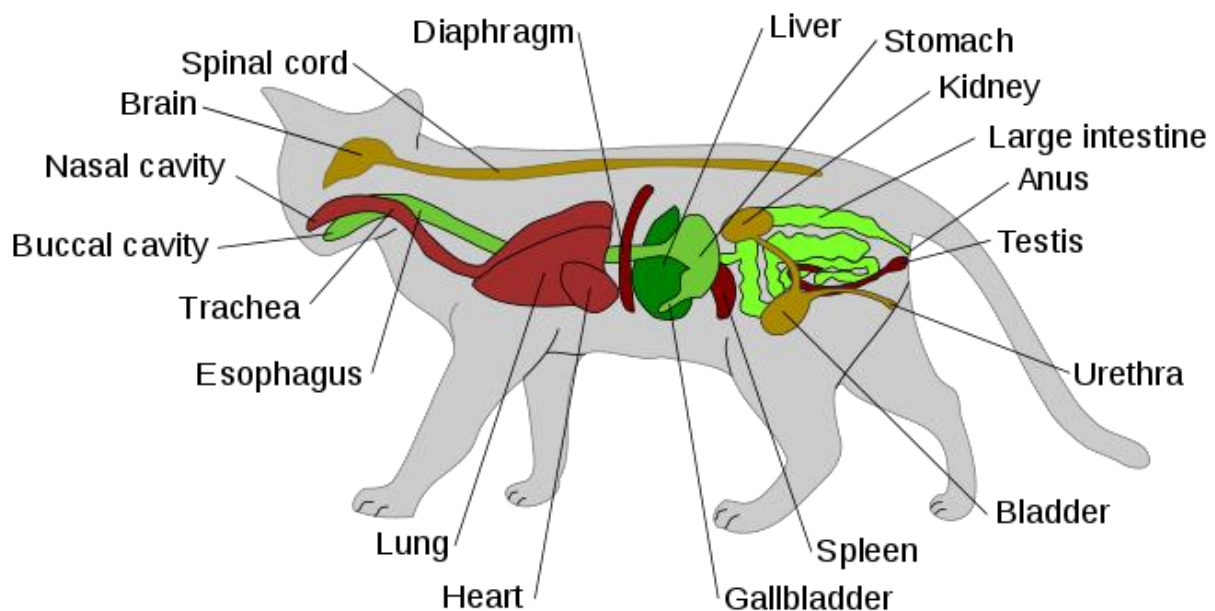
### AVIAN REPRODUCTIVE SYSTEM – FEMALE

- Summary
  - Loads of interesting detail and photos of a chicken's egg-making system.
- Verbatim
  - Infectious bronchitis and egg drop syndrome also have been known to cause an increase in shell-less eggs.
- Verbatim re: only L ovary functional
  - In almost all species of birds, including poultry, only the left ovary and oviduct are functional. Although the female embryo has two ovaries, only the left one develops. The right one typically regresses during development and is nonfunctional in the adult bird. (There have been cases in which the left ovary has been damaged and the right one has developed to replace it.)
- Summary
  - Poultry Extension seems to work with US Dept. of Agriculture (USDA).
    - 2022 (no month).
    - Dr. Jacquie Jacob, University of Kentucky
    - <https://poultry.extension.org/articles/poultry-anatomy/avian-reproductive-female/>

### AVIAN RESPIRATORY SYSTEM.

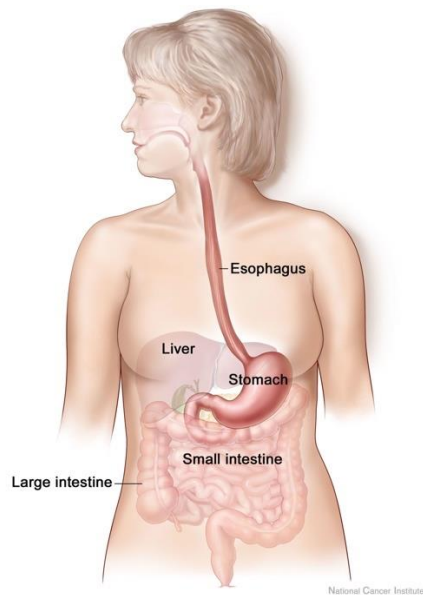
- There's a drawing of the bird respiratory system. There is no diaphragm.
- The syrinx is the voicebox, more or less.
  - Poultry Extension. 2022 (no month).
  - Dr. Jacquie Jacob, University of Kentucky. Same author as article above.
  - <https://poultry.extension.org/articles/poultry-anatomy/avian-respiratory-system/>

# Page 121 – “Things went downhill after the diarrhea started,” said my cat. Cat #1



## Cat anatomy

- Summary
  - Notice the **diaphragm**.
    - It's *vertical* in a cat – which walks on 4 legs.
    - Could it be *horizontal* in a cat? Yes, if the cat walked on 2 legs like a human.
- [https://commons.wikimedia.org/wiki/File:Scheme\\_cat\\_anatomy.svg](https://commons.wikimedia.org/wiki/File:Scheme_cat_anatomy.svg)



Human digestive system. Wikipedia.

- [https://en.wikipedia.org/wiki/Human\\_digestive\\_system](https://en.wikipedia.org/wiki/Human_digestive_system)
- That's a human for comparison.

Feline coronavirus

- NCBI
- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Tree&id=12663&lvl=3&lin=f&keep=1&srchmode=1&unlock>

## Nice version – Feline Enteric Coronavirus

Feline Enteric Coronavirus

- Summary
  - Feline coronavirus (FCoV)
    - Infects cats globally.
      - FECV and FIPV found in domestic cats and wild cats globally with similar prevalence.
      - FCoV
        - Serotype I
          - This guy seems to be the one involved with FIP.
        - Serotype II
    - There are 2 types, actually:
      - Feline Enteric Corona Virus (FECV)
        - FECV-Associated Gastroenteritis
        - Seems mild. The cats are chronic carriers. Some cats are Resistant. (Wik)
        - The rest of this info is Merck Vet Manual.
        - Mild GI illness: mild diarrhea and vomiting in kittens.
        - 13% of cats are chronic carriers.
        - Ingest/inhale infected feces. = fecal-oral
        - Vertical tx from 'infected queen' (what?) to unborn kitten.
        - FECV infects and replicates in brush border. SOMPOO: Remember this.
          - Specifically, in mature apical epithelial cells.
          - Histo: Villi slough, atrophy, fuse.

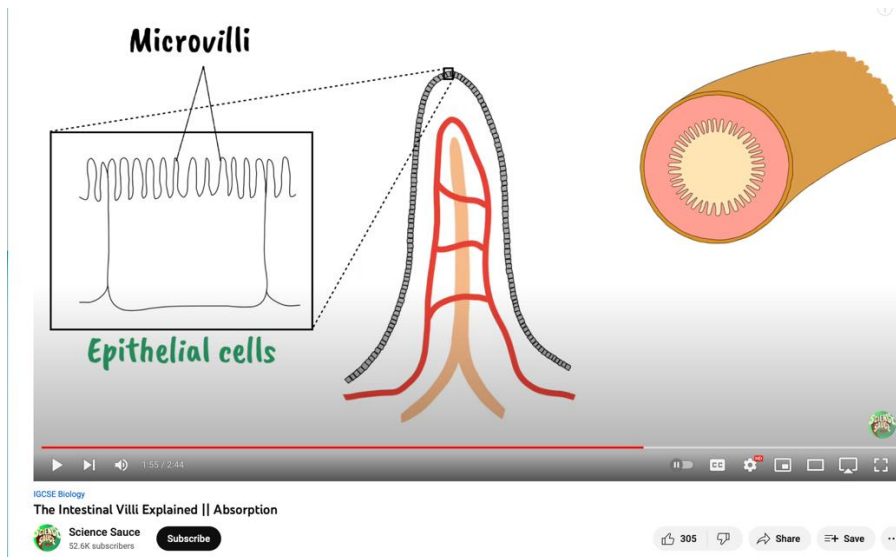


- Reverse transcriptase PCR
    - Coronavirus AB+ in up to 40% of house cats and 90% of catteries!
    - Rx: supportive. Death uncommon.
  - Feline Infectious Peritonitis Virus (FIPV)
    - Tx = Fecal-oral
- Verbatim
  - Mutation of FECV to a biotype capable of infection and replication within macrophages is responsible for development of feline infectious peritonitis (FIP), a highly fatal, multisystemic disease.
- Source
  - Merck Vet Manual
    - Last review/revision Jun 2020 | Modified Oct 2022
    - <https://www.merckvetmanual.com/digestive-system/diseases-of-the-stomach-and-intestines-in-small-animals/feline-enteric-coronavirus>
- Author
  - Alex Gallagher , DVM, MS, DACVIM-SAIM, Department of Small Animal Clinical Sciences, College of Veterinary Medicine, University of Florida

### Some cat definitions for cat lovers

- Summary
  - Cat
    - *Felis catus*
    - Only domesticated member of Family Felidae
    - Options:
      - house cat a.k.a. domestic cat
      - farm cat a.k.a. barn cat
        - = domestic cat that is usually a mixed breed and lives primarily outdoors.
      - feral cat
        - = un-owned domestic cat
        - a.k.a. wild cat (uncommonly called this in Wik and only in setting of Sardinian wild cat)
        - NTBCW (Not To Be Confused With) wildcat which is actually:
          - *Felis sivestris*      European wildcat
          - *Felis lybica*      African wildcat
- <https://en.wikipedia.org/wiki/Cat>
- [https://en.wikipedia.org/wiki/Farm\\_cat](https://en.wikipedia.org/wiki/Farm_cat)
- [https://en.wikipedia.org/wiki/Feral\\_cat](https://en.wikipedia.org/wiki/Feral_cat)
- [https://en.wikipedia.org/wiki/Ship%27s\\_cat](https://en.wikipedia.org/wiki/Ship%27s_cat)
- <https://en.wikipedia.org/wiki/Wildcat>

Enterocyte



### The Intestinal Villi Explained || Absorption

#### • Summary

- This is a great 2 min 44 sec video that succinctly describes the **villi** (fingers) and **micro-villi** (micro-fingers) in the small intestine.
- It also describes how the **surface area** of a tube is increased with many fingers. Specifically, the surface area of the interior of the tube.

#### • Source

- Science Sauce. YouTube. **3 October 2022**.
- <https://www.youtube.com/watch?v=5BeCEO96LFg>

### Cell types – ENTEROCYTE.

#### • Summary

- Okay, check it out – these are photos of the lining of small intestine – in this case a **rat** (yes, a rat). It's basically the same arrangement for a cat or human.
- The small intestine is a **tube**. The tube is lined with a **shag carpet**.
- **Figure 1**
  - **Left image:** This is the **shag carpet** (a.k.a. **villi** a.k.a. **fingers**). You can see **4 tall fingers**. And **1 short finger** – it's probably short simply because of the way the intestine tissue was squished on the glass slide when it was being prepared. And by 'prepared,' I mean the intestine tissue was most likely **removed** from a rat, then the tissue was **frozen**, then **cut** into a thin slice using a **glorified meat slicer** called a **micro-tome**. And then carefully **laid flat** on a glass slide, and then a glass 'cover slip' placed overtop to sandwich it in place. And now you can look at it by peering through the microscope eyepieces. And photograph it.
  - **Right image:** This zooms in on a portion of a **single villus** (1 finger). It is made of cells called **entero-cytes**.
  - All these images are from a **standard microscope**.
- **Figure 2** is the same thing but with a **scanning electron microscope** that can create 3-dimensional images.

#### • Source

- **Atlas of plant and animal histology**
  - 2022-08-01
  - [Atlas of Plant and Animal Histology](https://mmegias.webs.uvigo.es/02-english/8-tipos-celulares/enterocito.php)  
Dep. of Functional Biology and Health Sciences.  
Faculty of Biology.  
University of Vigo  
Spain
  - <https://mmegias.webs.uvigo.es/02-english/8-tipos-celulares/enterocito.php>

*Wheater's Functional Histology: A Text and Colour Atlas*

- Summary
  - Lots of cool photographs of the lining of the intestine – either with a standard microscope or an electron microscope.
- Barbara Young, Geraldine O'Dowd, Phillip Woodford. Elsevier Canada; 6th edition. 4 November 2013.
  - [https://www.amazon.ca/Wheaters-Functional-Histology-Colour-Atlas-dp-0702047473/dp/0702047473/ref=dp\\_ob\\_title\\_bk](https://www.amazon.ca/Wheaters-Functional-Histology-Colour-Atlas-dp-0702047473/dp/0702047473/ref=dp_ob_title_bk)

## Page 122 – Cat #2

### Nice version (continued)

*Brush border*

- There are multiple definitions here of the **brush border**, to give you a better sense of it.
- The Free Dictionary.
- <https://medical-dictionary.thefreedictionary.com/brush+border>

*Shaping the intestinal brush border.*

- Summary
  - **Figure 1 images A – F** are increasing levels of zooming in on the shag carpet lining of the small intestine.
  - In **Figure 1B**, one of the labels is **apoptotic shedding**. That means these small intestine cells are designed to die after a short life span of only **4 to 5 days**.
    - **Apoptosis** (“a pop toe sis”) means **programmed cell death**. The ‘program’ is determined by the DNA in the cell.
    - When these cells of the small intestine lining die, they are ‘shed,’ as in join the feces and end up in your toilet. Hence, **apop-totic shedding**.
    - Apoptosis is not restricted to the small intestine. It happens all over the place. For example, a **fetus** in the womb has **webbed fingers**. There is apop-tosis of the cells during development and the **baby** is born with 5 separate fingers, rather than looking like a **beaver**.
- Source
  - The Journal of Cell Biology
    - 1 November 2014
    - <https://europepmc.org/article/pmc/4242837>
- Authors
  - **Crawley SW**
    - Department of Cell and Developmental Biology, Vanderbilt University Medical Center, Nashville, TN 37232.
  - **Mooseker MS**
    - Department of Molecular, Cellular and Developmental Biology, Department of Cell Biology, and Department of Pathology, Yale University, New Haven, CT 06520 Department of Molecular, Cellular and Developmental Biology, Department of Cell Biology, and Department of Pathology, Yale University, New Haven, CT 06520 Department of Molecular, Cellular and Developmental Biology, Department of Cell Biology, and Department of Pathology, Yale University, New Haven, CT 06520.
  - **Tyska MJ**

- Department of Cell and Developmental Biology, Vanderbilt University Medical Center, Nashville, TN

Question: 8. The Figure Below Is An Image Of Brush Border In The Small Intestine.

- This is an electron microscope photo of the **micro-villi** (mini-fingers) that make up the **'brush border'** of the **small intestine**. Basically, the finest part of the shag carpet, photographed by an electron microscope.
- Chegg
  - No date, no author.
  - <https://www.chegg.com/homework-help/questions-and-answers/8-figure-image-brush-border-small-intestine-based-knowledge-following-statements-true--cel-q42416061>

## Tropism

tropism

- Verbatim
  - noun *Biology*.
    - an orientation of an organism to an external stimulus, as light, especially by growth rather than by movement.
- Source
  - [Dictionary.com](https://www.dictionary.com)
    - <https://www.dictionary.com/browse/tropism>

tropism (n.)

- Summary
  - Tropism is one of those science words that only makes sense when you learn the Greek – in this case 'tropos' means **turning**. Get it? A plant or animal turns towards a stimulus. For example, flowers turn towards the sun.
  - **Viruses** cannot move so they cannot turn. So the definition is a bit different for viruses and requires some imagination. Let's just say the virus 'turns' its attention to a specific type of animal or a particular type of cell within that animal. For example, the **Rabies virus** likes dogs. That's how we get rabid dogs. Did you ever hear of a rabid dragonfly? No? That's because the rabies virus does not 'turn' towards dragonflies.
  - The **Coronavirus** clearly likes humans. It turns towards us, so to speak. Tropos. Tropism.
- Verbatim
  - 1899, "tendency of an animal or plant to turn or move in response to a stimulus," 1899, abstracted from **geotropism** or **heliotropism**, with the second element taken in an absolute sense; ultimately from Greek *tropos* "a turning" (from PIE root **\*trep-** "to turn").
    - The Greek word *tropos* is in turn is derived from *trep* in **PIE (Proto-Indo-European)**, which is like a mother tongue to other languages. Read the book, *Mother Tongue* by **Bill Bryson** to be fully entertained and learn all about the origins of the English language.
- Summary
  - [Online Etymology Dictionary](https://www.etymonline.com)
    - <https://www.etymonline.com/search?q=tropism>

tropism

- Summary

- This article addresses the concept of 'tropism' on a broad front. For examples, plants turn towards the light – that's called **photo-tropism** or **heliotropism** (if the plant turns towards sunlight).
- There's a **2 min 30 sec video** of plants moving in response to light or gravity. Kinda cool.
- Summary
  - **Encyclopedia Britannica**
    - <https://www.britannica.com/science/tropism>



Those are **daisies** turning towards the sun.

- Summary
  - This Wikipedia page has links to a whole bunch of different types of tropism:
    - **Gravi-tropism** Plant growth away from **gravity**.
    - **Magneto-tropism** Animal movement towards **magnetic fields**.
    - Lots of others.
- <https://en.wikipedia.org/wiki/Tropism>

### 9.5C: Tissue Tropism in Animal Viruses

- Summary
  - This article specifically looks at tropism in **viruses**.
  - These are the key points:
    - Viruses must bind to a **receptor** on the **surface** of a cell. Think of the receptor as a **doorbell**.
    - If there is no doorbell, there is no entry.
    - A virus is inside your body. Does it infect all cell types? Or only certain cell types (like say, only in the lung)? That depends on the kind of virus.
- Source
  - **LibreTexts Biology**
    - No date, no author.
    - [https://bio.libretexts.org/Bookshelves/Microbiology/Book%3AMicrobiology\\_\(Boundless\)/9%3AViruses/9.5%3AViral\\_Replication/9.5C%3ATissue\\_Tropism\\_in\\_Animal\\_Viruses](https://bio.libretexts.org/Bookshelves/Microbiology/Book%3AMicrobiology_(Boundless)/9%3AViruses/9.5%3AViral_Replication/9.5C%3ATissue_Tropism_in_Animal_Viruses)

### Tropism of and Innate Immune Responses to the Novel Human Betacoronavirus Lineage C Virus in Human Ex Vivo Respiratory Organ Cultures

- Summary
  - This article looks at tropism in the **coronavirus**.
  - Within our human lungs, the **SARS-Coronavirus-1** (think, **SARS pandemic**) has a preference for:
    - The cells that line that airways in the lungs.
    - Very specific cells within the air sacs.
      - Jump ahead to pages ##131 – 140 (in this **COVID 101**), and specifically page 135, for more on these special lung cells.
  - Basically, the very same preference is shown by the **SARS-Coronavirus-2** (the **COVID-19 pandemic**).

- Verbatim
  - The tropism of SARS-CoV in the respiratory tract was primarily restricted to differentiated human airway epithelium and alveolar type II pneumocytes, with limited tropism for alveolar type I pneumocytes.
- Source
  - Journal of Virology
    - 28 May 2013
    - [https://journals.asm.org/doi/10.1128/JVI.00009-13?site=JViro&utm\\_source=TrendMDJViro&utm\\_medium=TrendMDJViro&utm\\_campaign=trendmdalljournals\\_0](https://journals.asm.org/doi/10.1128/JVI.00009-13?site=JViro&utm_source=TrendMDJViro&utm_medium=TrendMDJViro&utm_campaign=trendmdalljournals_0)
- Authors
  - [Renee W. Y. Chan](#)
  - [Michael C. W. Chan](#)
  - [Sudhakar Agnihothram](#)
  - [Louisa L. Y. Chan](#)
  - [Denise I. T. Kuok](#)
  - [Joanne H. M. Fong](#)
  - [Y. Guan](#)
  - [Leo L. M. Poon](#)
  - [Ralph S. Baric](#)
  - [John M. Nicholls](#),
  - [J. S. Malik Peiris](#)

#### *Tobacco mosaic virus*

- 2000. Updated 2005.
- [Karen-Beth G. Scholthof](#). Texas A&M University.
- American Phytological Society
- <https://www.apsnet.org/edcenter/disandpath/viral/pdlessons/Pages/TobaccoMosaic.aspx>


## Insect gut micro-villi

#### *The Multi-Tasking Gut Epithelium of Insects*

- Verbatim
  - **Midgut enterocytes, for example, have a brush border of microvilli** on the apical membrane (facing the gut lumen) and irregularly convoluted infoldings of the basolateral membrane, consistent with their role in production of digestive enzymes and assimilation of nutrients.
- Source
  - Insect Biochemistry and Molecular Biology.
    - December 2015
    - <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4644519/>
- Authors
  - [Jia-Hsin Huang](#), [Xiangfeng Jing](#),<sup>a</sup> and [Angela E Douglass](#),<sup>b</sup>
  - <sup>a</sup>Department of Entomology, Cornell University, Ithaca, NY14853, USA
  - <sup>b</sup>Department of Molecular Biology and Genetics, Cornell University, Ithaca, NY14853, USA

#### *The digestive tract of Drosophila melanogaster.*

- Summary
  - **Drosophila melanogaster** is a **fruit fly**. It's famous in genetics because it's easy to breed and study mutations.

- “Dro sof ill ah” “mel an oh gas ter.”
-  Click on Figure 1. And then scroll within the enlarged image to look at image ‘c.’ This is to convince you that even a fruit fly has a gut, just like you. And entero-cytes, just like you. And micro-villi, just like you.
  - Remember, entero-cytes absorb nutrients. That is their job in life.
  - And micro-villi increase the surface area for absorbing.
- Source
  - Annual Review of Genetics.
    - 2013.
    - Figure 1 in Semantic Scholar.
    - <https://www.semanticscholar.org/paper/The-digestive-tract-of-Drosophila-melanogaster.-Lemaître-Miguel-Aliaga/e42239cbde8d645d5cd60bb58c22bfc99ed084ab>
- Author
  - Bruno Lemaitre<sup>1</sup> and Irene Miguel-Aliaga<sup>2</sup>
    - <sup>1</sup>Global Health Institute, School of Life Sciences, École Polytechnique Fédérale Lausanne (EPFL), CH-1015 Lausanne, Switzerland
    - <sup>2</sup>MRC Clinical Sciences Center, Imperial College London, London W12 0NN, United Kingdom

### Midgut

- Summary
  - In the right column about ¼ down in the paper titled *Metabolic Systems* is a drawing of an insect gut lumen cell with microvilli.
  - **Lumen** is a fancy word for the hollow interior of some structure. It could be the lumen of the intestines (as in this paper). It could be the lumen of a blood vessel.
  - It could be the lumen of a drinking straw but that’s not an anatomic structure but that’s what we’d call it if it was. Okay I think that was terrible English.
- Source
  - Science Direct
    - <https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/midgut>

## Villous atrophy

### Celiac disease

- Summary
  - **Click on the illustration** to contrast a normal intestinal lining versus a flattened one. Get it? The **fingers (villi)** are all flattened a.k.a. **villous atrophy**.
- Verbatim
  - **Celiac disease**, sometimes called **celiac sprue** or **gluten-sensitive enteropathy**, is an immune reaction to eating gluten, a protein found in wheat, barley and rye.
  - If you have celiac disease, eating gluten triggers an immune response in your small intestine. Over time, this reaction damages your small intestine's lining and prevents it from absorbing some nutrients (malabsorption).
- Source
  - **Mayo Clinic**
    - Mayo Clinic Staff. No date.
    - <https://www.mayoclinic.org/diseases-conditions/celiac-disease/symptoms-causes/syc-20352220>

### Pathogenesis of coeliac disease: Implications for treatment

- Summary
  - This is kinda technical.
- Verbatim
  - Coeliac disease (CD) is an enteropathy, characterised by villous atrophy, which occurs in genetically susceptible individuals. It affects mainly the proximal small intestine, and is caused by an intolerance to cereal storage proteins found in wheat, barley and rye. Due to earlier diagnosis, and the recognition of 'silent' or 'latent' forms of the disease, the very severe symptoms that were seen previously are not very common now.
- Source
  - World Journal of Gastroenterology
    - 15 Dec 2001
    - Jocelyn S Fraser and Paul J Ciclitira.
    - <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4695591/>

# Page 123 – Cat #3

## Nasty version – Feline Infectious Peritonitis

### Feline infectious peritonitis virus

- NCBI
- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Tree&id=11135&lvl=3&lin=f&keep=1&srchmode=1&unlock>

### Overview of Feline Infectious Peritonitis

- Summary
  - Feline Infectious Peritonitis Virus (FIPV)
    - Feline Infectious Peritonitis (FIP)
    - This info is Merck Vet Manual.
    - FCoV infection and FIP occur worldwide with similar prevalence and are found in domestic and wild cats.
      - FECV mutates to FIPV.
      - I think it's actually this: FECV (FCoV Serotype 1) mutates to → FIPV (FCoV Serotype 2).
        - A virulent FCoV in enterocyte mutates to → virulent FCoV that can replicate within macrophage. That's a theory.
        - May involve furin which converts pre-protein to active protein.
      - FCoV Serotype 1 and FIPV (FCoV Serotype 2) can both cause
      - There is some antigenic relationship to Canine Coronavirus.
        - Though 90% of cats in cattery might have FCoV, only 5% develop FIP.
      - Most are < 12 months old.
    - Breeds susceptible
      - Susceptibility to FIP is a polygenic inherited trait in Persians and Birman. Breeds with higher prevalence of FIP include:
        - Abyssinian
        - Bengal
        - Birman
          - Allegedly the origin is in Burma.
        - Himalayan



- Ragdoll
  - Rex
- Fecal-oral
- Pathophys / SS
  - It's a **vasculitis** involving: CNS, eye, pancreas, liver, kidneys.
    - Organ failure 2ary to vasculitis
  - **Fibrinous peritonitis**
  - Thoracic effusions → dyspnea, open-mouth breathing. Patchy density on CXR
  - **Retina** granulomatous change.
  - CNS:
    - Ataxia common
    - Seizure
    - Loss of menace reflex. Hmmm.
    - Hydrocephalus postmortem in 75%
- Dx
  - WBC inc or dec.
  - Lymphopenia 2ary to apoptosis of T-lymphocytes (usually CD8+). Wow.
    - WBC counts can be decreased or increased. Lymphopenia is commonly present, mainly caused by apoptosis of uninfected T cells, primarily CD8+ T cells, as a result of high TNF-α concentrations produced by virus-infected macrophages. However, lymphopenia in combination with neutrophilia can occur in many severe diseases in cats. A mild to moderate nonregenerative anemia is another nonspecific finding that may be seen in almost any chronic disease in cats.
  - No specific AB test other than anti-FCoV which is probably going to be positive anyways.
- Px – poor prognosis. Death in 9 days in a study of 43 cats with FIP.
- Rx
  - Supportive: Fluids, nutrition.
  - Immune modulators tried but no controlled trials.
- Vax
  - FCoV strain DF2-FIPV
    - Replicates in the cool URT of cat.
  - Intranasal
  - Give at 16 weeks
  - Not routinely recom by American Association of Feline Practitioners
- Source
  - MERCK MANUAL – Veterinary Manual.
    - Last review/revision Jan 2014 | Modified Oct 2022
    - <https://www.merckvetmanual.com/generalized-conditions/feline-infectious-peritonitis/overview-of-feline-infectious-peritonitis>
- Authors
  - Julie K. Levy , DVM, PhD, DACVIM, University of Florida College of Veterinary Medicine;
  - Staci Hutsell , DVM, University of Florida College of Veterinary Medicine

## Peritoneum and Peritonitis

### Some background

- **Periton-eum**
  - The peritoneum is basically a Ziploc bag that surrounds the abdominal organs – stomach, liver, gall bladder, intestines.

- Or imagine it like **Saran Wrap**, if you like.
  - But it's complicated because some of the organs are only partly in the bag. Imagine that's it's not completely zipped shut. Then it's called **retro-peritoneal**. **Surgeons** have to know this stuff.
- **Peritonitis**
  - The bag is irritated a.k.a. inflamed.

### Peritonitis

- Summary
  - This is a decent overview of **peritonitis**. But no matter who explains the topic – even the excellent **Mayo Clinic** – it's still difficult to understand.
- Source
  - Mayo Clinic
    - Mayo Clinic Staff. No date
    - <https://www.mayoclinic.org/diseases-conditions/peritonitis/symptoms-causes/syc-20376247>

### 4.9 Peritoneal development: step 0, model, introduction.

- Summary
  - This is a wondrously strange video that comes at the **peritoneum** from a different perspective. The producers build a man-sized cabinet that represents the abdomen, and a giant bag wraps the abdominal organs. The narrator has a cool Dutch accent.
- Source
  - **Center for Innovation** – **Leiden University**. YouTube. 6 July 2016.
  - 8 Minute video
  - Leiden University is in the city of **Leiden**. It's about 30 minutes by train from **Amsterdam**.
  - <https://www.youtube.com/watch?v=SMcLRFqLiHs>

## Cats susceptible to the Feline Infectious Peritonitis Virus

Remember, it's a nasty coronavirus of cats, not humans.

My cat drawings were all from Wikipedia.



Abyssinian cat

- Those are dreadfully cute Abyssinian kittens.
- Abyssinia (“ab iss in ee ah”) is close to the horn of Africa that pokes east into the Indian Ocean. But the cats are not actually from there. Whatever.
- [https://en.wikipedia.org/wiki/Abyssinian\\_cat](https://en.wikipedia.org/wiki/Abyssinian_cat)



Bengal cat

- Oddly, these cats suffer from “ho kum” just like humans. The heart muscle becomes thickened and does not contract properly. This is called **HOCM** a.k.a. **Hyper-trophic Obstructive Cardio-Myopathy**.
- [https://en.wikipedia.org/wiki/Bengal\\_cat](https://en.wikipedia.org/wiki/Bengal_cat)



*Birman cat*

- These cats are from **Burma** so shouldn't the spelling be Burman? Whatever.
- <https://en.wikipedia.org/wiki/Birman>



*Himalayan cat*

- Fantastic scowl.
- 'Jinx' is the Himalayan cat in *Meet the Parents* starring Ben Stiller and Robert De Niro. Here is a 1m 38s clip:
  - *MEET THE PARENTS* Greg and Jinx. YouTube
  - <https://www.youtube.com/watch?v=bcUTrC6nuaQ>
- [https://en.wikipedia.org/wiki/Himalayan\\_cat](https://en.wikipedia.org/wiki/Himalayan_cat)



*Persian cat*

- These cats hail from **Persia** which is basically modern **Iran**.
- [https://en.wikipedia.org/wiki/Persian\\_cat](https://en.wikipedia.org/wiki/Persian_cat)

# Page 124 – Cheetah, civet, dog

**Cheetah**



### Cheetah

- The scientific name is *Acinonyx jubatus*. It's easier to say cheetah.
- <https://en.wikipedia.org/wiki/Cheetah>

### *Acinonyx jubatus coronavirus*

- Summary
  - This is the genetic code of the coronavirus found in a cheetah.
- Source
  - NCBI Taxonomy Browser
    - <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Info&id=263509&lvl=3&lin=f&keep=1&srchmode=1&unlock>

### *Detection of Feline Coronavirus Infection in Captive Cheetahs (Acinonyx jubatus) by Polymerase Chain Reaction.*

- Verbatim
  - Cheetahs (*Acinonyx jubatus*) are especially vulnerable to FCoV-induced disease ...
- Source
  - Journal of Zoo and Wildlife Medicine
    - Published By: **American Association of Zoo Veterinarians**
    - [Vol. 32, No. 1 \(Mar., 2001\)](#), pp. 25-30 (6 pages)
    - <https://www.jstor.org/stable/20096062>
- Authors
  - Melissa Kennedy, Scott Citino, Terry Dolorico, Amanda Hillis McNabb, Amy Serino Moffat and Stephen Kania

### *Coronavirus outbreak in cheetahs: Lessons for SARS*

- Summary
  - This paper offers an explanation as to why cheetahs are susceptible to the coronavirus.
  - There was an outbreak of **Feline Infectious Peritonitis** in cheetahs at a game park in **Winston, Oregon** in the 1980s. So that means the coronavirus was causing problems in cheetahs long before it became headline news in humans.
  - I'm going to exaggerate to make a point. Cheetahs are so similar to each other they are like a giant family of clones. It would be like if the entire human population was 7 billion copies of you. So if one gets sick, they can all get sick.

- The watered down (and more realistic) version of that concept is that all cheetahs have very similar DNA. And therefore very similar immune systems (since the DNA is what codes for the immune system). So if a coronavirus infects one, it can infect another.
- This paper gets into the genetics, and something known as a Major Histo-compatibility Complex (MHC). See the 2<sup>nd</sup> last sentence of the verbatim below. The MHC is an important concept in the study of the immune system.
- Verbatim
  - A fatal epizootic of a related coronavirus in captive African cheetahs at Winston Safari park in the early 1980s may offer comparative insight into the prospects for a coronavirus-based epidemic. The affected animals died of feline infectious peritonitis (FIP), caused by a feline coronavirus (FCoV, also called FIPV).
  - Cheetahs are known as the world's fastest land animal but also for their extreme genetic uniformity, a consequence of their escape from extinction some 12,000 years ago. Remarkably, unrelated cheetahs accept skin grafts from non-relatives, a characteristic of highly inbred laboratory strains of mice or rats. The most likely explanation for the high mortality in cheetahs is their genetic uniformity, particularly at immune genes like the MHC. This may have rendered the species susceptible to an emerging virulent strain that had evolved to circumvent the defenses of the first victim.
- Source
  - Current Biology
    - 23 March 2004
    - <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7126726/>
- Authors
  - Alison J Pearks Wilkerson, Emma C Teeling, Jennifer L Troyer, Gila Kahila Bar-Gal, Melody Roelke, Laurie Marker, Jill Pecon-Slattery, and Stephen J O'Brien
    - Laboratory of Genomic Diversity, National Cancer Institute, SAIC Frederick, Maryland, USA

## Masked palm civet

### *Civet SARS CoV 007/2004*

- This is the genetic code of the coronavirus found in a civet.
- NCBI
- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Info&id=285945&lvl=3&lin=f&keep=1&srchmode=1&unlock>





*Masked palm civet*

- *Paguma larvata*
- Kinda strange looking.
- [https://en.wikipedia.org/wiki/Masked\\_palm\\_civet](https://en.wikipedia.org/wiki/Masked_palm_civet)



That's where it lives.

- [https://en.wikipedia.org/wiki/Masked\\_palm\\_civet](https://en.wikipedia.org/wiki/Masked_palm_civet)



Those are **coffee beans** in the crap (feces) of a civet. Now the 'specialty coffee' gets made.

- [https://en.wikipedia.org/wiki/Kopi\\_luwak](https://en.wikipedia.org/wiki/Kopi_luwak)



That's a **palm civet** trapped in a cage just to make a specialty coffee. Essentially a captive barista.

- **How about we just drink another brand of coffee. Like, *any other brand.***

- [https://en.wikipedia.org/wiki/Kopi\\_luwak](https://en.wikipedia.org/wiki/Kopi_luwak)

#### *Bats, civets and the emergence of SARS*

- Summary
  - This is the proposed infectious pathway for the **SARS pandemic of 2003**.
  - A **coronavirus** in a **horseshoe bat** 'spilled over' to **civets** and that in turn spilled over to **humans**.
    - The **virus** is the 'infectious organism' a.k.a. 'infectious agent' a.k.a. 'causative agent' a.k.a. 'pathogen.'
    - The **bat** is the 'natural reservoir' of the virus.
    - The **civet** is the 'intermediate host' of the virus.
    - The **human** is the 'definitive host' of the virus.
  - Get it? Bat → civet → human.
- Verbatim (Abstract of the paper)
  - Severe acute respiratory syndrome (SARS) was the first pandemic transmissible disease of previously unknown aetiology in the twenty-first century. Early epidemiologic investigations suggested an animal origin for SARS-CoV. Virological and serological studies indicated that masked palm civets (*Paguma larvata*), together with two other wildlife animals, sampled from a live animal market were infected with SARS-CoV or a closely related virus. Recently, horseshoe bats in the genus *Rhinolophus* have been identified as natural reservoir of SARS-like coronaviruses. Here, we review studies by different groups demonstrating that SARS-CoV succeeded in spillover from a wildlife reservoir (probably bats) to human population via an intermediate host(s) and that rapid virus evolution played a key role in the adaptation of SARS-CoVs in at least two nonreservoir species within a short period.
- Source
  - Current topics in microbiology and immunology
    - 2007
    - <https://pubmed.ncbi.nlm.nih.gov/17848070/>
- Authors

- L F Wang and B T Eaton. L F Wang <sup>1</sup>, B T Eaton
  - <sup>1</sup> CSIRO Livestock Industries, Australian Animal Health Laboratory, Geelong, Victoria, 3220 Australia.

### *Severe acute respiratory syndrome coronavirus-like virus in Chinese horseshoe bats.*

- Summary
  - This is a thorough article about the search for the **SARS coronavirus** (think, 2003) in the Hong Kong Special Administrative Region (HKSAR).
  - **Check out the map in Figure 1.**
    - **Black stars** are where samples were taken.
    - **Red stars** are where the bats were positive for **bat-SARS-CoV**.
  - There is detailed information on the genetics laboratory techniques that were used to identify the coronavirus in the bats.
- Verbatim
  - In addition, the presence of a 29-bp insertion in ORF 8 of bat-SARS-CoV genome, not in most human SARS-CoV genomes, suggests that it has a common ancestor with civet SARS-CoV.
- Source
  - **Proceedings of the National Academy of Sciences (PNAS)**
    - 16 September 2005
    - <https://www.pnas.org/doi/10.1073/pnas.0506735102>
- Authors
  - **Susanna K. P. Lau<sup>§</sup>**
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  - **Samson S. Y. Wong**
  - **Suet-Yi Leung**
  - **Kwok-Hung Chan**
  - **Kwok-Yung Yuen<sup>||,§</sup>**

**Dog**

### *Canine coronavirus*

- **This is the genetic code of the virus.**
- **NCBI**
- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Tree&id=11153&lvl=3&lin=f&keep=1&srchmode=1&unlock>

### *Canine respiratory coronavirus*

- **This is the genetic code of the virus.**
- **NCBI**
- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Info&id=215681&lvl=3&lin=f&keep=1&srchmode=1&unlock>

### Canine Respiratory Coronavirus FAQ

- Summary
  - Lots of good answers to lots of good questions.
- Verbatim 1
  - Question: What is canine respiratory coronavirus?
  - Answer: Canine respiratory coronavirus (CRCoV) is a group 2 coronavirus. It is genetically related to the bovine coronavirus (which can cause respiratory infections in cattle) and the human coronavirus that causes the "common cold" in people. CRCoV is NOT related to the group 1 enteric coronavirus that can cause diarrhea in dogs.
  - Translation
    - Group 1 = Alpha
      - It's called 'enteric' because that refers to the intestines where the diarrhea is occurring.
    - Group 2 = Beta
- Verbatim 2
  - A small minority of dogs infected with CRCoV have progressed to pneumonia, particularly if co-infected with other respiratory pathogens.
- Source
  - American Veterinary Medical Association (AVMA)
    - April 2008.
    - <https://www.avma.org/resources/pet-owners/petcare/canine-respiratory-coronavirus-faq>

### Dr. Sims on Parvo: Everything you need to know about Canine Parvovirus

- Summary
  - This is a nice explanation of the canine parvo-virus by a vet.
  - The canine parvo-virus infects the intestines of dogs. Remember that.
  - Take note, in very sick dogs, the bone marrow makes less white blood cells. That means less ability to fight infections. (This makes sense if you look at the next paper in the bibliography, by Dr. Alex Gallagher).
- Verbatim
  - The virus causes destruction of the epithelial cells of the small intestine, which is the lining that helps to absorb nutrients and provides a barrier against fluid loss and bacterial invasion from the gut into the body. Severe diarrhea and nausea are the initial result, but eventually the intestinal surface can become so damaged that it begins to break down, and the bacteria that are normally contained in the gut penetrate the intestine walls and enter the bloodstream. To make matters worse, the body's immune system is already weakened, as its ability to produce new white blood cells to fight infection has been hampered by the invasion of Parvo into the bone marrow. Parvo is not always fatal, but when it does kill, death is as a result of either dehydration and/or shock, along with the effects of septic toxins produced by the intestinal bacteria roaming throughout the bloodstream.
- Source
  - Dr. Shari Sims. Pembroke Animal Hospital, Pembroke, Ontario, Canada
  - 13 August 2018
  - <https://pemah.com/dr-sims-on-parvo-everything-you-need-to-know-about-canine-parvovirus/>

### Canine Parvovirus

- Summary
  - This is a bit more technical as this web page is intended as a resource for vets. But we shan't let that stop us!

- The **canine parvo-virus** infects the **intestines** of dogs. Remember that.
- Verbatim 1
  - Histologically, intestinal lesions are characterized by multifocal necrosis of the crypt epithelium, loss of crypt architecture, and villous blunting and sloughing.
  - Translation
    - **Histology** = the study of tissues under a microscope.
    - **Multi-focal necrosis** = many places of cell death.
    - **Crypt epithelium** = Basically, the tiny little valley between the fingers (villi). This is normal anatomy.
    - **Villous blunting** and **sloughing** = The fingers (villi) of the shag carpet are flattened (blunting) and shed (sloughing).
- Verbatim 2
  - Pulmonary edema, alveolitis, and bacterial colonization of the lungs and liver may be seen in dogs that died of complicating acute respiratory distress syndrome, systemic inflammatory response syndrome, endotoxemia, or septicemia.
  - Translation
    - **Pulmonary edema** = the air sacs in the lungs fill with fluid.
    - **Alveolitis** (“al vee oh lie tiss”) = the air sacs (alveoli) are inflamed.
    - Importantly, in some dogs, they are so horribly ill from the infection of the intestines that their lungs can get colonized by bacteria. Easy to die now.
    - **Acute respiratory distress syndrome** = The lungs are shutting down. Happens to dogs. Happens to humans. Complicated topic.
- Source
  - **MERCK MANUAL – Veterinary Manual**
    - Last review/revision Jun 2020 | Modified Oct 2022.
    - <https://www.merckvetmanual.com/digestive-system/diseases-of-the-stomach-and-intestines-in-small-animals/canine-parvovirus>
- Author
  - **Alex Gallagher, DVM**, MS, DACVIM-SAIM, Department of Small Animal Clinical Sciences, College of Veterinary Medicine, **University of Florida**.

# Page 125 – European hedgehog, 1-hump camel

## European hedgehog

### *Erinaceus hedgehog coronavirus HKU31*

- This is the genetic code of the **coronavirus** that infects the **European hedgehog**.
- NCBI
- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Info&id=2664184&lvl=3&lin=f&keep=1&srchmode=1&unlock>

## Characterization of a Novel Betacoronavirus Related to Middle East Respiratory Syndrome Coronavirus in European Hedgehogs

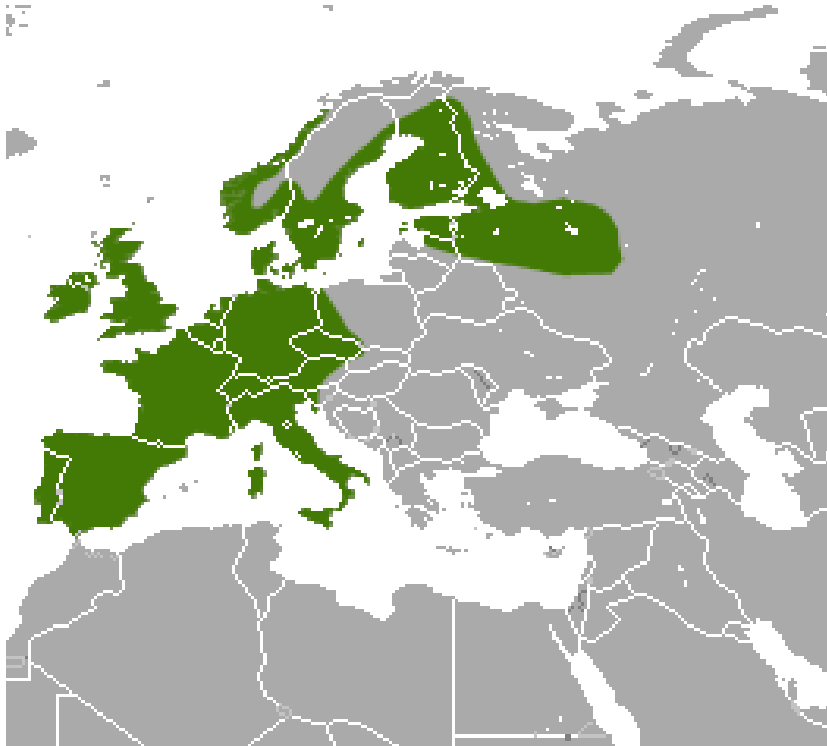
- Summary
  - This particular coronavirus is abbreviated as *EriCoV*.
    - *Eri* is the first three letters of its zoology name, *Erinaceus europaeus*.
    - The coronavirus was found in the **hedgehog feces**, consistent with the fact the virus infects its **intestines**. Furthermore, more virus was present in hedgehog feces than its blood or urine or 'solid' organs (e.g., liver).
    - **Figure 1** and **Figure 6** are **virus family trees** called **clades**, which play a big role in figuring out relationships. **Virologists** are big on clades.
- Verbatim
  - A total of 58.9% of hedgehog fecal specimens were positive for the novel CoV (*EriCoV*) at 7.9 log<sub>10</sub> mean RNA copies per ml. *EriCoV* RNA concentrations were higher in the intestine than in other solid organs, blood, or urine.
- Source
  - Journal of Virology
    - January 2014
    - <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3911734/>
- Authors
  - Victor Max Corman,<sup>a</sup> René Kallies,<sup>a</sup> Heike Philipps,<sup>b</sup> Gertraude Göpner,<sup>b</sup> Marcel Alexander Müller,<sup>a</sup> Isabella Eckerle,<sup>a</sup> Sebastian Brünink,<sup>a</sup> Christian Drosten,<sup>a</sup> and Jan Felix Drexler<sup>a</sup>
    - <sup>a</sup> Institute of Virology, University of Bonn Medical Centre, Bonn, Germany
    - <sup>b</sup> Igel-Schutz-Initiative e.V., Laatzten, Germany



European hedge-hog

- *Erinaceus europaeus*
- That's a hedgehog mom and her baby.
- [https://en.wikipedia.org/wiki/European\\_hedgehog](https://en.wikipedia.org/wiki/European_hedgehog)





Here's where it lives.

- [https://en.wikipedia.org/wiki/European\\_hedgehog](https://en.wikipedia.org/wiki/European_hedgehog)

## Camel coronavirus

### *Camel alphacoronavirus*

- NCBI
- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Info&id=1699095&lvl=3&lin=f&keep=1&srchmode=1&unlock>

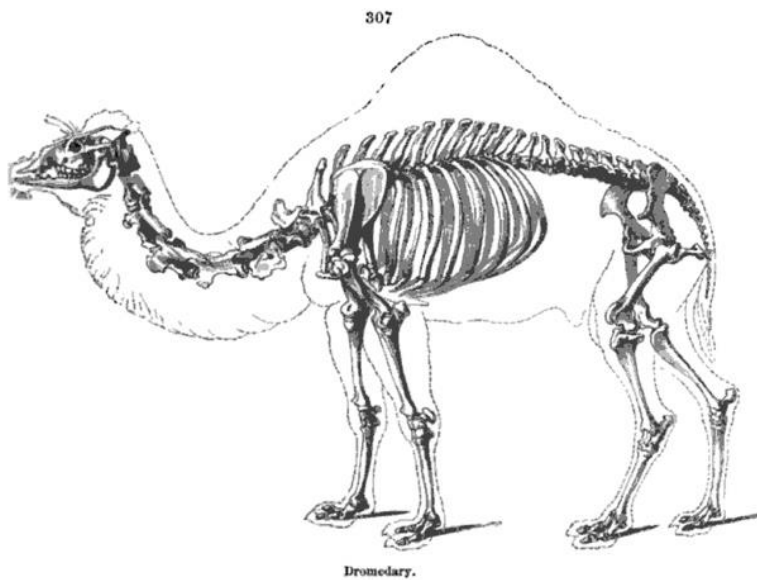
### *Camel alphacoronavirus Camel229E*

- NCBI
- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Info&id=1895985&lvl=3&lin=f&keep=1&srchmode=1&unlock>

### *Camel coronavirus HKU23*

- NCBI
- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Info&id=1699096&lvl=3&lin=f&keep=1&srchmode=1&unlock>

## 1 hump versus 2 humps



1-hump camel a.k.a. Arabian camel a.k.a. Dromedary

- This is the camel that gets infected by the corona-virus.
- <https://en.wikipedia.org/wiki/Dromedary>



2-hump camel a.k.a. Bactrian camel a.k.a. Mongolian camel

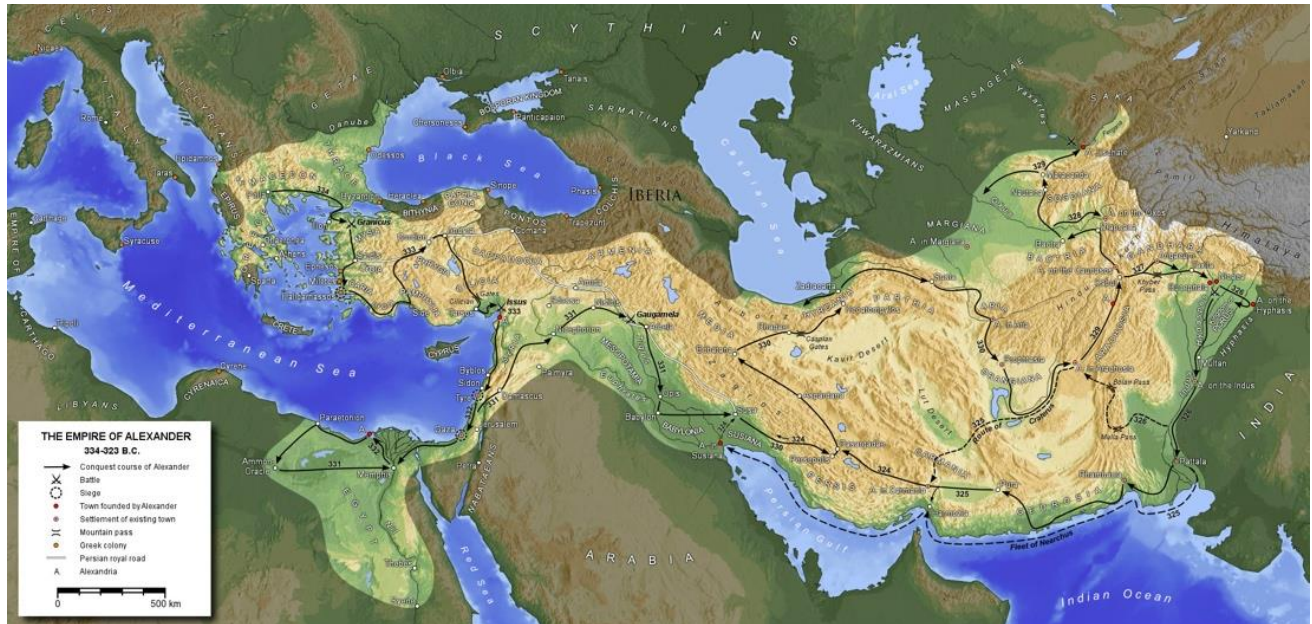
- No coronavirus.
- [https://en.wikipedia.org/wiki/Bactrian\\_camel](https://en.wikipedia.org/wiki/Bactrian_camel)

## Bactria



### Alexander the Great

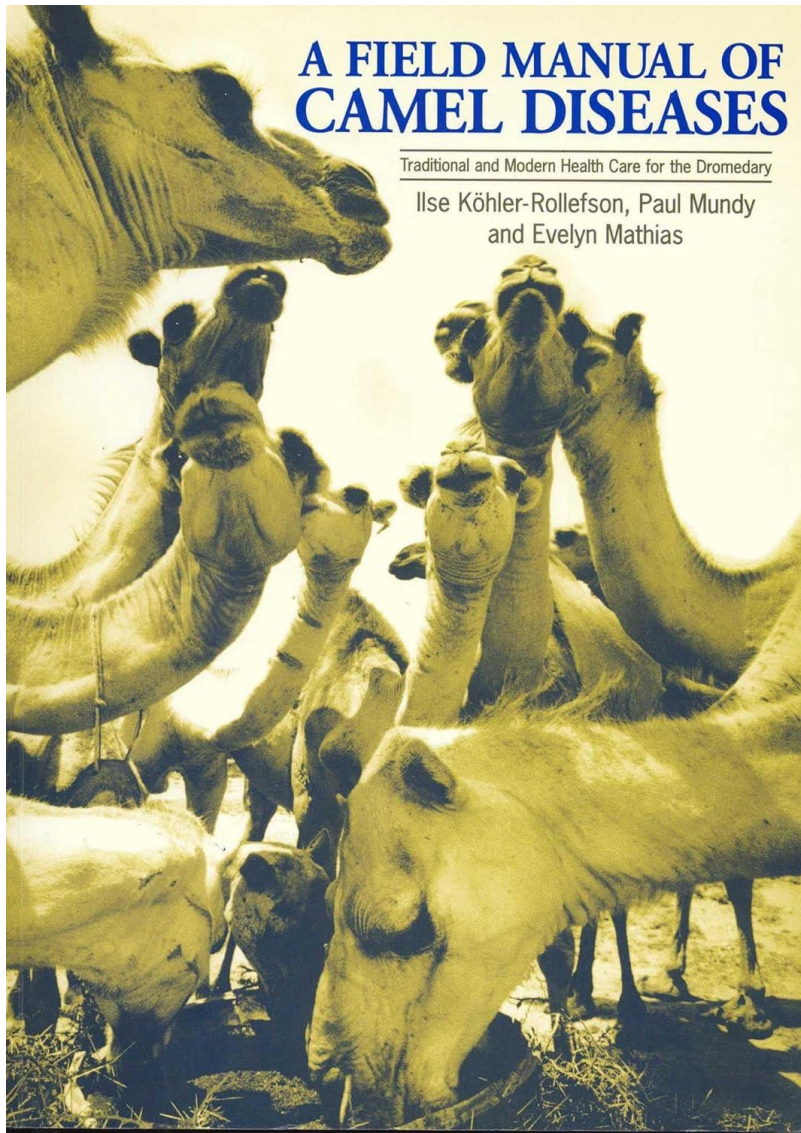
- The purple area is the empire of Alexander the Great.
- [https://en.wikipedia.org/wiki/Alexander\\_the\\_Great](https://en.wikipedia.org/wiki/Alexander_the_Great)



### Alexander the Great

- Same as above but zoomed in and the empire is colored in tan and light green.
- Bactria is in the north east corner of the empire. 2-humped camels (a.k.a. Bactrian camel) live here.
- [https://en.wikipedia.org/wiki/Alexander\\_the\\_Great](https://en.wikipedia.org/wiki/Alexander_the_Great)

Camel Pregnancy



*A Field Manual of Camel Diseases: Traditional and modern veterinary care for the dromedary*

- Summary
  - This is a cool book that gives pretty understandable explanations of camel medical problems and how to fix them ... if you're ever in that situation. I bought this book in Dubai.
- Source
  - ITDG Publishing (Dec 15 2001)
  - Amazon.ca
  - <https://www.amazon.ca/Field-Manual-Camel-Diseases-Traditional/dp/185339503X>
- Authors
  - Ilse Koehler-Rollefson
  - Evelyn Mathias
  - Paul Mundy

# Page 126 – The Pangolin Who Got Caught in the Middle



That's the **Sunda pangolin**.

- [https://en.wikipedia.org/wiki/Sunda\\_pangolin](https://en.wikipedia.org/wiki/Sunda_pangolin)



That's where the Sunda pangolin lives.

#### Pangolin coronavirus

- Spike sequence
  - 99% similarity to SARS-CoV-2.
- Whole genome sequence
  - 92% similarity to SARS-CoV-2.
  - This is why there is some doubt.
- Sunda pangolin
  - *Manis javanica*
  - Java, I assume.
  - It was the subject of the **J Proteome Research, 22 March 2020** where the tide is leaning back towards pangolin as intermediate between bats and humans.
    - Its lung is infected by coronavirus (1<sup>st</sup> sentence of Figure 5 in the paper) I'm not sure if the pangolin gets unwell. I think it's just a reservoir.

#### Pangolin coronavirus

- Genome.
- Beta
- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Info&id=2708335&lvl=3&lin=f&keep=1&srchmode=1&unlock>

# Page 127 – Porcine, bovine, murine – Hard to spell and harder to say

## Pathogenesis of Murine Coronavirus in the Central Nervous System

- Summary
  - Verifies that the murine (mouse) coronavirus is a model for **Multiple Sclerosis (MS)** in humans.
- Verbatim
  - Murine coronavirus (mouse hepatitis virus, MHV) is a collection of strains that induce disease in several organ systems of mice. Infection with neurotropic strains JHM and A59 causes **acute encephalitis**, and in survivors, **chronic demyelination**, the latter of which serves as an animal model for **multiple sclerosis**.
- Source
  - **J of Neuroimmune Pharmacology**
    - Official journal of the **Society on Neuroimmune Pharmacology**
    - 2010
    - <https://www.ncbi.nlm.nih.gov/pubmed/20369302>

## Murine coronavirus (M-CoV)

- Summary
  - **Latin murinus = mouse**. Hmmm, I finally get that.
  - **Enveloped ss + RNA**
  - Epidemics in mice.
  - High mortality in laboratory mice.
  - **Demyelinating encephalitis** from some strains so used to study **Multiple Sclerosis (MS)** in humans.
- Strain
  - **Murine Hepatitis Virus (MHV)** is a **strain**.
- Entry
  - CEACAM1 Receptors
    - **This is the entry point for the virus.**
- Synonyms
  - CEACAM1
  - Carcino-Embryonic Antigen-related Cell Adhesion Molecule 1
  - Biliary glycoprotein
  - Cluster of Differentiation 66a
  - CD66a
- Function
  - **Cell adhesion**
    - It's a member of the **CEA gene family** which is part of the **Immunoglobulin Superfamily**.
    - **Human glycoprotein.**
- [https://en.wikipedia.org/wiki/Murine\\_coronavirus](https://en.wikipedia.org/wiki/Murine_coronavirus)
- <https://en.wikipedia.org/wiki/CEACAM1>

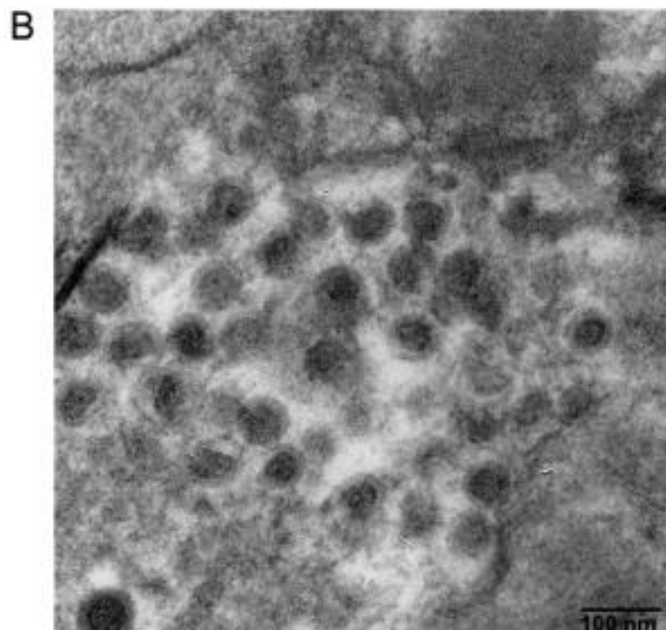


*Murine hepatitis virus*

- Beta
- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Tree&id=11138&lvl=3&lin=f&keep=1&srchmode=1&unlock>

# Page 128 – The Whale, the & the Seal

Beluga whale



*Identification of a novel coronavirus from a beluga whale by using a panviral microarray*

- Summary

- A 13-year old male beluga whale died in captivity.
- **A** is the liver of the dead beluga whale, as seen with the naked eye.
- **B** is a tiny, tiny portion of the liver magnified 129,000 x using an electron microscope. The black circles are **coronaviruses**. In the lower right is a 100 nano-meter (nm) scale bar.

- Verbatim

- The emergence of viruses such as severe acute respiratory syndrome coronavirus and Nipah virus has underscored the role of animal reservoirs in human disease and the need for reservoir surveillance. Here, we used a panviral DNA microarray to investigate the death of a captive beluga whale in an aquatic park. **A highly divergent coronavirus, tentatively named**

coronavirus SW1, was identified in liver tissue from the deceased whale. Subsequently, the entire genome of SW1 was sequenced, yielding a genome of 31,686 nucleotides. Phylogenetic analysis revealed SW1 to be a novel virus distantly related to but most similar to group III coronaviruses.

- Source
  - Journal of Virology
    - May 2008
    - <https://pubmed.ncbi.nlm.nih.gov/18353961/>
- Author
  - Kathie A Mihindukulasuriya - Department of Molecular Microbiology, Washington University School of Medicine, 660 S. Euclid Ave., St. Louis, Missouri, USA
  - Guang Wu, Judy St Leger, Robert W Nordhausen, David Wang

### Beluga whale coronavirus SW1

- Gamma
- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Tree&id=694015&lvl=3&lin=f&keep=1&srchmode=1&unlock>

## Bottlenose dolphin



[https://en.wikipedia.org/wiki/Indo-Pacific\\_bottlenose\\_dolphin](https://en.wikipedia.org/wiki/Indo-Pacific_bottlenose_dolphin)

### Bottlenose dolphin CoronaVirus HKU22 (BdCoV)

- Summary
  - This is basically a **case report**.
  - Obtained from fecal sample from 3 Indo-Pacific bottlenose dolphins (*Tursiops aduncus*).
  - Viral Load =  $10^3 - 10^5$  / ml
  - 32,000 bp
  - 74% similarity with spike protein bp sequence of Beluga coronavirus (the 13y M who died in captivity)
    - Authors suggest creating a new species, Cetacean coronavirus so I think the bottlenose and beluga would be strains.
- Fun facts

- Short, thick beak like a *bottle*.
- Eats spiny-fish head first so spines don't gouge its mouth. Swallows without chewing.
- **J Virol 2014 January**
  - *Discovery of a novel bottlenose dolphin coronavirus reveals a distinct species of marine mammal coronavirus in Gamma coronavirus*
  - Fecal sample case report.
  - <https://www.ncbi.nlm.nih.gov/pubmed/24227844>
- **National Center for Ecological Analysis and Synthesis**
  - Fun facts
  - <http://kids.nceas.ucsb.edu/mmp/bottlenose.html>

*Bottlenose dolphin coronavirus HKU22*

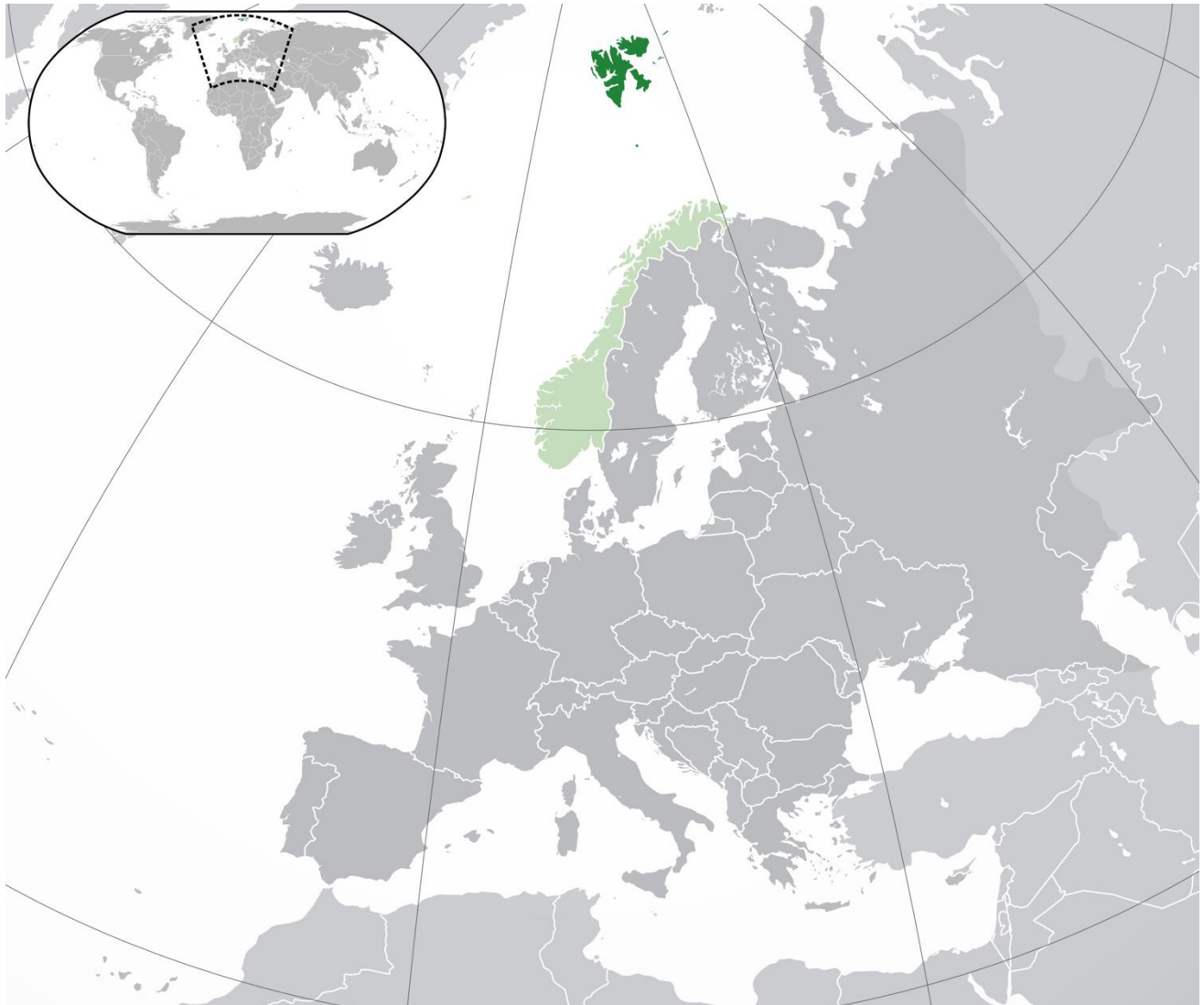
- Gamma
- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Info&id=1433215&lvl=3&lin=f&keep=1&srchmode=1&unlock>

## Harbor seal



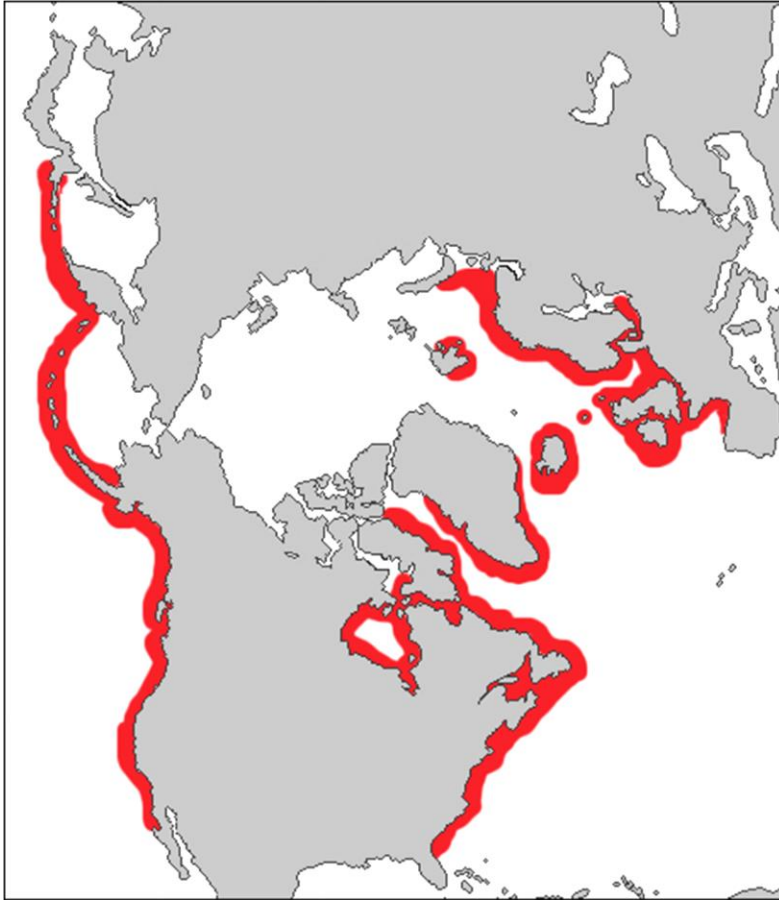
Harbor seal in Svalbard (map below).

- [https://en.wikipedia.org/wiki/Harbor\\_seal](https://en.wikipedia.org/wiki/Harbor_seal)



**Svalbard** (dark green) is several islands that belong to **Norway** (light green).

- I should think it's pretty cold in that water.
- The seal above was photographed at Svalbard.
- <https://en.wikipedia.org/wiki/Svalbard>



#### Harbor seal range.

- [https://en.wikipedia.org/wiki/Harbor\\_seal](https://en.wikipedia.org/wiki/Harbor_seal)
  - I rotated their map 90 degrees.

#### Harbor seal coronavirus (HSCoV)

- 21 harbor seals *Phoca vitulina richardsii* (California harbor seal) (Pacific harbor seal) found dead on California beach, 2010 June.
  - This is essentially a case report.
  - Pulmonary congestion, consolidation, hemorrhage.
  - Lobar pneumonia with intra-lesional bacteria (what type not stated in abstract which is all I can get).
  - Unclear the contribution of the coronavirus.
- Cool trivia:
  - Pup can swim 1 hour after birth.
  - Mum will take off if threatened but then return to pup so don't 'rescue it'.
  - Don't chew food, rather swallow it whole.
- [https://en.wikipedia.org/wiki/Harbor\\_seal](https://en.wikipedia.org/wiki/Harbor_seal)
- <https://www.ncbi.nlm.nih.gov/pubmed/20662367>
  - Hendrik Nollens DVM PHD (now of Seaworld San Diego)
  - Dis Aquat Organ (Diseases of Aquatic Organisms) 2010
  - Case report on 21 beached seals.
- <https://www.afsc.noaa.gov/nmml/education/pinnipeds/harbor.php>
  - Cool trivia from NOAA.

#### Harbor seal coronavirus 1

- Alpha

- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Info&id=679171&lvl=3&lin=f&keep=1&srchmode=1&unlock>

# Page 129 – Birds



## SARS-ANI VIS - A Global Open Access Dataset of Reported SARS-CoV-2 Events in Animals

- Verbatim
  - This is very cool website to explore the animals infected by the coronavirus in the 2019 pandemic. It is much more thorough than what I have presented.
  - 🖱️ Hover (don't click) the computer mouse over the icons. There are a number of graphics so keep on scrolling down the page.
- Source
  - Complexity Science Hub
    - [https://vis.csh.ac.at/sars-ani/?utm\\_source=Nature+Briefing&utm\\_campaign=747f216f03-briefing-dy-20220921&utm\\_medium=email&utm\\_term=0\\_c9dfd39373-747f216f03-43234521](https://vis.csh.ac.at/sars-ani/?utm_source=Nature+Briefing&utm_campaign=747f216f03-briefing-dy-20220921&utm_medium=email&utm_term=0_c9dfd39373-747f216f03-43234521)

Black skimmer



[https://en.wikipedia.org/wiki/Black\\_skimmer](https://en.wikipedia.org/wiki/Black_skimmer)

European oystercatcher





[https://en.wikipedia.org/wiki/Eurasian\\_oystercatcher](https://en.wikipedia.org/wiki/Eurasian_oystercatcher)

*Oystercatcher coronavirus*

- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Info&id=643399&lvl=3&lin=f&keep=1&srchmode=1&unlock>

Red knot



[https://en.wikipedia.org/wiki/Red\\_knot](https://en.wikipedia.org/wiki/Red_knot)

*Red knot coronavirus*

- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Info&id=643398&lvl=3&lin=f&keep=1&srchmode=1&unlock>

**Blue-winged teal**



[https://en.wikipedia.org/wiki/Blue-winged\\_teal](https://en.wikipedia.org/wiki/Blue-winged_teal)

Mallard



<https://en.wikipedia.org/wiki/Mallard>

Wigeon



<https://en.wikipedia.org/wiki/Wigeon>

*Wigeon coronavirus*

- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Info&id=1159908&lvl=3&lin=f&keep=1&srchmode=1&unlock>

Common moorhen



[https://en.wikipedia.org/wiki/Common\\_moorhen](https://en.wikipedia.org/wiki/Common_moorhen)

*Common moorhen coronavirus*

- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Info&id=1159902&lvl=3&lin=f&keep=1&srchmode=1&unlock>

**White-eye**



<https://en.wikipedia.org/wiki/White-eye>


*White-eye coronavirus*

- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Info&id=1159907&lvl=3&lin=f&keep=1&srchmode=1&unlock>

Canada goose



### Canada goose

-  You can hear an audio clip of it honking.
- Wingspan is 50 – 73". That's 4' 2" – 6' 1". In metric, 127 – 185 cm.
- [https://en.wikipedia.org/wiki/Canada\\_goose](https://en.wikipedia.org/wiki/Canada_goose)





Canada

- Victoria Island is shaded red-orange.
  - Cambridge Bay is here. Canada goose with coronavirus was found here.
  - 2<sup>nd</sup> biggest island of Canada.
  - [https://en.wikipedia.org/wiki/Victoria\\_Island](https://en.wikipedia.org/wiki/Victoria_Island)
- Baffin Island
  - It's east of Victoria Island.
  - Biggest island of Canada.



Cambridge Bay is on the south coast of Victoria Island. Canada goose with coronavirus was found here.

- [https://en.wikipedia.org/wiki/Victoria\\_Island](https://en.wikipedia.org/wiki/Victoria_Island)

#### Canada goose coronavirus

- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Info&id=2569586&lvl=3&lin=f&keep=1&srchmode=1&unlock>
- 🖐 On this page, click on View and Analyze sequences in NCBI Virus. It will open the page below.

Accession	Organism Name	Submitters	Organization	Release Date	Isolate	Species	Length	Nucleotide Details
<a href="#">NC_046965</a>	Canada goose cor...	Papineau,A...	National Cent...	2020-04-12		Canada ...	28539	<p><a href="#">NC_046965</a></p> <p>Canada goose coronavirus strain Cambridge_Bay_2017, complete genome (Papineau,A., et al.)</p> <p><b>Attributes</b></p> <p><b>Nuc Completeness:</b> complete <b>Strain:</b> Cambridge_Bay_2017 <b>Length:</b> 28539 <b>Mol Type:</b> RNA <b>Host:</b> Branta canadensis <b>Isolate:</b> feces <b>Geo Location:</b> Canada <b>Collection Date:</b> 2017-08</p> <p><b>Publications</b></p> <p><b>PubMed:</b> <a href="#">1 publication</a> <b>BioProject:</b> <a href="#">1 project</a></p> <p><b>Submitters Names</b></p> <p>Papineau,A., Berhane,Y., Wylie,T.N., Wylie,K.M., Sharpe,S., Lung,O., Wylie,T., Wylie,K.</p> <p><b>Organization (Submitters' Institutional Affiliation)</b></p> <p>National Center for Biotechnology Information, NIH</p> <p><b>Affiliation Location</b></p> <p>USA</p>
<a href="#">MK359255</a>	Canada goose cor...	Papineau,A...	Canadian Foo...	2019-04-21		Canada ...	28539	

### Canada goose coronavirus

- At the far right it says the bird was found at **Cambridge Bay** by **Papineau** and others (paper below).
- **NCBI**
  - [https://www.ncbi.nlm.nih.gov/labs/virus/vssi/#/virus?SeqType\\_s=Nucleotide&VirusLineage\\_ss=Canada%20goose%20coronavirus,%20taxid:2569586](https://www.ncbi.nlm.nih.gov/labs/virus/vssi/#/virus?SeqType_s=Nucleotide&VirusLineage_ss=Canada%20goose%20coronavirus,%20taxid:2569586)

### Genome Organization of Canada Goose Coronavirus, A Novel Species Identified in a Mass Die-off of Canada Geese

- Summary
  - This describes the *Canada goose coronavirus*.
- Verbatim – Abstract
  - The complete genome of a novel coronavirus was sequenced directly from the **cloacal swab** of a Canada goose that perished in a die-off of Canada and Snow geese in **Cambridge Bay, Nunavut, Canada**. Comparative genomics and phylogenetic analysis indicate it is a new species of Gammacoronavirus, as it falls below the threshold of 90% amino acid similarity in the protein domains used to demarcate Coronaviridae. Additional features that distinguish the genome of Canada goose coronavirus include 6 novel ORFs, a partial duplication of the 4 gene and a presumptive change in the proteolytic processing of polyproteins 1a and 1ab.
- Translation
  - The **cloaca** (“clow” – clow rhymes with slow – “a ka”) is the the common exit for urine, feces and sperm or eggs. This structure is present in amphibians, reptiles and birds. Hence a ‘cloacal swab’ would in this case be detecting coronavirus in the feces of the Canada goose. That’s pronounced “clow a kull”.
    - <https://en.wikipedia.org/wiki/Cloaca>
- Source
  - Pubmed
    - 11 April 2019
    - <https://pubmed.ncbi.nlm.nih.gov/30976080/>
- Authors

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**Page 130 – More birds,  
Gentoo penguin, alpaca,  
COW**

**White-rumped munia**

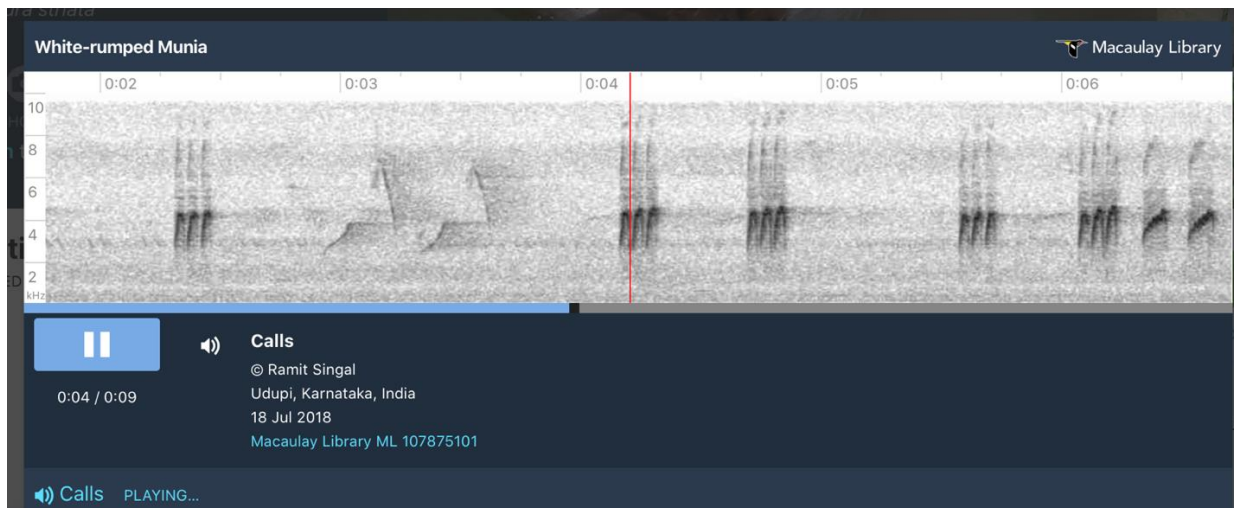


[https://en.wikipedia.org/wiki/White-rumped\\_munia](https://en.wikipedia.org/wiki/White-rumped_munia)



White-rumped munia

- **Cornell Ornithology**
  - <https://ebird.org/species/whrmun>



White-rumped munia

- You can listen to it on the awesome Cornell website.
- **Cornell Ornithology**
  - <https://ebird.org/species/whrmun>

## White-rumped munia

- It gets infected by **coronavirus**. This particular coronavirus does not appear to infect humans.
- Names
  - White-rumped munia
  - White-rumped mannikin
  - Striated finch
  - Sharp-tailed finch
  - White-backed finch
  - Wild Bengalese
  - Bengalese finch
- General
  - It's a **hardy** bird.
  - <http://www.efinch.com/species/whiterump.htm>
- Diet
  - Sometimes eats **algae**.
    - [https://en.wikipedia.org/wiki/White-rumped\\_munia](https://en.wikipedia.org/wiki/White-rumped_munia)
  - This **breeder** gives them a **calcium** source like **cuttlefish** ground up.
    - <https://www.beautyofbirds.com/whiterumpedmunias.html>
- Cornell Ornithology
  - Great photo **above**.
  - **50,163** people have observed this bird.
  - Image & Sounds
    - To find it, have to **1<sup>st</sup> hit the Logo in top left: then Explore tab: then enter Genus and species *Lonchura striata***
  - <https://ebird.org/species/whrmun>
- Language
  - Studied to learn about language. Hmm ... I knew I would find something interesting.
  - **It was thought only humans must hear sounds in a logical order to learn them.**
    - **So does the white-rumped munia.**
  - Verbatim - *Guardian*
    - This bird's domesticated and hybridised cousins, the Bengalese finch (*Lonchura striata* var. *domestica*), are common pets throughout the world. But more interesting, these birds are popular models for language acquisition research. Recently, a paper was published in *Nature Neuroscience* demonstrating that these birds rely on strict syntactical rules to discriminate songs [doi:10.1038/nn.2869]. This syntax is learned and further, **songs with incorrect syllable syntax are ignored**. This research indicates that passerine songbirds **must hear sounds in a logical sequence** for these sounds to make sense, a trait that was thought to be unique to humans.
      - <https://www.theguardian.com/science/punctuated-equilibrium/2011/sep/30/5>
        - They include a link to **Nature Neuroscience**.
  - Verbatim - Nature Neuroscience
    - Whether the computational systems in language perception involve specific abilities in humans is debated. The vocalizations of songbirds share many features with human speech, but whether songbirds possess a similar computational ability to process auditory information as humans is unknown. We analyzed their spontaneous discrimination of auditory stimuli and found that the Bengalese finch (*Lonchura striata* var. *domestica*) can use the syntactical information processing of syllables to discriminate songs). These finches were also able to acquire artificial grammatical rules from synthesized syllable strings and to


discriminate novel auditory information according to them. We found that a specific brain region was involved in such discrimination and that **this ability was acquired postnatally** through the encounter with various conspecific songs. Our results indicate that passerine songbirds spontaneously acquire the ability to process hierarchical structures, an ability that was previously supposed to be specific to humans.

- **Nature Neuroscience 2011**
- <https://www.nature.com/articles/nn.2869>

#### Sources

- General
  - [https://en.wikipedia.org/wiki/White-rumped\\_munia](https://en.wikipedia.org/wiki/White-rumped_munia)
  - <http://www.efinch.com/species/whiterump.htm>
  - <https://www.beautyofbirds.com/whiterumpedmunias.html>
- **Cornell Ornithology**
  - <https://ebird.org/species/whrmun>
- Language
  - **Guardian**
    - <https://www.theguardian.com/science/punctuated-equilibrium/2011/sep/30/5>
      - They include a link to **Nature Neuroscience**.
  - **Nature Neuroscience 2011**
    - <https://www.nature.com/articles/nn.2869>

#### *Munia coronavirus*

- **Munia coronavirus HKU13**
  - **Munia coronavirus HKU13-3514**
    - [https://www.ncbi.nlm.nih.gov/labs/virus/vssi/#/virus?SeqType\\_s=Nucleotide&VirusLineage\\_ss=Munia%20coronavirus%20HKU13-3514,%20taxid:572289](https://www.ncbi.nlm.nih.gov/labs/virus/vssi/#/virus?SeqType_s=Nucleotide&VirusLineage_ss=Munia%20coronavirus%20HKU13-3514,%20taxid:572289)
      -  Click on NC 01150. You will see the info just below displayed at right.
  - **NCBI**
    - [NC\\_011550](#)
    - **Munia coronavirus HKU13-3514, complete genome (Woo,P.C., et al.)**
    - **Attributes**
    - **Nuc Completeness:** complete
    - **Length:** 26552
    - **Mol Type:** RNA
    - **Host:** *Lonchura striata*
    - **Geo Location:** Hong Kong
    - **Collection Date:** 2007-04





That's where the **white-rumped munia** lives ... which is why the Cornell recording was from **India** and the genome sample was from **Hong Kong**.

## Houbara bustard



[https://en.wikipedia.org/wiki/Houbara\\_bustard](https://en.wikipedia.org/wiki/Houbara_bustard)

*Houbara coronavirus*

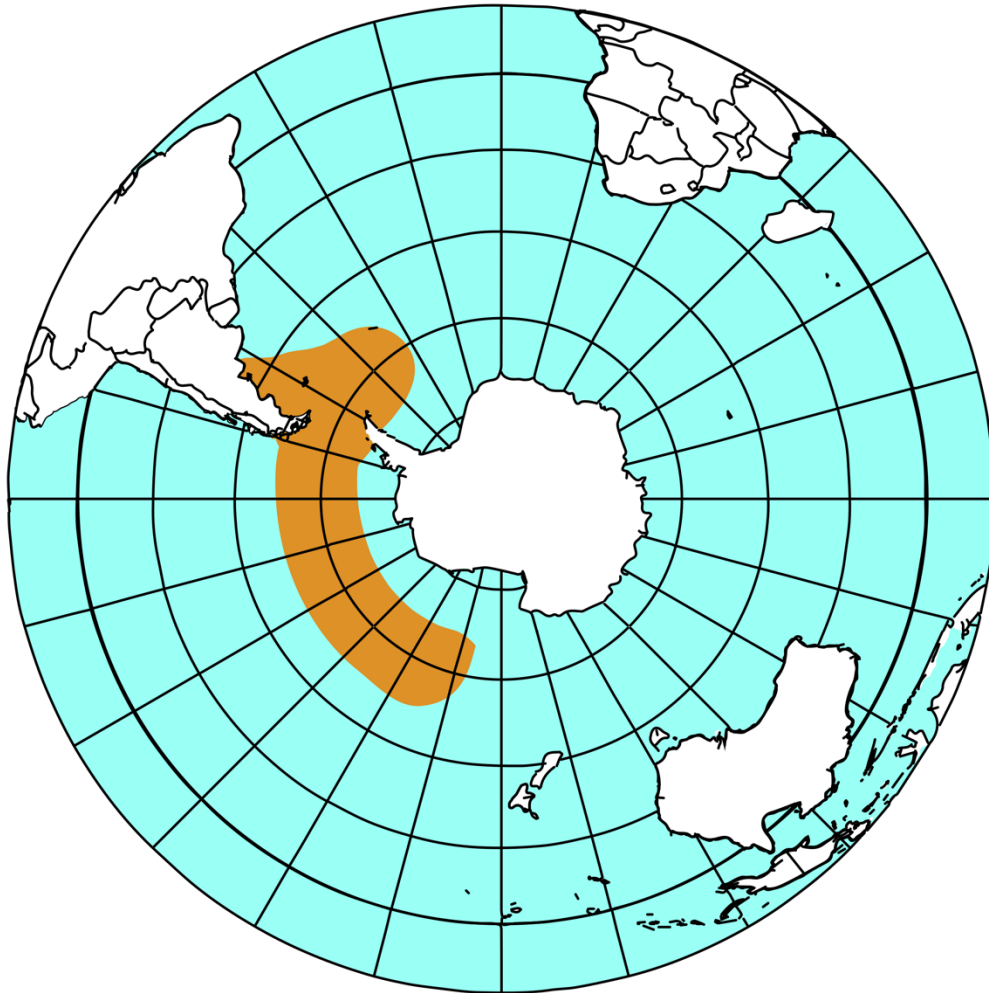
- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Info&id=2078577&lvl=3&lin=f&keep=1&srchmode=1&unlock>

## Gentoo penguin



The **Gentoo penguin** is the fastest swimmer of all the penguins. 22 mph / 36 kmh.

- [https://en.wikipedia.org/wiki/Gentoo\\_penguin](https://en.wikipedia.org/wiki/Gentoo_penguin)



**Gentoo penguin range.**

- [https://en.wikipedia.org/wiki/Gentoo\\_penguin](https://en.wikipedia.org/wiki/Gentoo_penguin)

***Gentoo penguin coronavirus***

- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Info&id=2707191&lvl=3&lin=f&keep=1&srchmode=1&unlock>



#### Seabird tick

- It lives in both [Alaska](#) and [Australia](#). That's impressive range.
- *Ixodes uriae* ("Ick so deez" "yer ee a")
- How gross.
- 1 mm is about the width of this letter 'u.'
- There are about 100 species of *Ixodes* tick.
- [https://en.wikipedia.org/wiki/Ixodes\\_uriae](https://en.wikipedia.org/wiki/Ixodes_uriae)
- <https://en.wikipedia.org/wiki/Ixodes>

Alpaca



*Alpaca*

- <https://en.wikipedia.org/wiki/Alpaca>

*Alpaca respiratory coronavirus isolate CA08-1/2008, complete genome*

- Summary
  - The genome CGAT is here. And amino acid sequence.
- Source
  - [NCBI Taxonomy Browser](https://www.ncbi.nlm.nih.gov/nuccore/JQ410000)
    - <https://www.ncbi.nlm.nih.gov/nuccore/JQ410000>

Cow



Cow calf – so cute.

- <https://en.wikipedia.org/wiki/Calf>
- This picture is no longer there.

#### *Bovine coronavirus cow*

- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Tree&id=11128&lvl=3&lin=f&keep=1&srchmode=1&unlock>
  - There are 12 *Bovine coronavirus cow*.
- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Info&id=756646&lvl=3&lin=f&keep=1&srchmode=1&unlock>
  - This is for the calf in my drawing on page 130. It's the first in the list.

**Page 131 – water buffalo,  
giraffe, Sambar deer, yak**

**Water buffalo**



Water buffalo

- [Bubalus bubalis](#).
- [https://en.wikipedia.org/wiki/Water\\_buffalo](https://en.wikipedia.org/wiki/Water_buffalo)

*Bovine coronavirus Bubalus*

- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Tree&id=11128&lvl=3&lin=f&keep=1&srchmode=1&unlock>
  - Whole bunch of bovine coronaviruses here. The first 4 are from the water buffalo *Bubalus*.

Giraffe



It would be hard to mistake a giraffe for anything else. Or would it? The species name for the giraffe is derived from 2 Latin words:

- *Kamelos* means **camel**.
- *Pardos* means **leopard** ... for the spots.
- So the Genus and species of the giraffe is therefore *Giraffa camelopardis*. It is the camel with leopard spots. Hmm.
- **Online Etymology Dictionary**
  - As always, love this site.
  - <https://www.etymonline.com/search?q=giraffe>
- <https://en.wikipedia.org/wiki/Giraffe>





A giraffe has 2 toes.

- <https://en.wikipedia.org/wiki/Giraffe>

#### *Giraffe coronavirus*

- It is a beta coronavirus, one of many Bovine coronaviruses.
- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Info&id=422139&lvl=3&lin=f&keep=1&srchmode=1&unlock>

**Sambar deer**



The Sambar deer is a rather handsome creature.

- [https://en.wikipedia.org/wiki/Sambar\\_deer](https://en.wikipedia.org/wiki/Sambar_deer)

*Sambar deer coronavirus*

- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Info&id=422133&lvl=3&lin=f&keep=1&srchmode=1&unlock>

Yak



This domestic yak is at the sacred Yamdrok Lake in Tibet.

- The lake is called Yamzho Yumco in Google maps.
  - <https://www.google.com/maps/place/Yamzho+Yumco/@28.9733194,90.5561618,11z/data=!3m1!4b1!4m6!3m5!1s0x37608c357f352281:0x1cfa412ad0f47e8f!8m2!3d28.9160871!4d90.705779!16zL20vMDdyY3Bu?authuser=1&entry=ttu>
- [https://en.wikipedia.org/wiki/Domestic\\_yak](https://en.wikipedia.org/wiki/Domestic_yak)

### Yak coronavirus

- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=2501420>

## Grammar

### Subject-object-verb word order

- Summary
- These all mean the same thing in different languages.
  - “Cows grass eat.” Japanese
  - “Cows eat grass.” English That’s the most familiar (to me).
  - “Eat cows grass.” Welsh
  - “Eat grass cows.” Fijian
  - “Grass eat cows.” Hixkaryana (spoken by 500 people in Brazil)
  - “Grass cows eat.” Tobati (spoken by 100 people in New Guinea)

- [https://en.wikipedia.org/wiki/Subject-object-verb\\_word\\_order](https://en.wikipedia.org/wiki/Subject-object-verb_word_order)

*How Does Word Order Work? English puts the subject first, then the verb, and then the object, but that's not the case in every language.*

- Summary
  - This nicely summarizes why word-for-word translation can be difficult.
- Verbatim
  - Word order, as the name implies, is how words are arranged in a sentence. The words "I saw Sam" can't be rearranged as "I Sam saw," "Saw Sam I" or any other configuration without either changing the meaning or descending into gibberish. But if you were to translate this sentence into another language, the word order would need to change to fit the norms. It's one of the biggest reasons that translating a sentence word-by-word doesn't work: if the word order in a language is different, the whole sentence needs to be restructured.
- Source
  - Babbel.com
    - Thomas Moore Devlin
    - 18 March 2021
    - <https://www.babbel.com/en/magazine/what-is-word-order>

**Page 132 – hyena, ferret,  
raccoon dog, American mink**

Hyena



Spotted hyena

- *Crocuta crocuta*
- Another weird zoology instance where Genus and species are the same.
- [https://en.wikipedia.org/wiki/Spotted\\_hyena](https://en.wikipedia.org/wiki/Spotted_hyena)

*Spotted hyena coronavirus*

- It's found in Genus Alpha under Canine coronavirus which if click on that then opens up to the canine options.
  - <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Tree&id=11153&lvl=3&lin=f&keep=1&srchmode=1&unlock>
- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Info&id=363228&lvl=3&lin=f&keep=1&srchmode=1&unlock>

Ferret



That's a ferret.

- *Mustela furo*.
- <https://en.wikipedia.org/wiki/Ferret>

#### *Ferret coronavirus*

- There are 2 choices here:
  - *Ferret enteric coronavirus*
  - *Ferret systemic coronavirus*
- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Tree&id=1264898&lvl=3&lin=f&keep=1&srchmode=1&unlock>

Raccoon dog



Common raccoon dog – top

Japanese raccoon dog – bottom

I think it looks more like a raccoon than a dog.

- <https://en.wikipedia.org/wiki/Nyctereutes>

Raccoon dog coronavirus

- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?mode=Info&id=434614&lvl=3&lin=f&keep=1&srchmode=1&unlock>

## American mink



### American mink

- Found in North America but also in in South America and Europe due to 'human intervention.'
- *Neovison vison*
  - *Neogale* seems to be the new Genus, however, i.e., a taxonomy shakeup by zoologists in search of excitement.
- [https://en.wikipedia.org/wiki/American\\_mink](https://en.wikipedia.org/wiki/American_mink)

### Mink coronavirus

- [https://www.ncbi.nlm.nih.gov/labs/virus/vssi/#/virus?SeqType\\_s=Nucleotide&VirusLineage\\_ss=Mink%20coronavirus%20strain%20WD1127,%20taxid:766791](https://www.ncbi.nlm.nih.gov/labs/virus/vssi/#/virus?SeqType_s=Nucleotide&VirusLineage_ss=Mink%20coronavirus%20strain%20WD1127,%20taxid:766791)

**Page 133 – The Tiger Sisters  
at the Bronx Zoo who tested  
Coronavirus positive**





[https://en.wikipedia.org/wiki/German\\_Shepherd](https://en.wikipedia.org/wiki/German_Shepherd)

*Evidence of exposure to SARS-CoV-2 in cats and dogs from households in Italy.*

- This Italian study shows 3% of dogs were **SARS-CoV-2 Antibody Positive**.
- **bioRxiv, 23 July 2020**
  - These are not yet per reviewed.
- E.I. Patterson, G. Elia, A. Grassi, A. Giordano, C. Desario, M. Medardo, S.L. Smith, E.R. Anderson, T. Prince, G.T. Patterson, E. Lorusso, M.S. Lucente, G. Lanave, S. Lauzi, U. Bonfanti, A. Stranieri, V. Martella, F. Solari Basano, V.R. Barrs, A.D. Radford, U. Agrimi, G. L. Hughes, S. Paltrinieri, N. Decaro



#### Bronx zoo African lions

- Triplet sisters
  - Adamma
  - Nala
  - Shani
- Verbatim
  - New York Daily News readers picked their favorite names for these lion cubs. Shani has lighter-colored fur, but the girl cubs Adamma and Nala are harder to tell apart.
- Source
  - *Daily News*
    - 9 April 2018
    - This has been a newspaper in New York City since 1919.
    - <https://www.nydailynews.com/new-york/picked-em-bronx-zoo-reveals-names-lion-triplets-nala-adamma-shani-article-1.183964>
- Author
  - Barry Paddock



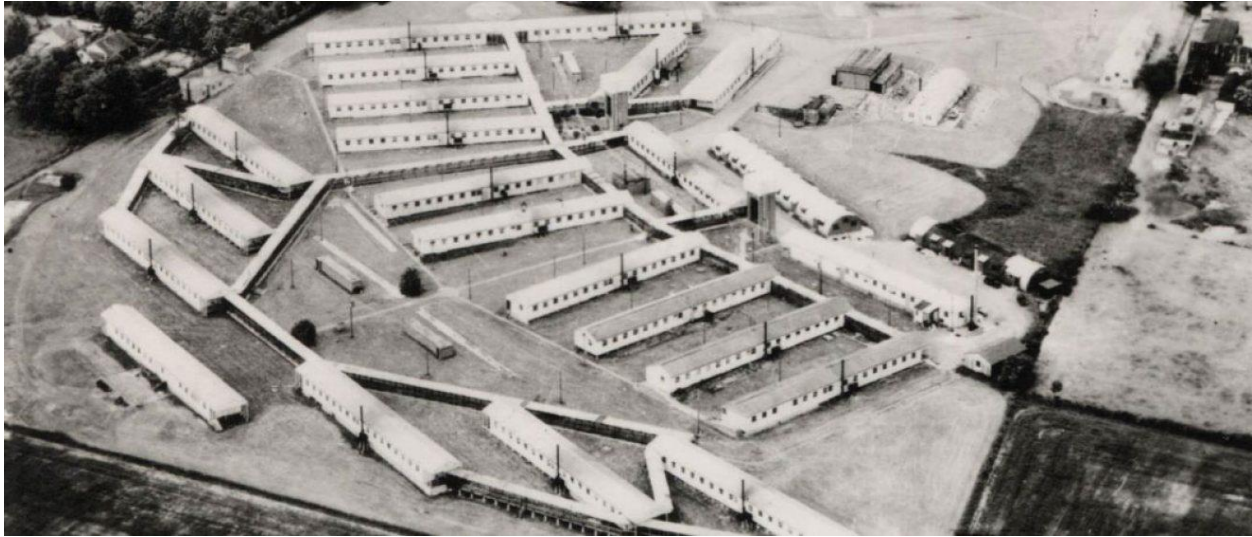
2 tiger cubs at Bronx Zoo

- omg, too cute.
- Not sure if sibs.
- No names given.
- Not sure what species.
- April 2016
- <https://bronxzoo.com/updates/tiger-cubs>

Malayan tiger

- Nadia #1
- Azul #2 - Nadia's sister
- Bumi #3
- <https://www.today.com/video/so-cute-meet-the-new-tiger-cubs-at-the-bronx-zoo-657967683653>
  - The cubs chuff (make this tiger-specific kind of noise) in this 4-minute video.

**Page 134 – human  
Coronavirus 229E**



Common Cold Unit at Harvard Hospital, Wiltshire, UK.

- **Nasal washings sample B814** here is identified later as *coronavirus* – this is when it was first identified.
- <https://salisburyhealthcarehistory.uk/harvard-hospital-common-cold-unit/>



Common Cold Unit (CCU) located at Wiltshire, UK.

- **5 hours walk from Stonehenge**. In case you ran out of gas for your car.

Cold symptoms	Flu symptoms
Low or no fever	High fever
Sometimes a headache	A headache very common
Stuffy, runny nose	Clear nose
Sneezing	Sometimes sneezing
Mild, hacking cough	Cough, often becoming severe
Slight aches and pains	Often severe aches and pains
Mild fatigue	Several weeks of fatigue
Sore throat	Sometimes a sore throat
Normal energy level or may feel sluggish	Extreme exhaustion

### Common Cold

- **Johns Hopkins**
  - [https://www.hopkinsmedicine.org/health/conditions-and-diseases/common-cold#:~:text=The%20droplets%20are%20then%20inhaled,early%20fall%20to%20late%20winter\).](https://www.hopkinsmedicine.org/health/conditions-and-diseases/common-cold#:~:text=The%20droplets%20are%20then%20inhaled,early%20fall%20to%20late%20winter).)
- **Cold (left column) versus Flu (right column)**. This is really useful.
- 200 viruses cause the Common Cold.

### Human Rhinoviruses

- This is amazing.
- **Human RhinoVirus (HRV)**
- Great info on rhinovirus serotypes. Info on ICAM et al Rc used by **rhinoviruses** so great contrast to **CoV** using ACE2.
- It also comments on the extent of **LRT infection** by **HRV**.
  - <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3553670/>

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
		RHINOVIRUS									
CORONAVIRUS					ENTEROVIRUS						
ADENOVIRUS											
		PIV-3					PIV2,3				
RSV											RSV
INFLUENZA											
MPV											
GROUP A STREPT											

#### *Rhinovirus (RV) Infection (Common Cold)*

- Virus and bacteria versus month. The fancy name is **seasonal pathogen table**.
- **Medscape**
  - <https://emedicine.medscape.com/article/227820-overview#a1>

#### *Viruses and Bacteria in the Etiology of the Common Cold*

- Table 1 shows the causes of the common cold.
- Bacterial infections were rare, supporting the concept that the common cold is almost exclusively a viral disease.
- **J Clinical Microbio 1998**
- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC104573/>

650

NATURE, VOL. 220, NOVEMBER 16, 1968

but not 50S subunits is the same as in wild type strains. In other words, it is the 30S subunits and other components necessary for initiation and not the 70S ribosomes which affect mRNA synthesis.

#### GENE CONTROL

### Histones—Animal and Vegetable

from our Molecular Biology Correspondent

THE biochemical world has long been divided on the question of whether the histones are actively involved in suppression and activation of genes, or whether they exist as essentially passive—and therefore, according to one view, slightly dreary—packaging materials. Among the indications that the role of the histones is not purely passive are the many observations of the enzymic modification of certain of their side chains under circumstances which suggest that this may somehow be involved in the control of transcription of the DNA. The attachment of acetyl groups to the N-terminal of two of the histones, and of methyl and phosphoryl groups to side chains of others, has been demonstrated. Alfrey and his co-workers found that whereas some of these modifying groups remain more or less permanently bound, others are metabolically active, in the sense that a radioactive precursor is rapidly incorporated at these points.

Gershy, Vidali and Alfrey (*J. Biol. Chem.*, **243**, 5018; 1968) have now found, from experiments involving pulse-labelling of calf thymus nuclei with  $^{14}\text{C}$  acetate, that the histone component  $\beta_2\text{ol}$  exhibits this type of rapid turnover. Moreover, proteolytic digestion of the histone and separation of the fragments led to the identification of the label in a single  $\alpha$ -acetyl-lysine residue. This is therefore the metabolically active site. Rapid labelling also occurs in the arginine-rich fraction,  $\beta_3$ .

Meanwhile, in E. L. Smith's laboratory in Los Angeles, the latter protein (also termed histone-IV in another system of nomenclature) has been completely sequenced, and the modified side chain located. This work, reported at the autumn meeting of the National Academy of Sciences, must surely be expected to stimulate a wide renaissance of interest in the histone field. The protein has 102 residues, the rapidly labelled site being lys-16. In the protein, as isolated, this residue is acetylated in half the molecules. There is also a fully methylated lysine at position 20, the remaining nine lysines being unmodified. The sequence shows some curious features—in particular a marked polarization of charge, such that the N-terminal end contains a predominance of the positive groups, and the other end most of the negative and hydrophobic side chains. This suggests that the attachment to DNA may primarily involve one end of the molecule, perhaps leaving the other free to engage in some function which is as yet unknown.

The same workers (Delange, Fambrough, Smith and Bonner) also prepared the corresponding histone fraction from pea seedlings—an operation involving germination of no less than 20 tons of seeds—and now have the substantially complete sequence. An early report, in which the first 19 residues from the C-terminal end were found to be identical in the pea and calf thymus proteins, is borne out. Indeed, it appears that the chains are identical in length, and differ only by two replacements, one of arginine for lysine, the

other of isoleucine for valine; in addition lys-20 is not methylated in the pea protein. Apart from this astonishing evolutionary conservation of sequence—a phenomenon altogether unique among the very considerable number of known sequences in a range of proteins of the most diverse functions—this result points ineluctably to some highly specific and precisely defined biochemical function for the histone.

#### VIROLOGY

### Coronaviruses

A new group of viruses with the name of coronaviruses has been recognized by an informal group of virologists who have sent their conclusions to *Nature*. (They are J. D. Almeida; D. M. Berry; C. H. Cunningham; D. Hamre; M. S. Hofstad; L. Mallico; K. McIntosh; D. A. J. Tyrrell.)

They point out that with negative staining, avian infectious bronchitis virus has a characteristic electron microscopic appearance resembling, but distinct from, that of myxoviruses. Particles are more or less rounded in profile; although there is a certain amount of polymorphism, there is also a characteristic "fringe" of projections 200 Å long, which are rounded or petal shaped, rather than sharp or pointed, as in the myxoviruses. This appearance, recalling the solar corona, is shared by mouse hepatitis virus and several viruses recently recovered from man, namely strain B814, 229E and several others. These viruses also share a number of other properties as indicated in the table. (Anyone interested in the data on which the table is based may obtain a short bibliography on application to Dr D. A. J. Tyrrell at the Common Cold Research Unit, Salisbury, Wiltshire.)

#### PROPERTIES OF THESE VIRUSES

Size. Filtration	Avian		
	infectious bronchitis	Mouse hepatitis	Human strains
	80-120 m $\mu$ *	100 m $\mu$	80-140 m $\mu$
Electron microscopy*	+	+	+
Characteristic surface structure	+	+	+
Essential lipid (ether lability)	+	+	+
Apparent ribonucleic acid content	+	+	+
(Immunosensitivity to DNA inhibitors)	+	+	+
Density of infectious unit	1.18	?	1.19
Replication in cytoplasmic vesicles	+	+	+

\* Negative contrast technique—projections are included in the diameter of the particle.

Some other relevant properties should be mentioned. There is an antigenic relationship between the human and murine strains, but none has been detected between avian strains and the others. A haemagglutinin has been detected by certain workers using avian infectious bronchitis virus and also antigens separable from the virus particle, but these have so far not been recorded for the human or murine strains.

In the opinion of the eight virologists these viruses are members of a previously unrecognized group which they suggest should be called the coronaviruses, to recall the characteristic appearance by which these viruses are identified in the electron microscope.

These suggestions have been received by members of the Myxovirus Study Group (chairman, Professor A. P. Waterson) under the International Committee for the Nomenclature of Viruses (ICNV). The suggestions were found acceptable and are now to be considered by the Vertebrate Virus Committee of the ICNV.

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## Nature 1968

- <https://www.nature.com/articles/220650b0.pdf>
- Enlarged below.

## PROPERTIES OF THESE VIRUSES

Size.	Filtration	Avian		
		infectious bronchitis	Mouse hepatitis	Human strains
	Electron microscopy*	80-120 m $\mu$	100 m $\mu$	89 m $\mu$ 80-160 m $\mu$
	Characteristic surface structure	+	+	+
	Essential lipid (ether lability)	+	+	+
	Apparent ribonucleic acid content (unsusceptibility to DNA inhibitors)	+	+	+
	Density of infectious unit	1.18	?	1.19
	Replication in cytoplasmic vesicles	+	+	+

\* Negative contrast technique—projections are included in the diameter of the particle.

## VIROLOGY

**Coronaviruses**

A NEW group of viruses with the name of coronaviruses has been recognized by an informal group of virologists who have sent their conclusions to *Nature*. (They are J. D. Almeida; D. M. Berry; C. H. Cunningham; D. Hamre; M. S. Hofstad; L. Mallucci; K. McIntosh; D. A. J. Tyrrell.)

They point out that with negative staining, avian infectious bronchitis virus has a characteristic electron microscopic appearance resembling, but distinct from, that of myxoviruses. Particles are more or less rounded in profile; although there is a certain amount of polymorphism, there is also a characteristic "fringe" of projections 200 Å long, which are rounded or petal shaped, rather than sharp or pointed, as in the myxoviruses. This appearance, recalling the solar corona, is shared by mouse hepatitis virus and several viruses recently recovered from man, namely strain B814, 229E and several others. These viruses also share a number of other properties as indicated in the table. (Anyone interested in the data on which the table is based may obtain a short bibliography on application to Dr D. A. J. Tyrrell at the Common Cold Research Unit, Salisbury, Wiltshire.)

Some other relevant properties should be mentioned. There is an antigenic relationship between the human and murine strains, but none has been detected between avian strains and the others. A haemagglutinin has been detected by certain workers using avian infectious bronchitis virus and also antigens separable from the virus particle, but these have so far not been recorded for the human or murine strains.

In the opinion of the eight virologists these viruses are members of a previously unrecognized group which they suggest should be called the coronaviruses, to recall the characteristic appearance by which these viruses are identified in the electron microscope.

These suggestions have been received by members of the Myxovirus Study Group (chairman, Professor A. P. Waterson) under the International Committee for the Nomenclature of Viruses (ICNV). The suggestions were found acceptable and are now to be considered by the Vertebrate Virus Committee of the ICNV.

**Coronaviruses**

- This is a screenshot from previous image.
- Verbatim
  - They point out that with negative staining, avian infectious bronchitis virus has a characteristic electron microscopic appearance resembling, but distinct from, that of myxoviruses.
  - This appearance, recalling the solar corona, is shared by mouse hepatitis virus and several viruses recently recovered from man, namely strain B814, 229E and several others.
  - There is an antigenic relationship between the human and murine strains, but none has been detected between avian strains and the others.
  - In the opinion of the eight virologists these viruses are members of a previously unrecognized group which they suggest should be called **coronaviruses**, to recall the characteristic appearance by which these viruses are identified in the electron microscope.
- Source
  - **Nature 1968**
  - <https://www.nature.com/articles/220650b0.pdf>



# Page 135 – human Coronavirus NL63

## Background

- Okay, you need to get a few terms straight.
- **Bronchiolitis**
  - That's inflammation of airways the diameter of an eyelash. Those airways are **bronchioles**.
- **Bronchitis**
  - That's inflammation (plus mucous production sometimes) in airways larger than bronchioles.
- **Emphysema**
  - This is irreversible destruction of air sacs. Smoking is the usual cause.
- **COPD**
  - = Emphysema + Bronchitis = Chronic Obstructive Pulmonary Disease. Smoking is the usual cause.

## Structure of Main Protease from Human Coronavirus NL63: Insights for Wide Spectrum Anti-Coronavirus Drug Design

- Verbatim
  - Human coronavirus NL63 (HCoV-NL63) was first isolated in 2004 from a 7-month-old child suffering from bronchiolitis and conjunctivitis in the Netherlands.
- Source
  - **Nature scientific reports**
    - **7 March 2016**
    - <https://www.nature.com/articles/srep22677> (This confirms the conjunctivitis)
- Authors
  - Fenghua Wang
  - Cheng Chen
  - Wenjie Tan
  - Kailin Yang
  - Haitao Yang

## Bronchiolitis

- Summary
  - A nice readable summary and nice drawing by the **Mayo Clinic**.
- Source
  - Mayo Clinic
    - Mayo Clinic Staff
    - <https://www.mayoclinic.org/diseases-conditions/bronchiolitis/symptoms-causes/syc-20351565>

## Bronchitis

- Summary
  - This nicely explains acute bronchitis, chronic bronchitis, and acute-on-chronic bronchitis.

- Source
  - Mayo Clinic
    - Mayo Clinic Staff
    - <https://www.mayoclinic.org/diseases-conditions/bronchitis/symptoms-causes/syc-20355566>

## COPD

- Summary
  - Nice drawings of **Emphysema** and **Bronchitis**, the 2 things that are the hallmarks of COPD.
- Source
  - Mayo Clinic
    - Mayo Clinic Staff
    - <https://www.mayoclinic.org/diseases-conditions/copd/symptoms-causes/syc-20353679>

I guess I think the Mayo Clinic is 'nice.'

# Page 136 - human Coronavirus HKU1 & human Coronavirus OC43

## Coronavirus HKU1

*Characterization and Complete Genome Sequence of a Novel Coronavirus, Coronavirus HKU1, from Patients with Pneumonia*

- Summary
  - This describes the discovery of *coronavirus HKU1*.
- Verbatim
  - In the past 3 years, several novel respiratory viruses, including human metapneumovirus, severe acute respiratory syndrome (SARS) coronavirus (SARS-CoV), and human coronavirus NL63, were discovered. Here we report the discovery of another novel coronavirus, coronavirus HKU1 (CoV-HKU1), from a 71-year-old man with pneumonia who had just returned from Shenzhen, China.
- Source
  - Journal of Virology
    - January 2005
    - <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC538593/>
- Authors
  - [Patrick C. Y. Woo](#),<sup>1,2,†</sup> [Susanna K. P. Lau](#),<sup>1,2,†</sup> [Chung-ming Chu](#),<sup>3</sup> [Kwok-hung Chan](#),<sup>1</sup> [Hoi-wah Tsoi](#),<sup>1</sup> [Yi Huang](#),<sup>1</sup> [Beatrice H. L. Wong](#),<sup>1</sup> [Rosana W. S. Poon](#),<sup>1</sup> [James J. Cai](#),<sup>1</sup> [Wei-](#)

[kwang Luk](#),<sup>4</sup> [Leo L. M. Poon](#),<sup>1,2</sup> [Samson S. Y. Wong](#),<sup>1,2</sup> [Yi Guan](#),<sup>1,2</sup> [J. S. Malik Peiris](#),<sup>1,2</sup> and [Kwok-yung Yuen](#)<sup>1,2,†</sup>

- Department of Microbiology,<sup>1</sup> State Key Laboratory of Emerging Infectious Diseases, The University of Hong Kong,<sup>2</sup> Division of Respiratory Medicine, Department of Medicine, United Christian Hospital,<sup>3</sup> Department of Microbiology, Tseung Kwan O Hospital, Hong Kong<sup>4</sup>
- <sup>†</sup>Corresponding author. Mailing address: Department of Microbiology, The University of Hong Kong, University Pathology Building, Queen Mary Hospital, Hong Kong.
- <sup>†</sup>P. C. Y. Woo, S. K. P. Lau, and K.-y. Yuen are all principal investigators and contributed equally to the manuscript.

### Johann Rahn

- He creates the therefore sign. ∴

*I am hungry ∴ I am going to Burger King.*

- [https://en.wikipedia.org/wiki/Johann\\_Rahn](https://en.wikipedia.org/wiki/Johann_Rahn)

## Coronavirus OC43

### Science Direct

- There are about 10 articles on [229E](#) in here.
- <https://www.sciencedirect.com/topics/neuroscience/human-coronavirus-229e>

# Page 137 – SARS Coronavirus

### SARS-CoV pandemic 2003

- [Severe Acute Resp Syndrome \(SARS\) Corona-Virus \(SARS-CoV\)](#)
- [Genus Beta coronavirus](#)
- Enveloped single-stranded pos RNA
- Epid
  - **2003** – started in [Asia](#).
    - **10,000 masked palm civets** killed in [Guangdong province, China](#) (Wik – SARS coronavirus)
  - **2004** – No cases since
  - **774 deaths / 8098 infected = 9.5% CFR**
  - Source: [CDC](#) <https://www.cdc.gov/sars/index.html>
- **Travel alert vs Travel advisory**
  - I am not clear on this concept.
  - <https://www.travelandleisure.com/travel-tips/travel-alert-vs-travel-warning>
- Timeline (read, sequence of actions taken by [CDC](#))
  - <https://www.cdc.gov/about/history/sars/timeline.htm>
  - Severe Acute Respiratory Syndrome (SARS) was first discovered in Asia in February 2003. The outbreak lasted approximately six months as the disease spread to more than two dozen countries in North America, South America,

Europe, and Asia before it was stopped in July 2003. See below a timeline of CDC's key activities conducted during the outbreak and beyond.

- **2002 November 16:** 1<sup>st</sup> case **Atypical Pneumonia, Guangdong province, southern China.**
- **2003 March 12:** WHO issues global alert for a severe form of pneumonia of unknown origin in persons from China, Vietnam, and Hong Kong.
- **2003 March 14:** CDC activated its **Emergency Operations Center (EOC).**
- **2003 March 15:** CDC issues first health alert and hosts media telebriefing about an atypical pneumonia that has been named **Severe Acute Respiratory Syndrome (SARS).** CDC issues interim guidelines for state and local health departments on SARS.
- CDC issues a "Health Alert Notice" for travelers to the United States from Hong Kong, Guangdong Province (China).
- **2003 March 20:** CDC issues infection control precautions for **aerosol-generating procedures** on patients who are suspected of having SARS.
- **2003 March 22:** CDC issues interim **laboratory biosafety guidelines** for handling and processing specimens associated with SARS.
- **2003 March 24:** CDC laboratory analysis suggests a new **coronavirus** may be the cause of SARS. In the United States, 39 suspect cases (*to date*) had been identified. Of those cases, 32 of 39 had traveled to countries where SARS was reported.
- **2003 March 27:** CDC issues interim domestic guidelines for management of exposures to SARS for healthcare and other institutional settings.
- **2003 March 28:** The SARS outbreak is more widespread. **CDC begins utilizing pandemic planning for SARS.**
- **2003 March 29:** CDC extended its travel advisory for SARS to include all of mainland China and added Singapore. CDC quarantine staff began meeting planes, cargo ships and cruise ships coming either directly or indirectly to the United States from China, Singapore and Vietnam and also begins distributing health alert cards to travelers.
- **2003 April 4:** The number of suspected U.S. SARS cases was 115; reported from 29 states. There were no deaths among these suspect cases of SARS in the United States.
- **2003 April 5:** CDC establishes community outreach team to address stigmatization associated with SARS.
- **2003 April 10:** CDC issued specific guidance for students exposed to SARS.
- **2003 April 14:** CDC publishes a sequence of the virus believed to be responsible for the global epidemic of SARS. Identifying the genetic sequence of a new virus is important to treatment and prevention efforts. The results came just 12 days after a team of scientists and technicians began working around the clock to grow cells taken from the throat culture of a SARS patient.
- **2003 April 22:** CDC issues a health alert for travelers to Toronto, Ontario (Canada)
- **2003 May 6:** In the United States, no new probable cases were reported in the last 24 hours, and there was no evidence of ongoing transmission beyond the initial case reports in travelers for more than 20 days. The containment in the United States has been successful.
- **2003 May 20:** CDC lifted the travel alert on Toronto because **more than 30 days** (or three SARS incubation periods) had elapsed since the date of onset of symptoms for the last reported case.
- **2003 May 23:** CDC reinstated travel alert for Toronto because on May 22, Canadian health officials reported a cluster of five new probable SARS cases.
- **2003 June 4:** CDC removed the travel alert for Singapore and downgraded the traveler notification for Hong Kong from a *travel advisory* to a *travel alert*.
- **2003 July 3:** CDC removed the travel alert for mainland China.
- **2003 July 5:** WHO announced that the **global SARS outbreak was contained.**
- **2003 July 10:** CDC removed the travel alert for Hong Kong and Toronto.
- **2003 July 15:** CDC removed the travel alert for Taiwan.
- **2003 July 17:** CDC updated the SARS case definition which reduced the number of U.S. cases by half. The change results from excluding cases in which blood specimens that were collected more than 21 days after the onset of illness test negative.
- **2003 December 31:** Globally, WHO received reports of SARS from 29 countries and regions; 8,096 persons with probable SARS resulting in 774 deaths. In the United States, eight SARS infections were documented by laboratory testing and an additional 19 probable SARS infections were reported.
- **2004 January 13:** CDC issues "**Notice of Embargo of Civets.**"

- A SARS-like virus had been isolated from civets (captured in areas of China where the SARS outbreak originated).
- CDC banned the importation of civets.
- The civet is a mammal with a catlike body, long legs, a long tail, and a masked face resembling a raccoon or weasel.
- The ban is currently still in effect.
- **2012 October 5:** The National Select Agent Registry Program declared SARS-coronavirus a select agent.
  - A select agent is a bacterium, virus or toxin that has the potential to pose a severe threat to public health and safety.
- Who does it infect?
  - Bats
    - = Natural reservoir ... but no disease shown for this particular coronavirus.
    - [ However, some scientists suggests the bats may get mild diarrhea. ]
  - human
  - Masked palm civet
    - *Paguma larvata*
    - Zoonosis
      - (Bat?) → Civet → human (2002)
      - Like the camel, it's a SARS-CoV reservoir / vector ... but does not seem to suffer disease.
      - Uncooked meat at the Guangdong province local market so that seems to be the way it gets into human.
      - SARS crosses the xenographic barrier from civet to human.
    - Diet
      - Omnivore
      - Rats, birds, figs, mangoes, bananas, molluscs, bark, snakes, frogs.
    - [https://en.wikipedia.org/wiki/Masked\\_palm\\_civet](https://en.wikipedia.org/wiki/Masked_palm_civet)
- Genome
  - ID'ed in 2003 by:
    - CDC
    - National Microbio Lab, Winnipeg
      - Biosafety level 4
- Entry
  - ACE2 Receptor
- 11% mortality
- [https://en.wikipedia.org/wiki/Severe\\_acute\\_respiratory\\_syndrome\\_coronavirus](https://en.wikipedia.org/wiki/Severe_acute_respiratory_syndrome_coronavirus)

# Page 138 – MERS Coronavirus

## Susan Baker (Coronaviridae Study Group)

- For MERS-CoV, dromedary camels now are suspected as the zoonotic source for transmission to humans, since MERS-CoV sequences with 99% nucleotide identity to human MERS-CoV isolates have been detected in respiratory samples from camels

(9). Although there are reports of human-to-human transmission of MERS-CoV (10, 11), current strains seem to cause mostly lower respiratory tract disease and are not as highly transmissible as SARS-CoV.

- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4403493/>

### Broad-spectrum coronavirus antiviral drug discovery.

- **Summary**
  - The point here is that the need to be vigilant about future coronaviruses was made in March 2019, prior to the start of the COVID-19 pandemic (which started in approximately December 2019 or January 2020).
- **Verbatim**
  - **Introduction:** The highly pathogenic coronaviruses severe acute respiratory syndrome coronavirus (SARS-CoV) and Middle East respiratory syndrome coronavirus (MERS-CoV) are lethal zoonotic viruses that have emerged into human populations these past 15 years. These coronaviruses are associated with novel respiratory syndromes that spread from person-to-person via close contact, resulting in high morbidity and mortality caused by the progression to Acute Respiratory Distress Syndrome (ARDS).
  - **Expert opinion:** Treatment of SARS and MERS in outbreak settings has focused on therapeutics with general antiviral activity and good safety profiles rather than efficacy data provided by cellular, rodent, or nonhuman primate models of highly pathogenic coronavirus infection. Based on lessons learned from SARS and MERS outbreaks, lack of drugs capable of pan-coronavirus antiviral activity increases the vulnerability of public health systems to a highly pathogenic coronavirus pandemic.
- **Source**
  - Expert Opinion on Drug Discovery
    - Pages 397-412 | Received 16 Aug 2018, Accepted 07 Feb 2019, Published online: 08 Mar 2019
    - <https://doi.org/10.1080/17460441.2019.1581171>
    - <https://www.tandfonline.com/doi/full/10.1080/17460441.2019.1581171>
- **Authors**
  - Allison L. Tatura.
    - Division of Molecular and Translational Sciences, United States Army Medical Research Institute of Infectious Diseases, Fort Detrick, MD, USA
  - Sina Bavari
    - Division of Molecular and Translational Sciences, United States Army Medical Research Institute of Infectious Diseases, Fort Detrick, MD, USA

## Terminology

### MERS-CoV 2012

- Genus *Beta coronavirus*
- **Names**
  - Middle East Respiratory Syndrome corona-virus (MERS-HCoV) (MERS-CoV)
  - 2012-nCoV
    - Original name
    - n = novel
- **Hx**
  - There was initially an outbreak in Saudi Arabia in 2012.
  - Case 1 – It was ID'ed from a man's lungs by an Egyptian virologist.

- Case 2 – A man from Qatar.
- Was present in 21 countries as of 2015 (Wik – I assume that's wrong)
- Was present in 27 countries as of 2012 Sept (WHO – link below)
- Epid
  - 858 deaths / 2494 cases = 34% CFR
    - That's WHO data as of November 2019
    - <https://www.who.int/emergencies/mers-cov/en/>
  - 80% of cases in Saudi Arabia.
    - [https://www.who.int/news-room/fact-sheets/detail/middle-east-respiratory-syndrome-coronavirus-\(mers-cov\)](https://www.who.int/news-room/fact-sheets/detail/middle-east-respiratory-syndrome-coronavirus-(mers-cov))
  - Korea
    - The largest outbreak outside of Arabian Peninsula was in Korea, due to a returning traveller. Wow. The Power of One.
      - <https://www.cdc.gov/coronavirus/mers/about/transmission.html>
- Still spreading?
  - Yes.
  - CDC
    - CDC continues to closely monitor the MERS situation globally.
      - This is as of 2 August 2019.
      - <https://www.cdc.gov/coronavirus/mers/about/index.html>
    - We recognize the potential for MERS-CoV to spread further and cause more cases in the United States and globally.
      - This is as of 2 August 2019.
      - <https://www.cdc.gov/coronavirus/mers/faq.html>
  - WHO
    - From 1 December 2019 through 31 January 2020, the National IHR Focal Point of Saudi Arabia reported 19 additional cases of MERS-CoV infection, including 8 associated deaths.
      - The cases were reported from Aseer (7 cases), Riyadh (6 cases), Al-Qassim (2 cases), Eastern (2 cases), Madinah (1 case), and Aljouf (1 case) regions.
      - In January 2020, a hospital outbreak was reported in Aseer region with a cluster of 6 cases.
        - Three of the cases were health care workers, two were patients and one was a visitor.
        - One of the cases of this cluster died on 4 February 2020.
        - This is as of 24 Feb 2020.
      - <https://www.who.int/csr/don/24-february-2020-mers-saudi-arabia/en/>
    - This WHO has about 50 links.
      - <https://www.who.int/emergencies/mers-cov/en/>
    - WHO Fact Sheet Nov 2019
      - This is dope. It's a link from the article immediately above.
      - See Pix: MERS fact sheet Nov 2019
      - <https://applications.emro.who.int/docs/EMRPUB-CSR-241-2019-EN.pdf?ua=1&ua=1&ua=1>
    - WHO FAQ
      - Dromedary camels in these countries carry MERS-CoV
        - MERS-CoV has been found in dromedary camels in several countries, including in Burkina Faso, Egypt, Ethiopia, Iran, Jordan, Kenya, Kingdom of Saudi Arabia, Kuwait, Mali, Morocco, Netherlands, Nigeria, Oman, Pakistan, Qatar, Spain (Canary Islands), Somalia, Sudan, Tunisia, and the United Arab Emirates.
      - Reservoirs

- It is possible that other animal reservoirs exist. However, animals including goats, cows, sheep, water buffalo, swine, and wild birds have been tested for MERS-CoV and the virus has not been found. These studies support the premise that dromedary camels are the likely source of infection in humans, but studies and investigations have not yet identified how humans are infected with the MERS virus.
    - Sick animals
      - Sick animals [camels] should never be slaughtered for consumption. People should avoid direct contact with any animal that has been confirmed positive for MERS-CoV infection.
    - [https://www.who.int/csr/disease/coronavirus\\_infections/faq/en/](https://www.who.int/csr/disease/coronavirus_infections/faq/en/)
- RF
  - Direct contact with camels.
    - <https://www.cdc.gov/coronavirus/mers/risk.html>
- Origin
  - Bats
    - MERS CoV is closely related to bat coronaviruses:
      - Pipi-strellus bat coronavirus HKU5
      - Tylonycteris bat coronavirus HKU4
  - Camel
    - Semantics
      - Dromedary = Arabian camel = 1 hump
      - Bactrian camel = 2 humps
    - It's a MERS-CoV reservoir ... but does not seem to suffer disease.
      - Case report of a guy getting MERS-CoV from drinking camel milk.
      - Maybe from eating camel meat.
      - 50 dromedary camels in Oman all had MERS-CoV AB.
    - Although most of human cases of MERS-CoV infections have been attributed to human-to-human infections in health care settings, current scientific evidence suggests that dromedary camels are a major reservoir host for MERS-CoV and an animal source of MERS infection in humans. However, the exact role of dromedaries in transmission of the virus and the exact route(s) of transmission are unknown. (WHO)
      - [https://www.who.int/news-room/fact-sheets/detail/middle-east-respiratory-syndrome-coronavirus-\(mers-cov\)](https://www.who.int/news-room/fact-sheets/detail/middle-east-respiratory-syndrome-coronavirus-(mers-cov))
    - As expected, several animals had antibodies against OC43 in their blood, and none carried antibodies against SARS. **But 50 dromedary camels from Oman that were tested all had antibodies against the MERS virus**, the scientists report today in *The Lancet Infectious Diseases*. (This link will be live after 6:30 pm U.S. Eastern time.) "There is something circulating in dromedary camels that looks very much like MERS coronavirus," Koopmans says. The camels are all female retired racing camels used for breeding, but they belong to different owners in separate locations.
      - <https://www.sciencemag.org/news/2013/08/camels-may-transmit-new-middle-eastern-virus>



- **Lancet 2013** ref within science mag  
[https://www.thelancet.com/journals/laninf/article/PIIS1473-3099\(13\)70164-6/fulltext](https://www.thelancet.com/journals/laninf/article/PIIS1473-3099(13)70164-6/fulltext)
  - Michael Osterholm MD
    - Dr Michael Osterholm talking to Peter Attia MD on 31 March 2020 (at least, that's date of podcast).
      - <https://peterattiamd.com/michaelosterholm/>
    - **MERS**
      - He was in Abu Dhabi when it was 110° F.
        - Transmission was "going on just fine, thank you." (7m21s)
      - **Endemic in Arabian peninsula: MERS transmits year round.**
        - "Camels are not going to be put down."
  - Bat → camel → human
    - This is speculated.
- Entry
  - CD26
    - It's an **enzyme** on the **surface** of cells. Hmm, that's a new one
    - **DPP4 gene**
    - [https://en.wikipedia.org/wiki/Dipeptidyl\\_peptidase-4](https://en.wikipedia.org/wiki/Dipeptidyl_peptidase-4)
- Cell culture
  - **MERS-CoV** grows on **Vero cells**.
  - **Vero cell**
    - It's a **cell line**.
      - **Kidney epithelial cell** from **African green monkey**.
    - **1962** – **The lineage is created at Chiba University, Chiba, Chiba Prefecture, Japan.**
      - The original cell line was named "**Vero**" after an **abbreviation of *verda reno***, which means "green kidney" in Esperanto, while **vero** itself means "truth" in Esperanto. (Wik – Vero cell)
      - It was created by **Polish ophthalmologist L. L. Zamenhof** in 1887 (Wik – Esperanto)
    - [https://en.wikipedia.org/wiki/Vero\\_cell](https://en.wikipedia.org/wiki/Vero_cell)
    - <https://en.wikipedia.org/wiki/Esperanto>
- Pathophys
  - **Strong tropism for non-ciliated bronchial epithelial cells.**
  - **Evades innate immune response** by **antagonizing interferon (IFN)** in these cells.
  - **The tropism is unique because most respiratory viruses target ciliated cells.**
    - (Mostly word for word from Wik.)
- **MERS**
  - 72% required **mechanical ventilation**.
  - **Severe pneumonia** → **ARDS** → **SIRS / MOF** (it would seem): **Renal Failure, DIC, pericarditis**
- Source
  - [https://en.wikipedia.org/wiki/Middle\\_East\\_respiratory\\_syndrome-related\\_coronavirus](https://en.wikipedia.org/wiki/Middle_East_respiratory_syndrome-related_coronavirus)
  - [https://en.wikipedia.org/wiki/Middle\\_East\\_respiratory\\_syndrome](https://en.wikipedia.org/wiki/Middle_East_respiratory_syndrome)
- Back-up to the Osterholm comment
  - "Our research has shown that the SARS coronavirus found in human victims is the same as the SARS coronavirus found in civet cats," said Wang Ming, an official from the Guangzhou Centre for Disease Control and Prevention.
    - [http://www.chinadaily.com.cn/china/2006-11/23/content\\_740511.htm](http://www.chinadaily.com.cn/china/2006-11/23/content_740511.htm)

## Case Fatality Rate (CFR)

*Middle East respiratory syndrome coronavirus (MERS-CoV)*. WHO. No date, no author.

- [https://www.who.int/health-topics/middle-east-respiratory-syndrome-coronavirus-mers#tab=tab\\_1](https://www.who.int/health-topics/middle-east-respiratory-syndrome-coronavirus-mers#tab=tab_1)
- Verbatim
  - In total, 27 countries have reported cases since 2012, leading to 858 known deaths due to the infection and related complications.

Case Fatality Rate (CFR)

- Summary
  - **Sep 2022 – 28 Feb 2022**
    - My math: 34%
    - WHO: 35%. They were ever so charitable with their significant figures.
    - 891 deaths =  $0.3447 = 0.345 = 0.35 = 35\% \text{ CFR}$  = that's some charitable rounding up.
    - 2585 cases
  - **1 Aug 2021 – 28 Feb 2022**
    - **N = 6 MERS cases in Saudi Arabia**. See map above.
      - 4 deaths
      - 4 cases Riyadh
      - 1 case 'Eastern'
      - 1 case Taif

## Still spreading?

Yes.

## Here to there

Spread from Camel to Human

- Summary
  - Routes
    - **Nasal secretions** – most likely.
      - **The technical way of spread is by 'close contact' with the camel.** And that would mean close contact with its nose because it sheds high amounts of the MERS coronavirus are found in its nose. That's why I said kiss the camel on the nose.
    - **Camel milk?**
    - **Camel meat?**

*102 – Michael Osterholm, Ph.D.: COVID-19—Lessons learned, challenges ahead, and reasons for optimism and concern*

- Summary
  - **Dr. Peter Attia, MD interviews Dr. Michael Osterholm, PhD** in this **1 h 22 min** podcast.
  - **"Camels are not going to be put down."**
- Source
  - 
  - **31 March 2020**

- <https://peterattiamd.com/michaelosterholm/>

*Middle East respiratory syndrome coronavirus in dromedary camels: an outbreak investigation*

- Summary
  - This paper is great science. This is the bar, if you're wondering how high the bar is.
- Source
  - Lancet
    - 2014
    - Marion Koopmans DVM, PhD
    - Bart Haagmans PhD
    - <https://www.sciencedirect.com/science/article/pii/S147330991370690X>

## WHO

See page 180 for what an A-Z list of medical problems the WHO addresses.

See page 184 for the 6 WHO regions and their directors.

# Page 139 – COVID-19 Coronavirus a.k.a. SARS- CoronaVirus-2 (our current pandemic)

## Synonyms

*A new coronavirus associated with human respiratory disease in China.*

- Verbatim
  - This virus strain was designated as **WH-Human 1 coronavirus (WHCV)** (and has also been referred to as '2019-nCoV') and its whole genome sequence (29,903 nt) has been assigned GenBank accession number MN908947.
- Source
  - **Nature**
  - **3 Feb 2020**
  - 2020; **579**(7798): 265–269
    - This paper and the one below are back to back.
  - Yong-Zhen Zhang et al.

- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7094943/>

### *A pneumonia outbreak associated with a new coronavirus of probable bat origin*

- Summary
  - They call it a **new coronavirus** and say its name is **2019-nCoV**.
- Verbatim
  - Here we report the identification and characterization of a new coronavirus (2019-nCoV), which caused an epidemic of acute respiratory syndrome in humans in Wuhan, China.
- Source
  - **Nature**
  - **3 Feb 2020**
    - This paper and the one above are back to back.
    - 2020; 579, pages 270–273
  - Peng Zhou et al.
  - <https://www.nature.com/articles/s41586-020-2012-7>
    - This is the full article.

### *The species Severe acute respiratory syndrome-related coronavirus: classifying 2019-nCoV and naming it SARS-CoV-2*

- Summary
  - This paper describes how the coronavirus of the COVID pandemic was classified and named, as per the ICTV, specifically by the **Coronaviridae** (“corona vy rih day”) **Study Group**.
  - This paper was also mentioned on page 113.
- Verbatim
  - The present outbreak of a coronavirus-associated acute respiratory disease called coronavirus disease 19 (COVID-19) is the third documented spillover of an animal coronavirus to humans in only two decades that has resulted in a major epidemic. The *Coronaviridae* Study Group (CSG) of the International Committee on Taxonomy of Viruses, which is responsible for developing the classification of viruses and taxon nomenclature of the family *Coronaviridae*, has assessed the placement of the human pathogen, tentatively named 2019-nCoV, within the *Coronaviridae*.
- Source
  - nature microbiology
    - Volume 5, pages 536–544 (2020)
    - 2 March 2020
    - <https://www.nature.com/articles/s41564-020-0695-z>
- Authors
  - **Coronaviridae Study Group** of the International Committee on Taxonomy of Viruses (ICTV)
    - Alexander E. Gorbalenya
    - Susan C. Baker
    - Ralph S. Baric
    - Raoul J. de Groot
    - Christian Drosten
    - Anastasia A. Gulyaeva
    - Bart L. Haagmans
    - Chris Lauber
    - Andrey M. Leontovich
    - Benjamin W. Neuman
    - Dmitry Penzar
    - Stanley Perlman
    - Leo L. M. Poon
    - Dmitry V. Samborskiy
    - Igor A. Sidorov

- Isabel Sola
- John Ziebuhr

*Coronavirus Disease 2019 (COVID-19)*

- David J Cennimo et al. Medscape. 10 November 2022.
- <https://emedicine.medscape.com/article/2500114-overview#showall>

# Page 140 – Here to There // What's special about COVID?

## Case Fatality Rate (CFR)

- This is a fantastic example of how analysis must be applied to data. A 1% CFR at face value seems like the safer scenario. *Oh, there's only a 1% chance I will die. No big deal.* But what if that particular virus spreads like mad? Now you're talking 1% of the human race if everyone gets infected (and that's when spread goes unchecked a.k.a. R-nought is high). 1% of 8 billion alive humans is 80 million dead humans. Now that 1% is a very significant percent.

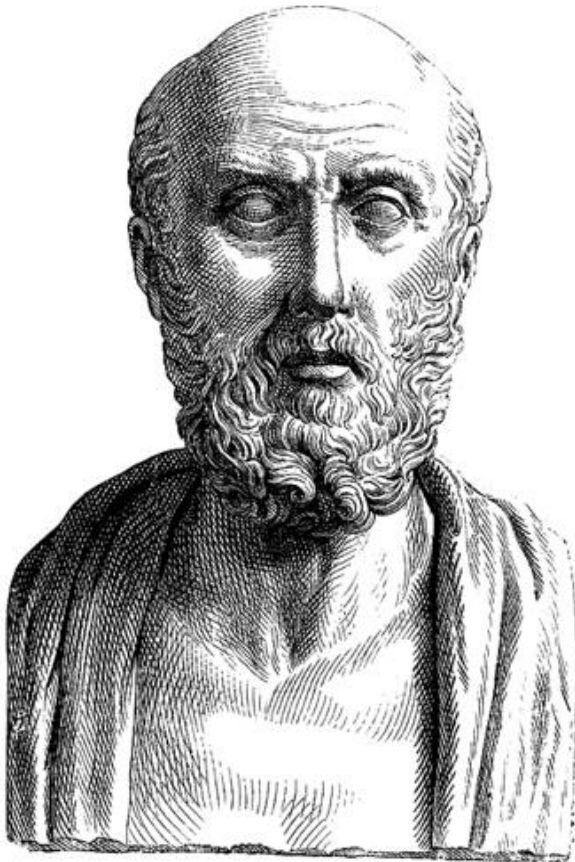
# Page 141 – Let's collect our thoughts

Not much to say here.

# Page 142 – Anatomy, Anatomy, Anatomy

See page 143.

# Page 143 – SOMPOO's Soliloquy



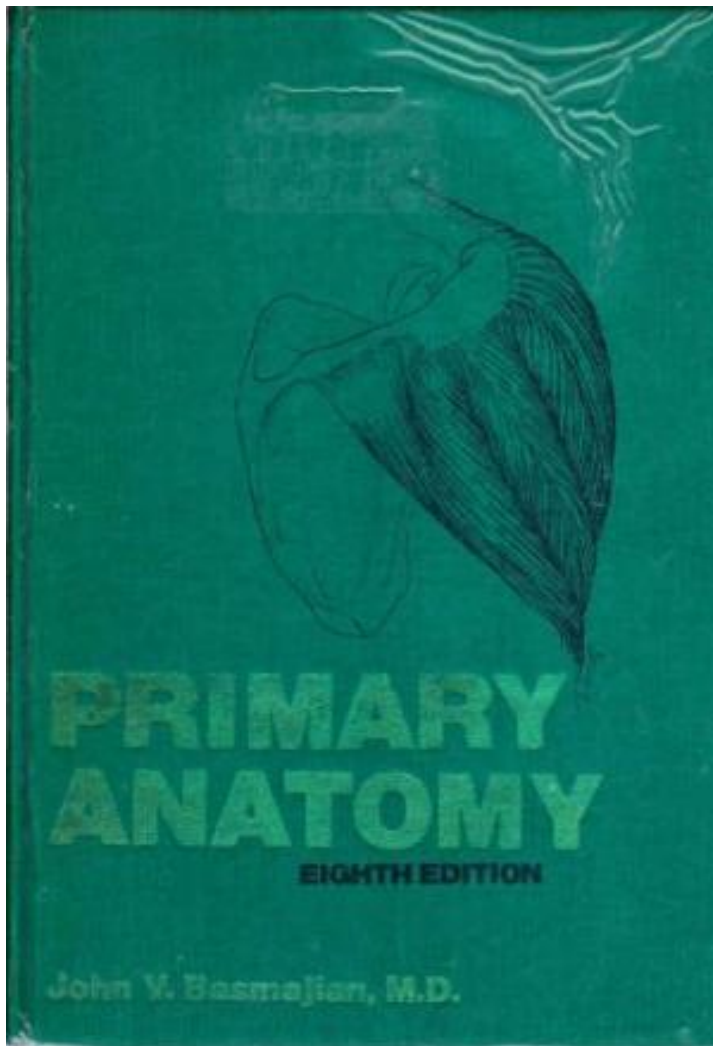
<https://en.wikipedia.org/wiki/Hippocrates>

- This is why doctor's take a **Hippocratic oath** – it's named after him.



<https://en.wikipedia.org/wiki/Galen>

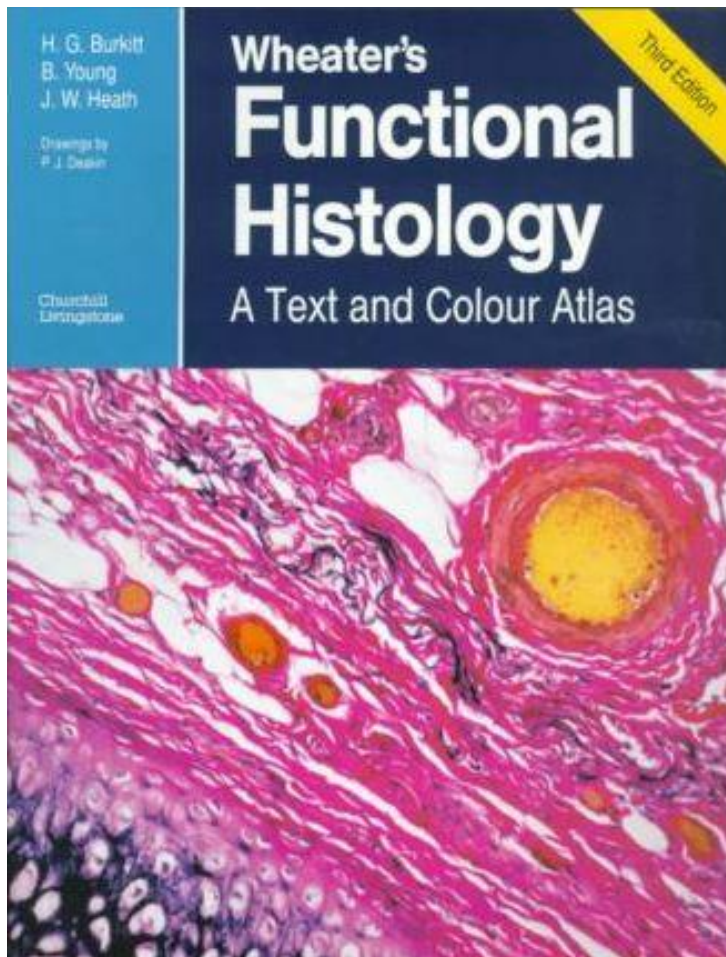
- Galen was a Roman physician whose teachings influenced doctors for centuries.



### Primary Anatomy 8<sup>th</sup> Ed

- Summary
  - This is the anatomy book to start with if you know absolutely nothing. You will still drown in information but it's a good kind of drowning.
  - The cover image is the shoulder blade (scapula) and deltoid muscle, as viewed from the back of the body.
- Source
  - **Williams & Wilkins**; Subsequent edition (January 1, 1982)
  - 452 page textbook
  - [https://www.amazon.com/Primary-Anatomy-John-V-Basmajian/dp/0683005502/ref=sr\\_1\\_4?Adv-Srch-Books-Submit.x=0&Adv-Srch-Books-Submit.y=0&qid=1668184972&refinements=p\\_28%3Aanatomy%2Cp\\_27%3ABasmajian&s=books&sr=1-4&unfiltered=1](https://www.amazon.com/Primary-Anatomy-John-V-Basmajian/dp/0683005502/ref=sr_1_4?Adv-Srch-Books-Submit.x=0&Adv-Srch-Books-Submit.y=0&qid=1668184972&refinements=p_28%3Aanatomy%2Cp_27%3ABasmajian&s=books&sr=1-4&unfiltered=1)
- Author
  - **John V. Basmajian**
    - Born 1921, Istanbul.
    - **Armenian**.
    - Parents emigrated to Brantford, Ontario, Canada (the home of **Wayne Gretzky**) when he was 12 years **old**. Now there is some hockey trivia, but not really.
    - WW2 – Royal Canadian Medical Corps.
    - 1945 – M.D. at University of Toronto





*Wheater's Functional Histology: A Text and Colour Atlas*

- Summary
  - **Histology** (“hiss tall aw jee”) is the study of tissues under a microscope.
  - The book is named after **Paul Wheater** who was a **histologist** (“his tall oh jist”) – someone who studies histology.
  - **Every cell type in the human body is explored in this book.** It usually starts with the view through an **optical microscope**, then examines a particular feature (for example the cell’s energy factory called the mitochondria) with an **electron microscope**.
  - For example, the complex structure of the **air sacs** in the lungs is especially evident with an electron microscope. When you see these amazing images, you’re like, *Oh so that’s where coronavirus does damage*. It’s no longer imaginary. It’s a real biological landscape.
  - This was one of my textbooks in the 1<sup>st</sup> year of medical school.
  - **This, in my opinion, is one of the most amazing books on the planet. I would take it to Mars.**
- Cover photo

- At the bottom left corner are cartilage cells that secrete **collagen**. Collagen is a protein. You're a dead duck without it. There are 4 types of collagen. There's a whole area of medicine called '**connective tissue disorders**' where collagen is impaired. Indeed, collagen connects things. The technical name for the cartilage cells is **chondro-cytes** ("con draw sites").
- Source
  - 3<sup>rd</sup> Edition
    - This is the copy I have.
    - Publisher **Churchill Livingstone**.
    - 1993
    - Authors
      - **H. George Burkitt**
      - **Barbara Young**
      - **John W. Heath**
      - **Paul Wheater**
    - amazon
      - [https://www.amazon.ca/Wheaters-Functional-Histology-Colour-Atlas/dp/0443046913/ref=sr\\_1\\_6?qid=1649718193&refinements=p\\_27%3APaul+R.+Wheater&s=books&sr=1-6&text=Paul+R.+Wheater](https://www.amazon.ca/Wheaters-Functional-Histology-Colour-Atlas/dp/0443046913/ref=sr_1_6?qid=1649718193&refinements=p_27%3APaul+R.+Wheater&s=books&sr=1-6&text=Paul+R.+Wheater)
  - 6<sup>th</sup> Edition
    - This is a link to the 6<sup>th</sup> edition. If it's too much \$\$\$ just buy an earlier edition since the cell types in the human body don't change. A Red Blood Cell (RBC) is always a Red Blood Cell (RBC).
    - **Elsevier Canada**; 6th edition. 4 November 2013.
    - Authors
      - **Barbara Young**
      - **Geraldine O'Dowd**
      - **Phillip Woodford**
    - amazon
      - [https://www.amazon.ca/Wheaters-Functional-Histology-Colour-Atlas-dp-0702047473/dp/0702047473/ref=dp\\_ob\\_title\\_bk](https://www.amazon.ca/Wheaters-Functional-Histology-Colour-Atlas-dp-0702047473/dp/0702047473/ref=dp_ob_title_bk)

## Page 144 – Epithelium

### Coronavirus Pandemic Update 37: The ACE-2 Receptor - The Doorway to COVID-19 (ACE Inhibitors & ARBs)

- Summary
  - This 18-minute video focuses on the **ACE-2 Receptor**, the 'doorway' for the coronavirus to enter a human cell.
  - This is one of many fabulous videos by **Roger Seheult, MD**, a **lung specialist** a.k.a. **respirologist** a.k.a. **pulmonologist**, and whom I affectionately refer to in my notes as **Roger the Respirologist**.
  - These videos are very technical and extremely accurate but you probably need a **medical physiology** course to understand them. This underscores my lamentation about information during this entire pandemic – the *most accurate* information is the *least understandable* by the layman.
- Source
  - **Roger Seheult, MD**
    - Co-founder of MedCram.com
      - MedCram.com is a website that prepares interns (a.k.a. residents) for their board exams to become certified in their specialty. But also Continuing Medical Education (CME) for doctors, registered nurse (RN), respiratory technician (RT)
      - I have zero point zero to do with it. Just telling you what it is.
    - Clinical and Exam Preparation Instructor
    - Board Certified in Internal Medicine, Pulmonary, Critical Care, and Sleep Medicine

- [https://www.youtube.com/watch?v=1vZDVbqRhyM&list=PLQ\\_IRFkDInv\\_zLVFTgXA8tW0Mf1iiuuM&index=40](https://www.youtube.com/watch?v=1vZDVbqRhyM&list=PLQ_IRFkDInv_zLVFTgXA8tW0Mf1iiuuM&index=40)

### ACE-2: The Receptor for SARS-CoV-2

- **Figure 1** has a nice diagram of an anti-body directed against the **Spike (S) protein** of the SARS-Coronavirus-2 (our current pandemic).
- <https://www.rndsystems.com/resources/articles/ace-2-sars-receptor-identified>
- The source of this information is a company called Bio-Techne that makes and sells anti-bodies. I have zero point zero to do with it. Just telling you what it is.

### The spike protein of SARS-CoV — a target for vaccine and therapeutic development

- This is about the Spike (S) protein of the **SARS-Coronavirus** that caused the **SARS pandemic in 2003**. This virus is very similar to the **SARS-Coronavirus-2** of the current pandemic.
- <https://www.nature.com/articles/nrmicro2090>
- **Nature**
- **9 February 2009**
- **Authors: Du, Lanying** (also mentioned on page 147 bibliography) **and others**.

## Page 145 – ACE2 Rc

See page 144.

## Page 146 – Bronchus x-s

### ACE2 Receptor

#### Numbers

- **There is not just one coronavirus infecting your nose**. Each virus makes let's say 1000 copies of itself. If there are 500 viruses, that 500,000 new viruses that will get made.
- There are scientists who actually quantify these numbers.

### Human Lungs Show Limited Permissiveness for SARS-CoV-2 Due to Scarce ACE2 Levels But Strong Virus-Induced Immune Activation in Alveolar Macrophages

- Summary
  - **This is a German study** showing 'scarce' ACE2 ("ace two") Receptors in the human lung.
  - Severe lung injury is not from direct viral damage on alveoli (air sacs), rather from 'overwhelming' immune activation.
- Verbatim - Abstract
  - **SARS-CoV-2 utilizes the ACE2 transmembrane peptidase as essential cellular entry receptor**. Several studies have suggested abundant ACE2 expression in

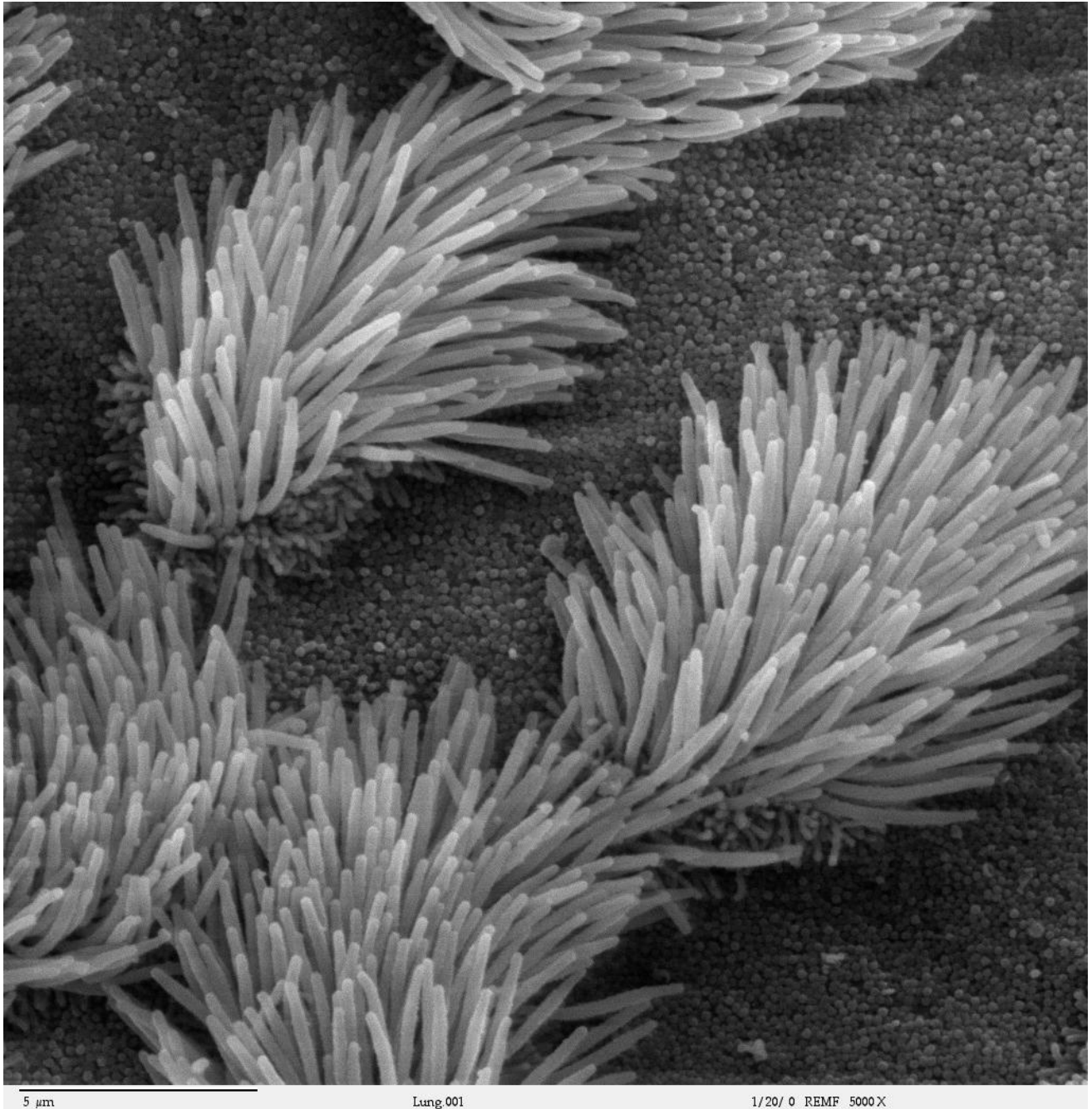
the human lung, inferring strong permissiveness to SARS-CoV-2 infection with resultant alveolar damage and lung injury. Against this expectation, we provide evidence that ACE2 expression must be considered scarce, thereby limiting SARS-CoV-2 propagation in the human alveolus. Instead, spectral imaging of ex vivo infected human lungs and COVID-19 autopsy samples depicted that alveolar macrophages were frequently positive for SARS-CoV-2, indicating viral phagocytosis. Single-cell transcriptomics of SARS-CoV-2 infected human lung tissue further revealed strong inflammatory and anti-viral activation responses in macrophages and monocytes, comparable to those induced by MERS-CoV, but with virus-specific gene expression profiles. Collectively, our findings indicate that severe lung injury in COVID-19 likely results from an overwhelming immune activation rather than direct viral damage of the alveolar compartment.

- Source
  - Cell
    - 6 October 2020
    - [https://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=3687020](https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3687020)
- Authors
  - There are 47 authors, mostly from Berlin.
  - [Katja Hönzke](#)
    - Charité - Universitätsmedizin Berlin - Department of Infectious Diseases and Respiratory Medicine
  - [Benedikt Obermayer](#)
    - Charité - Universitätsmedizin Berlin
  - [Christin Mache](#)
    - Robert Koch Institute - Unit 17 "Influenza and other Respiratory Viruses"
  - [Diana Fatykhova](#)
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    - Charité - Universitätsmedizin Berlin - Department of Infectious Diseases and Respiratory Medicine
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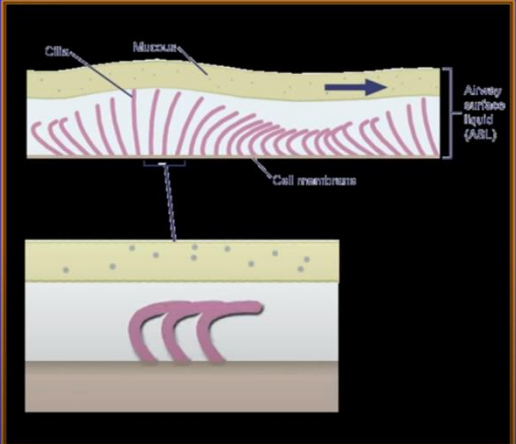
## Mucociliary Escalator



Those things that look like sea anemones are **cilia** (hairs). They are located on the surface of the cells that form the lining of the windpipe (trachea). They beat upwards. You can't see any mucuous ... I think it was all washed away during preparation of the tissue for an electron microscope. This is the **muco-ciliary escalator**.

- The scale bar is 5 microns. The width of between the tips of this letter 'u' is 1000 microns (1 millimeter) (1 mm).
- The **coronavirus** is 0.1 microns in diameter. It gets trapped in the mucous. It's not show in this image.
- [https://en.wikipedia.org/wiki/Mucociliary\\_clearance](https://en.wikipedia.org/wiki/Mucociliary_clearance)

## Mucociliary Escalator



- 250 cilia/cell
- Beat 1500 times/min
- Moves toward larynx @ 2 cm/min
- Cleansing mechanism

2:27 / 9:06

### 5 The Mucociliary Escalator



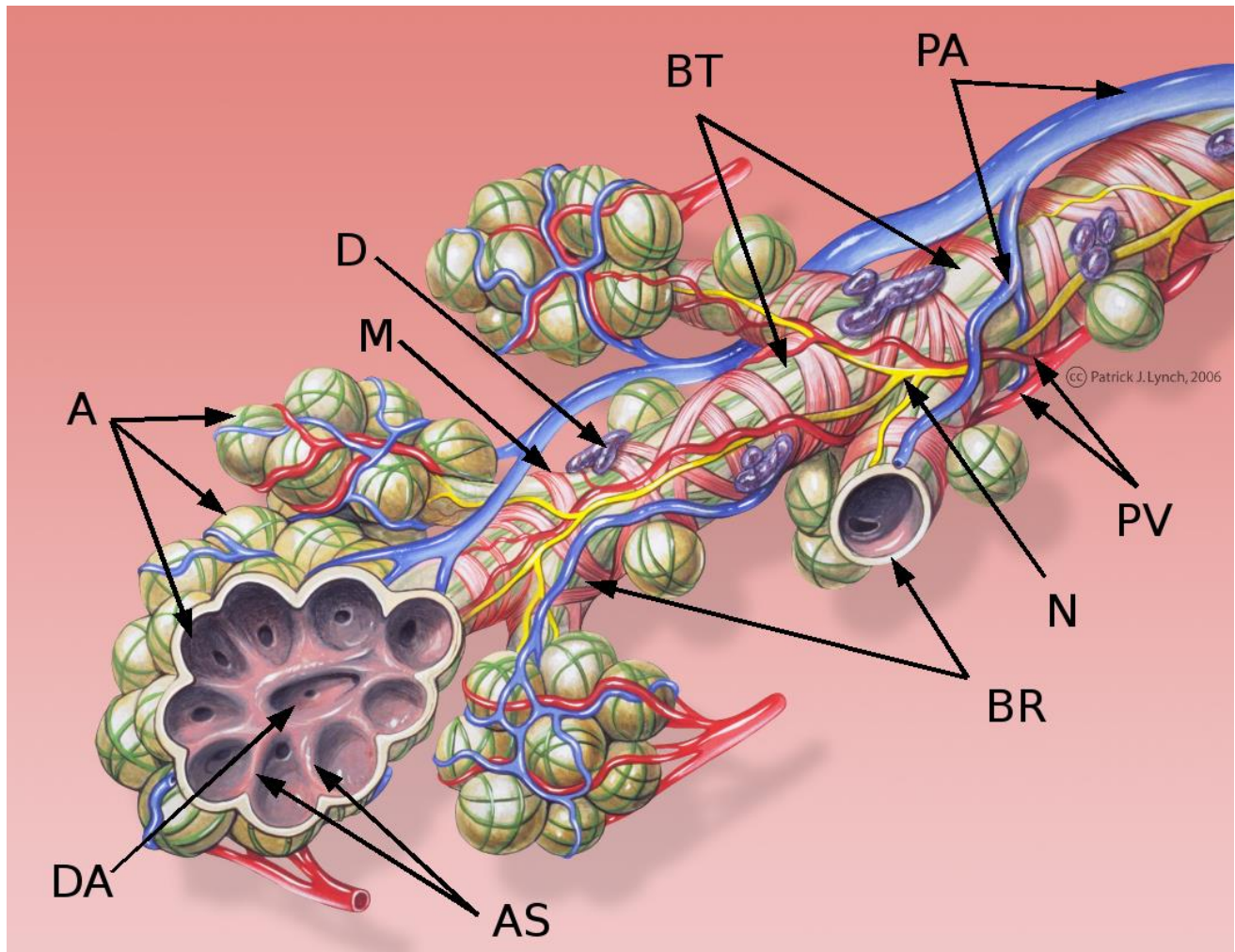
### The Mucociliary Escalator

- Summary
  - At the 2:27 mark of this video the beating of the cilia is described.
  - Each cell in the airway has 250 cilia (hairs) on its top surface. They beat fast: 25 times per second (1500 times per minute). In this case, the airways are the bronchi, the tubes inside the lung.
  - The **muco-ciliary escalator** moves upwards at 2 cm ( $\frac{3}{4}$ " ) per minute. That's quite a lot slower than a **mechanical escalator** (that we stand on) which moves at 36 meters (120 feet) per minute.
- Source 1
  - **Sinee Karpel** – the video
    - YouTube September 2015
    - <https://www.youtube.com/watch?v=idESpTuWRZ4>
- Source 2
  - **Britannica** – escalator
    - <https://www.britannica.com/technology/escalator>

**Page 147 – An air sac is a ping pong ball**

Type I Pneumocyte



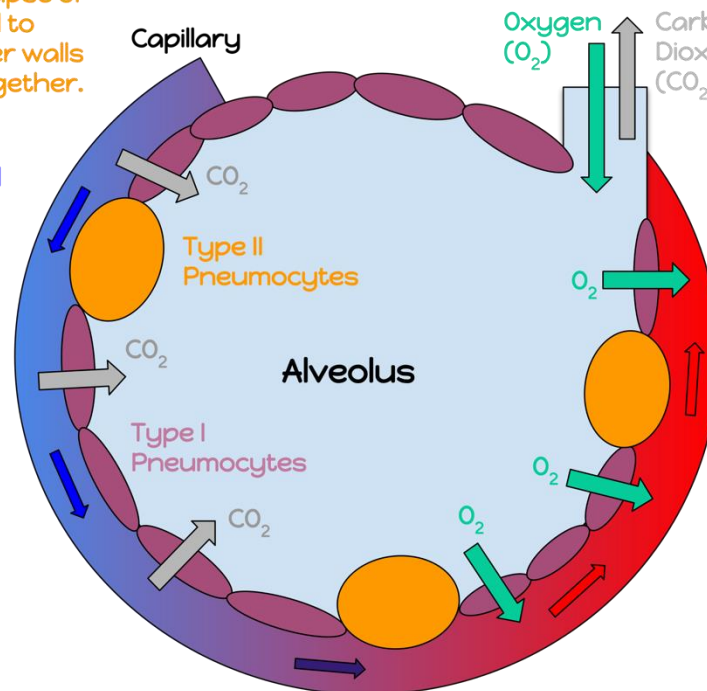


### Pulmonary alveolus

- Summary
  - This is a busy drawing ... pay attention to one thing ... do you see ping pong balls? Each one is a hollow air sac made of many **Type 1** and **Type 2 pneumo-cytes** (lung cells. Literally, *air cells*).
- Verbatim - Legend
  - **A = Alveolus** ("al vee oh luss"). That's the fancy name for **air sac**.
- AS - Septum alveolare
- BR - Bronchus respiratorius
- BT - Bronchus terminalis
- D - Mucous gland
- DA - Ductus alveolaris
- M - Musculus
- N - Nervus
- PA - Branch of Arteria pulm.
- PV - Branch of Vena pulm.
- Source
  - [https://en.wikipedia.org/wiki/Pulmonary\\_alveolus](https://en.wikipedia.org/wiki/Pulmonary_alveolus)
  - Patrick J. Lynch, medical illustrator, modified by [Christian2003](#) - Patrick J. Lynch, medical illustrator

Type II pneumocytes secrete surfactant to prevent the collapse of the alveolus and to prevent the inner walls from sticking together.

Deoxygenated blood coming from heart

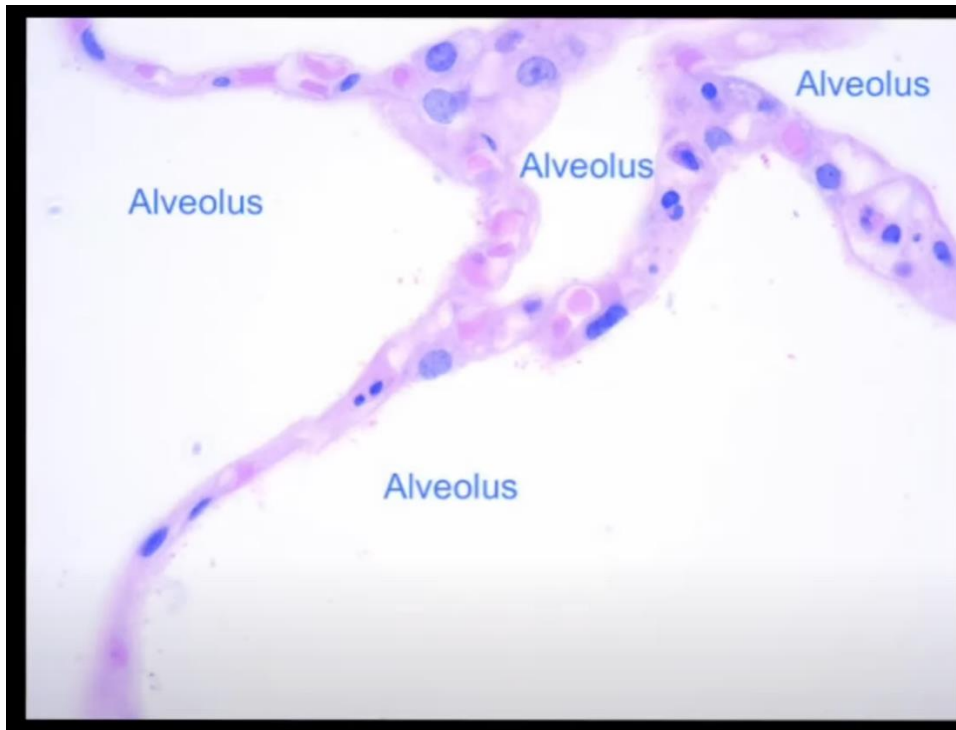


Oxygenated blood going to heart

Type I Pneumocytes are thin, flat cells which allow gas exchange between the alveolus and capillaries.

### Pulmonary alveolus

- That's a cross-section of an air sac. The ping pong ball (air sac) is intimately associated with the tiniest blood vessels called capillaries. You can see **Type I Pneumocytes** and **Type II Pneumocytes**.
- [https://en.wikipedia.org/wiki/Pulmonary\\_alveolus](https://en.wikipedia.org/wiki/Pulmonary_alveolus)



#### 6.4 Type I and II Pneumocytes

- Summary
  - This is a short and sweet 1-minute video showing the difference between **Type 1** and **Type 2 pneumo-cytes**. Of note, lung anatomy is pretty complex and it can take, as in hours to weeks, to figure it out.
- Source
  - YouTube Video: [Stephanie Castle](#)
  - Image: [Dr. P Takizawa](#), Yale Histology
  - <https://www.youtube.com/watch?v=RjWT0eNw40o&t=62s>

#### *Wheater's Functional Histology: A Text and Colour Atlas*

- See page 143.

## Type II Pneumocyte

See the sources above for Type I Pneumocyte.

### Type II Pneumocyte

- Point of clarity
  - The **Type II Pneumocyte** makes **surfactant** (“sir fact unt”). It’s a fluid that coats the interior of the **ping pong ball (air sac)**. But this isn’t the fluid that fills up the air sac when under severe attack by the coronavirus. The ‘bad’ fluid is due to a dramatic response by the immune system, causing fluid from the capillary to enter the air sac. This gets *very* complicated. See ARDS below.

## ARDS

## Acute Respiratory Distress Syndrome (ARDS)

- Summary
  - In **ARDS** (“A, R, D, S”) the lungs get beat up badly like in those street fights where a guy is on the ground and five thugs are kicking him. The thugs in this case are the immune system going on a rampage, kicking anything in the way, even the victim they are supposed to protect. Of course, this never happens to **Jack Reacher**.
  - There is damage all over the air sac. The fancy term is **Diffuse Alveolar Damage (DAD)**.
  - The lining of the capillary (tiny blood vessel) also gets beat up. The lining is called **endothelium** (“en dough thee lee um”). Getting beat up is called **endothelial injury**.
  - Fluid leaks from the capillary into the lungs. This fluid is called **exudate** (“ex you date” or “eggs you date”).
  - This is a very technical paper. Full-on medicalese.
- Verbatim
  - ARDS is associated with diffuse alveolar damage (DAD) and lung capillary endothelial injury. The early phase is described as being exudative, whereas the later phase is fibroproliferative in character.
- Source
  - Medscape
    - 27 March 2020
- Author
  - **Eloise M Harman, MD** Staff Physician and MICU Director, Pulmonary Division, Gainesville Veterans Affairs Medical Center
- Co-authors
  - **Leonard E Riley, MD** Assistant Professor of Medicine, Associate Program Director, Pulmonary and Critical Care Fellowship, Division of Pulmonary, Critical Care and Sleep Medicine, Department of Medicine, University of Florida College of Medicine
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- Acknowledgements
  - **Francisco Talavera, PharmD, PhD**. Adjunct Assistant Professor, University of Nebraska Medical Center College of Pharmacy; Editor-in-Chief, Medscape Drug Reference
  - **Rajat Walia, MD** Assistant Professor of Medicine, Division of Pulmonary and Critical Care Medicine, University of Florida College of Medicine

## Light's Criteria

- Summary
  - This is the tip of the iceberg of how complex lung physiology (function) is.
  - **Richard Light** was a doctor who advanced this knowledge.
- Verbatim
  - **Transudative effusion** occurs when fluid permeates the pleural cavity via intact pulmonary vessels, often associated with conditions like congestive heart failure (CHF). Conversely, **exudate** refers to fluid escaping into the pleural space through lesions in blood and lymph vessels due to inflammation.
- Source
  - Medscape
    - 20 December 2023
    - [https://emedicine.medscape.com/article/2172232-overview#?&icd=login\\_success\\_email\\_match\\_fpf](https://emedicine.medscape.com/article/2172232-overview#?&icd=login_success_email_match_fpf)
- Author

- **Swarup Sri Varaday, MD**, FRCA, FCARSI Associate Professor of Anesthesiology (Obstetric Anesthesiology), Co-Lead of Perioperative Department, Washington University in St Louis School of Medicine
- Chief Editor
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- Additional Contributors
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# Page 148 – What if the virus lands on your eyeball?

## ACE2 Receptors on the conjunctiva

### Some background

- The **conjunctiva** is the transparent layer that covers the white of the eye.

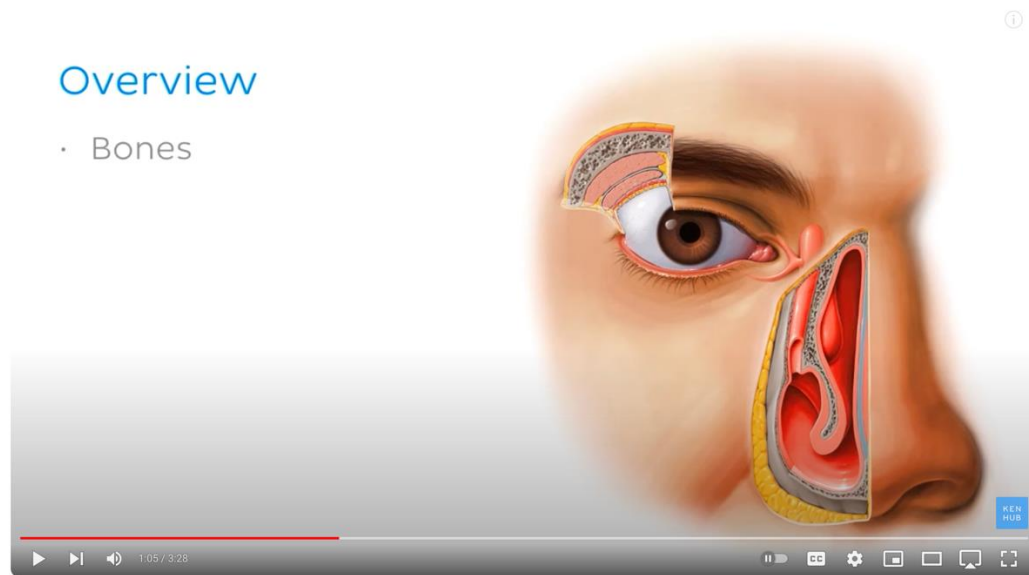
### *Many Faces of Renin-angiotensin System - Focus on Eye*

- **The ACE2 Receptor (Rc)** may play a role in **aqueous humor dynamics**. (Your eyeball has 2 fluid-filled regions: the **aqueous humor** in front of the lens, and the **vitreous humor** behind the lens.)
- **ACE2 Rc activation** → **dec retinal ganglion cell death** in **hyperglycemic rats**.
- **Open Ophthalmology Journal**
- 19 June 2017
- **Mervi Holappa**,<sup>1</sup> **Heikki Vapaatalo**,<sup>2</sup> and **Anu Vaajanen**<sup>3,4</sup>
- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5510558/>

### *Mechanism of the action between the SARS-CoV S240 protein and the ACE2 receptor in eyes*

- Verbatim
  - Positive expression of ACE2 was also detected in human conjunctival and corneal epithelial cells, however, ACE2 expression in human ocular surface is much less than in human lung and kidney tissues. **The binding capability of ACE2 protein on conjunctival epithelial cells to SARS-CoV spike protein is much lower than that on Vero E6 cells and that in lung tissues** [38][39][40][41]
- **International Journal of Ophthalmology**
  - **August 2006**
  - **Sun Y, Liu L, Pan X, Jing M**
  - **An ophthalmologist is a medical doctor who specializes in eye surgery.**
- [https://www.researchgate.net/publication/289011231\\_Mechanism\\_of\\_the\\_action\\_between\\_the\\_SARS-CoV\\_S240\\_protein\\_and\\_the\\_ACE2\\_receptor\\_in\\_eyes](https://www.researchgate.net/publication/289011231_Mechanism_of_the_action_between_the_SARS-CoV_S240_protein_and_the_ACE2_receptor_in_eyes)

# Page 149 – Crying (Lacrimal apparatus)



## Overview

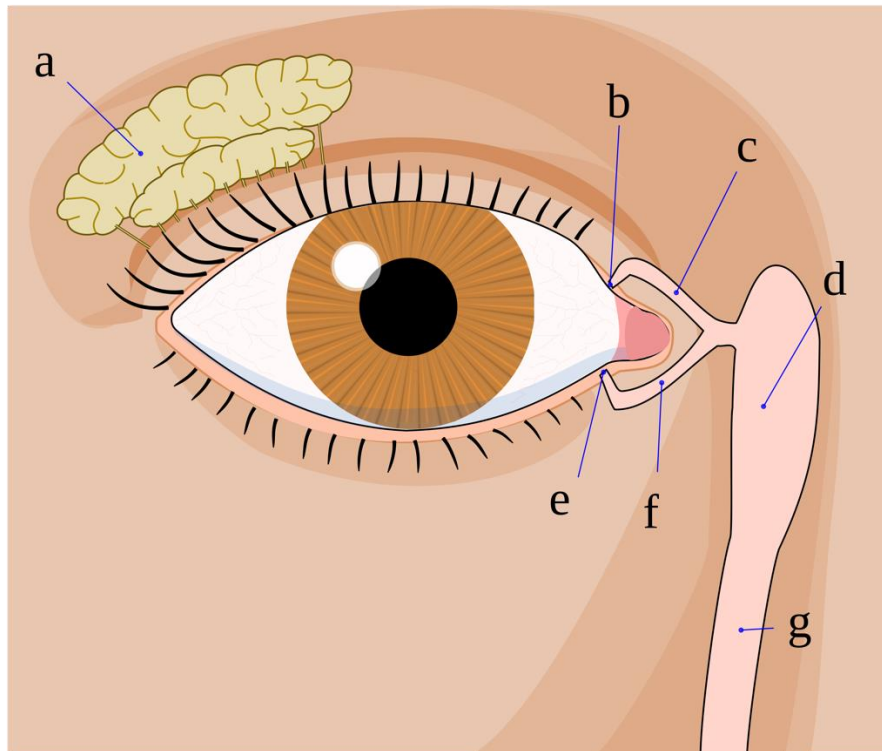
- Bones

Lacrimal apparatus: gland, canaliculi, duct and other structures (preview) - Human anatomy | Kenhub

Kenhub - Learn Human Anatomy 1.22M subscribers [Subscribe](#) [894](#) [Share](#) [Thanks](#) [Clip](#) [Save](#) [...](#)

*Lacrimal apparatus: gland, canaliculi, duct and other structures (preview) - Human anatomy | Kenhub*

- Summary
  - This 3-minute video describes the bones and anatomy of the structures that allow you to cry.
- Source
  - Kenhub is a fantastic anatomy resource. Their videos are great.
    - <https://www.youtube.com/watch?v=bBRwhv61x4k>



[https://en.wikipedia.org/wiki/Nasolacrimal\\_canal](https://en.wikipedia.org/wiki/Nasolacrimal_canal)  
[https://en.wikipedia.org/wiki/Nasolacrimal\\_duct](https://en.wikipedia.org/wiki/Nasolacrimal_duct)

## Page 150 – Can you swallow coronavirus?

*Digestive system is a potential route of COVID-19: an analysis of single-cell coexpression pattern of key proteins in viral entry process*

- Summary
  - The *coronavirus* can sometimes survive the acid in the stomach and therefore enter the intestine and infect the cells there. Specifically, it can infect the cells that form the inner lining of the small intestine. Those cells are called **entero-cytes**, which literally mean *gut cell*.
- Verbatim
  - Although most virus would be dead in the strong acid environment in the stomach, there is still a possibility that the saliva and secretions could carry the virus into the digestive tract where viral replication may be sustained in these susceptible cells. Thus, the enteric symptom of **diarrhoea** might be associated with the infected ACE2-expressing and TMPRSS2-expressing enterocytes. This could also help explain the fact that 10% of patients presented with **diarrhoea** and nausea 1 or 2 days before the development of fever and respiratory symptoms.<sup>6</sup>

- Source
  - Gut
    - June 2020
    - <https://gut.bmj.com/content/69/6/1010>
- Authors
  - Here are all the authors. Surname in bold.
    - Hao **Zhang**
    - Zijian **Kang**
    - Haiyi **Gong**
    - Da **Xu**
    - Jing **Wang**
    - Zhixiu **Li**
    - Zifu **Li**
    - Xinggang **Cui**
    - Jianru **Xiao**
    - Jian **Zhan**
    - Tong **Meng**
    - Wang **Zhou**
    - Jianmin **Liu**
    - Huji **Xu**
- Institutions
  - And here's where everybody is from.
  - Changzheng Hospital, Second Military Medical University, [Shanghai, China](#)
  - Peking-Tsinghua Center for Life Sciences, Tsinghua University, [Beijing, China](#)
  - Tongji Hospital affiliated to Tongji University School of Medicine, [Shanghai, China](#)
  - Institute for Glycomics, Griffith University, [Southport, Australia](#)

## Gut

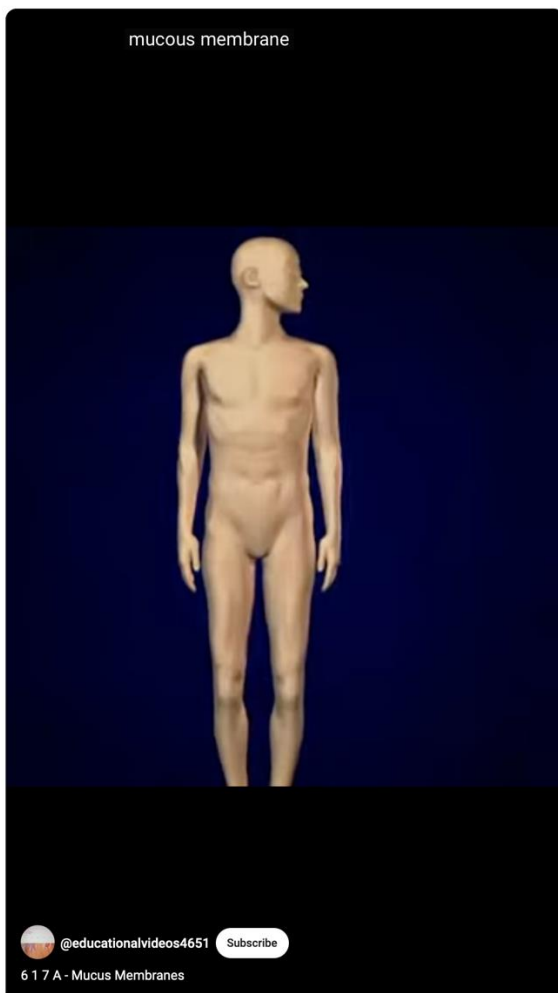
- Summary
  - The medical journal *Gut* is published by the British Society of Gastroenterology.
- What doctors get involved in the gut?
  - **Gastro-enterologist**
    - This doctor is a specialist of the abdominal organs.
    - The specialty is called **Gastro-enterology**.
    - This is the doctor who most commonly performs a colonoscopy to screen for Colon Cancer.
  - **Hepatologist**
    - This is a subspecialist of gastro-enterology who is focused on diseases of the liver.
    - The specialty is called **Hepatology**.
  - **General Surgeon**
    - This surgeon operates on the abdominal organs. For example, remove your appendix (**appendectomy**) (“app en deck tow me”).
    - The specialty is called **General Surgery**.
  - **Hepato-biliary Surgeon**
    - This surgeon focuses on the liver. They might do a liver transplant.
    - That's pronounced, “hep at tow bill ee air ee.”
- Verbatim
  - *Gut* is a leading international journal in gastroenterology and hepatology and has an established reputation for publishing first class clinical research of the alimentary tract, the liver, biliary tree and pancreas. *Gut* delivers up-to-date, authoritative, clinically oriented coverage in all areas of gastroenterology and hepatology. Regular features include articles by leading authorities describing novel mechanisms of disease and new management strategies, both diagnostic and therapeutic, likely to impact on clinical practice within the foreseeable future.



- *Gut* is an official journal of the **British Society of Gastroenterology**.
- Source
  - British Medical Journal
    - This is kind of the parent organization. Beyond my understanding at this point.
    - <https://gut.bmj.com>

# Page 151 - Mucous Membranes & Excretion versus Secretion

## Mucous Membrane



### mucous membrane

- Summary
  - This is a short and sweet 20-second video on mucous membranes.
- Source
  - Educational Videos
    - <https://www.youtube.com/shorts/dKDAPcSwtbU>

### Mucosa

- Summary
  - This steps it up a bit from the previous 20-second video and describes the 3 layers that make up a mucous membrane.
- Source
  - Cleveland Clinic
    - The Cleveland Clinic always has solid medical information.
    - <https://my.clevelandclinic.org/health/body/23930-mucosa>

## Excretion versus Secretion

### Excretion-Secretion

- Summary
  - There is something charming about the explanation of Excretion versus Secretion in this 3-minute video. The narrator talks slowly – and ironically because of a lack of *secretions* in his mouth – he has that tacky kind of enunciation. Nevertheless, it's got a great little table comparing excretion and secretion in both humans and plants so you understand the concept even better.
- Source
  - Mahi's Biology
    - <https://www.youtube.com/watch?v=i6YHlhHHHlw&t=3s>

### Drug Excretion

- Summary
  - This is a bit on the technical side. It's about how the drugs you are prescribed are eventually excreted from the body. After all, these drugs don't stay in you indefinitely.
  - The kidneys excrete drugs that can dissolve in water. That way they end up in your urine.
  - The liver helps out by attaching sugars to the drugs so they become water soluble.
  - This whole topic, which is insanely important, involves serious chemistry and lots of knowledge about how cells and cell membranes function.
  - But give it a go! You'll learn some good stuff.
- Verbatim
  - The kidneys are the principal organs for excreting water-soluble substances. The biliary system contributes to excretion to the degree that drug is not reabsorbed from the gastrointestinal (GI) tract.
- Translation
  - The **biliary system** refers to the massive network of tiny ducts inside the liver. All these ducts are made of tiny liver cells.
- Source
  - Merck Manual – Professional Version
    - June 2022
    - <https://www.merckmanuals.com/en-ca/professional/clinical-pharmacology/pharmacokinetics/drug-excretion>
- Author

- **Jennifer Le, PharmD**, MAS, BCPS-ID, FIDSA, FCCP, FCSHP, Skaggs School of Pharmacy and Pharmaceutical Sciences, University of California San Diego
  - If you remember from page 2, a pharmacist working at a pharmacy has a **Bachelor of Pharmacy** degree which is abbreviated at **B. Pharm** (or **PharmB**). If that same pharmacist does loads more academic and clinical study, they are now a **Doctor of Pharmacy** which is abbreviated as **D. Pharm** (or **PharmD**).
  - Point is, this rather technical article required the knowledge of a PharmD.

# Page 152 – Sarin gas & Cystic Fibrosis (CF)

## Sarin gas

The memory trick to remember the effects of **sarin gas** is **SLUDGE BAM**.

- **S – Salivation**
- **L – Lacrimation** (“lack rim a shun”). That means tears flowing from the eyes.
- **U – Urination** (pee, but it is involuntary).
- **D – Defecation** (poop, but it is involuntary).
- **G – GI cramps**. GI means gastro-intestinal. Basically, stomach cramps.
- **E – Emesis** (“em s iss”). That means vomiting.
- **B – Broncho-rrhea** (“brong kow” – kow rhymes with low – “ree ah”). That means excessive secretions in the airways of the lungs. **Broncho-constriction**. That means the airways constrict (they narrow in diameter) so less air flows ... this can be life threatening.
- **A – Abdominal upset** – kind of a catch-all term for the cramps and vomiting.
- **M – Miosis** (“my oh siss”). That means the pupils constrict. To be clear, the normal diameter of the pupils is **2 – 4 mm**. So a constricted pupil, would be like **1 mm** in diameter, like a small dot.

### *Nerve Agent and Organophosphate Pesticide Poisoning*

- Summary
  - Sarin gas is an **organo-phosphate**. Organo-phosphates are pesticides in small quantities but toxic to humans in higher doses.
  - On the left side of this CDC page is A-Z menu of Chemical Emergencies – some of which are chemical warfare agents.
- Source
  - **Centers for Disease Control and Prevention (CDC)**
    - 4 April 2018
    - <https://emergency.cdc.gov/agent/nerve/tsd.asp>

## Cystic Fibrosis (CF)

Some background

- **Mucous is not a bad thing – in fact it's a very necessary thing.** For example, the mucous lining of the airways in the lungs traps bacteria and viruses. You need that mucous. The problem in **Cystic Fibrosis** is that our thin, slick mucous is replaced by thick mucous that won't move ... so now the trapped bacteria and viruses multiply and spread in the lungs.
- But there is an opposite scenario. Remember the **1918 Influenza virus**? It beat the crap out the lungs, breaking down the protective mucous layer. So now bacteria could more easily invade – the 'superinfection' (see pages 24 and 28 in *Hidden Zoo* for details).
- Get it? **There is a Goldilocks amount of mucous.** *Too thick* and it's **Cystic Fibrosis**. *Too thin* and it's a **bacterial superinfection**. As a broad generality – it's more complex than this.

### Cystic fibrosis

- Summary
  - **This is a very good summary of Cystic Fibrosis (CF).**
  - "siss tick"
  - "fy" – fy rhymes with eye – "bro siss."
  - **There is a 7-minute video narrated by a lung specialist a.k.a. respirologist ("resp er all oh jist") a.k.a. pulmonologist ("pull mon all oh jist").**
- Source
  - Mayo Clinic
    - 23 November 2021
    - Mayo Clinic Staff
    - <https://www.mayoclinic.org/diseases-conditions/cystic-fibrosis/symptoms-causes/syc-20353700#:~:text=Cystic%20fibrosis%20is%20a%20disorder,mucus%2C%20sweat%20and%20digestive%20juices.>

## CHAPTER 5 – THE HORRENDOUSLY CONFUSING WORLD OF DROPLETS, AEROSOLS, PARTICLES, MASKS AND SOCIAL DISTANCING

Page 153

# Page 154 – Respirators

### Respirator Fact Sheet

- Summary
  - **This a description of the 5 kinds of respirators that are used to protect your lungs from harmful substances.**
- Verbatim (the bold items are theirs, not mine)
  - Gas mask
    - They filter or **clean chemical gases and possibly particles.**
    - Gas Masks are effective only if used with the correct cartridge or filter (these terms are often used interchangeably) for a particular biological or chemical substance. Selecting the proper filter can be a complicated process. There are cartridges available that protect against more than one hazard, but **there is no "all-in-one" filter that protects against all substances.** You need to know what hazards you will face in order to be certain you are choosing the right filters.
  - Escape respirator.

- Escape respirators are designed to be **used only in an emergency, and only to escape from a dangerous area to a safe area.** There are several escape respirators on the market. Many of them use a hood with a neck seal instead of a facepiece. They are typically designed for one-time use for a short period, typically 15 minutes to 1 hour. They may be available in a variety of sizes and will fit most adults. Individuals with small or very large neck sizes may not be able to use some escape hood designs-check the supplier product information before purchasing.
  - Self-Contained Breathing Apparatus (SCBA)
    - Self-Contained Breathing Apparatus (SCBA) is the respirator commonly used by firefighters. These **use their own air tank to supply clean air, so you don't need to worry about filters.** They also protect against higher concentrations of dangerous chemicals. However, they are very heavy (30 pounds or more), and require very special training to use and to maintain them. Also, the air tanks typically last an hour or less depending upon their rating and how hard you are breathing.
  - Powered Air-Purifying Respirator (PAPR)
    - Powered air-purifying respirators **use a fan to blow air through the filter** to the user. They are easier to breathe through and they need **a fully charged battery to work properly.** They use the same filters as gas masks, so you need to know what the hazard is, and how much of it is in the air.
  - Particulate respirator (for example, N95 mask)
    - Particulate respirators are the simplest, least expensive, and least protective of the respirator types available. These respirators **only protect against particles.** They do not protect against chemicals, gases, or vapors, and are intended only for low hazard levels.
- Source
  - The source of the information is the **National Personal Protective Technology Laboratory (NPPTL)** which is an arm of the **National Institute for Occupational Safety and Health (NIOSH)** which is an arm of the **Centers for Disease Control and Prevention (CDC)**.
  - Get it? **CDC > NIOSH > NPPTL**
    - <https://www.cdc.gov/niosh/npptl/topics/respirators/factsheets/respfact.html>

### Mining Topics

- Summary
  - **This is all about safety for miners, and includes stuff like methane gas, dust and respiratory diseases.**
- Source
  - **National Institute for Occupational Safety and Health (NIOSH)**
    - <https://www.cdc.gov/niosh/mining/topics/index.html>

### Personal thought

- **Considering the 5 types of respirators described above, think about how *unimaginably ineffective* a cigarette filter is – it allows all kinds of smoke into your lungs. You end up with **emphysema** (destruction of lung tissue) and **lung cancer**. No firefighter would ever want such a filter when fighting a fire. So why would you accept that filter for burning tobacco leaves in a cigarette? The answer is ... drum roll please ... nicotine is incredibly addictive ... the official medical term is **Nicotine Use Disorder**... but that's a topic for another book. Stay tuned.**

# Page 155 – Self-Contained Breathing Apparatus (SCBA) & N95

## Self-Contained Breathing Apparatus (SCBA)



*Self-contained Breathing Apparatus*

- Those firefighters are equipped with a **Self-Contained Breathing Apparatus (SBCA)**.
- [https://en.wikipedia.org/wiki/Self-contained\\_breathing\\_apparatus](https://en.wikipedia.org/wiki/Self-contained_breathing_apparatus)

NIOSH



### About NIOSH

- Summary
  - The National Institute for Occupational Safety and Health (NIOSH) is the arm of the CDC devoted to workplace health and safety. It was created in 1970 under POTUS Richard Nixon. They have 1300 employees. The headquarters are in Washington, DC.
  - I like their logo.
- Verbatim
  - NIOSH has the mandate to assure “every man and woman in the Nation safe and healthful working conditions and to preserve our human resources.”
- Semantics (a thing I obsess about)
  - We never say “Safety and Health” – unless it’s to make an acronym like NIOSH (“Ny osh”).
  - We always say “Health and Safety” – so NIOHS (“Ny – ohs”) would have been fine by me.
  - Obviously I am wasting valuable neurons on this.
- Source
  - National Institute for Occupational Safety and Health (NIOSH)
    - 12 April 2023
    - <https://www.cdc.gov/niosh/about/default.html>

## N95 mask

### NIOSH-Approved Particulate Filtering Facepiece Respirators

- Summary
  - Technical details on the N95 mask.
- Source
  - National Institute for Occupational Safety and Health (NIOSH)
    - 15 Sep 2021
    - [https://www.cdc.gov/niosh/npptl/topics/respirators/disp\\_part/](https://www.cdc.gov/niosh/npptl/topics/respirators/disp_part/)

### 3M™ Particulate Healthcare Respirator, 1860, N95, 120 per case

- Summary
  - Technical details on the N95 healthcare mask.
- Source
  - 3M
    - 3M is a gigantic company with 92,000 employees. They make **Post-It Notes** and many other things.
    - [https://www.3mcanada.ca/3M/en\\_CA/p/d/v000057463/](https://www.3mcanada.ca/3M/en_CA/p/d/v000057463/)

### N95 Masks Explained

- Summary
  - This shows an N95 mask with an **exhale valve**. The exhale valve mask is not used in hospitals because the user can exhale infectious agents.
- Source
  - Honeywell

- Honeywell is a gigantic company – it has 100,000 employees. They make **avionics** which is the electronics in aircraft, and lots of other stuff.
- <https://www.honeywell.com/us/en/news/2020/03/n95-masks-explained>

## Some history

### N95 Respirators and Surgical Masks

- Summary
  - 1900 – **Cotton gauze masks** for surgery.
  - 1919 – **US Bureau of Mines** establishes respirator standards for masks worn in mines and for gas warfare.
- Source
  - National Institute for Occupational Safety and Health (NIOSH)
    - NIOSH Science Blog
    - <https://blogs.cdc.gov/niosh-science-blog/2009/10/14/n95/>

## More N95 theory

### N95

- **Aerosol**
  - 1 hour =  $t_{1/2}$
  - 4 – 24 h = time to decay 1000-fold
- **Surface**
  - 1 - 7 hour =  $t_{1/2}$
  - 4 – 96 h = time to decay 1000-fold
  - Importantly, what's on that **surface**?
    - Live **virion**
    - mRNA that can be *detected* but is not *infectious*
- **N95 mask**
  - **Standard**
    - Removes 95% of **particles** 0.3  $\mu\text{m}$  (300 nm)
  - In *reality* (it's good news)
    - Removes 99.8% of **particles** 0.1  $\mu\text{m}$  (100 nm)
  - **SARS-CoV-2**
    - 0.1  $\mu\text{m}$  diameter (100 nm) ... so the **N95** stops them.
  - **Resp droplet**
    - **Small** < 5  $\mu\text{m}$  (< 5000 nm)
      - Evaporate into **droplet nuclei** and remain suspended
        - **Measles virus** transmitted this way.
        - **SARS-CoV-2** transmitted this way? Does NOT seem so.
      - **Cough**
        - 1  $\mu\text{m}$  (1000 nm)
        - It's a **small resp droplet**.
    - **Large** > 5  $\mu\text{m}$  (> 5000 nm)
      - Fall rapidly to **ground** (or **surface**)
      - This is thought to be the way **SARS-CoV-2** is mainly transmitted.
      - **Sneeze**
        - 100  $\mu\text{m}$  (100,000 nm)



- It's a very large resp droplet.
- Efficacy
  - **How can an N95 300 nm filter stop a 100 nm virus? (My question)**
  - My Answer
    - The virus is carried in a droplet > 300 nm.
    - Even a small droplet is 3 um (3000 nm) which is 10x bigger.
    - And a large droplet is 5+ um (5000 nm) which is about 170 x bigger.
  - **CIDRAP**
    - Nothing about nm mentioned in their April 2020 1-page article (NOT written by Dr. Osterholm).
  - **Medscape**
    - It's a summary of meta-analysis by Dr Derek Chu MD PHD McMaster Univ.
    - Basically, N95 works and is recom for HCW.
    - And if wear eye protections, dec from 16% to 5% tx.
    - <https://www.medscape.com/viewarticle/931551>
  - **Research Gate 1**
    - MS2 virus used to test N95 mask.
    - Virus is 10 – 80 nm diameter.
    - It seems the mask underperforms as more than 5% of virions got through. It's only an Abstract so no more info.
    - Verbatim
      - Respiratory protection devices are used to protect the wearers from inhaling particles suspended in the air. Filtering face piece respirators are usually tested utilizing nonbiologic particles, whereas their use often aims at reducing exposure to biologic aerosols, including infectious agents such as viruses and bacteria. The performance of 2 types of N95 half-mask, filtering face piece respirators and 2 types of surgical masks were determined. The collection efficiency of these respiratory protection devices was investigated using MS2 virus (a nonharmful simulant of several pathogens). The virions were detected in the particle size range of 10 to 80 nm. The results indicate that the penetration of virions through the National Institute for Occupational Safety and Health (NIOSH)-certified N95 respirators can exceed an expected level of 5%. As anticipated, the tested surgical masks showed a much higher particle penetration because they are known to be less efficient than the N95 respirators. The 2 surgical masks, which originated from the same manufacturer, showed tremendously different penetration levels of the MS2 virions: 20.5% and 84.5%, respectively, at an inhalation flow rate of 85 L/min. The N95 filtering face piece respirators may not provide the expected protection level against small virions. Some surgical masks may let a significant fraction of airborne viruses penetrate through their filters, providing very low protection against aerosolized infectious agents in the size range of 10 to 80 nm. It should be noted that the surgical masks are primarily designed to protect the environment from the wearer, whereas the respirators are supposed to protect the wearer from the environment.
      - [https://www.researchgate.net/publication/7285837\\_Do\\_N95\\_respirators\\_provide\\_95\\_protection\\_level\\_against\\_airborne\\_viruses\\_and\\_how\\_adequate\\_are\\_surgical\\_masks](https://www.researchgate.net/publication/7285837_Do_N95_respirators_provide_95_protection_level_against_airborne_viruses_and_how_adequate_are_surgical_masks)

- **Research Gate 2**
  - It is my question restated. But the writer *asks* the question on something of a blog. He does not answer it.
  - The question also arises, although the virus is smaller, would it (masks like n95 filter) help to eliminate the chances of contagion so that the mask stops drops loaded with viruses?
  - [https://www.researchgate.net/post/Which\\_mask\\_is\\_appropriate\\_in\\_COVID-19\\_pandemic](https://www.researchgate.net/post/Which_mask_is_appropriate_in_COVID-19_pandemic)
- Verbatim
  - N95 masks are designed to remove more than 95% of all particles that are at least 0.3 microns ( $\mu\text{m}$ ) in diameter (NIOSH 42 CFR Part 84). In fact, measurements of the particle filtration efficiency of N95 masks show that they are capable of filtering  $\approx 99.8\%$  of particles with a diameter of  $\sim 0.1 \mu\text{m}$  (Regnasamy et al. 2017).
  - SARS-CoV-2 is an enveloped virus  $\sim 0.1 \mu\text{m}$  in diameter, so N95 masks are capable of filtering most free virions, but they do more than that. How so?
  - Viruses are often transmitted through respiratory droplets produced by coughing and sneezing.
  - Respiratory droplets are usually divided into two size bins,
    - large droplets ( $> 5 \mu\text{m}$  in diameter) that fall rapidly to the ground and are thus transmitted only over short distances,
    - and small droplets ( $\leq 5 \mu\text{m}$  in diameter). Small droplets can evaporate into "droplet nuclei," remain suspended in air for significant periods of time and could be inhaled.
  - Some viruses, such as measles, can be transmitted by droplet nuclei (Tellier et al. 2019). At present there is no direct evidence showing SARS-CoV-2 transmission by droplet nuclei. Rather, larger droplets are believed to be the main vector of SARS-CoV-2 transmission, usually by settling onto surfaces that are touched and transported by hands onto mucosal membranes such as the eyes, nose and mouth (CDC 2020).
  - The characteristic diameter of large droplets produced by sneezing is  $\sim 100 \mu\text{m}$  (Han J. R. Soc. Interface 2013), while the diameter of droplet nuclei produced by coughing is on the order of  $\sim 1 \mu\text{m}$  (Yang et al 2007). Therefore, N95 masks likely protect against several modes of viral transmission.
  - e.life infographic
    - Weizmann Inst of Science , Revohot (30 km SSE of Tel Aviv)
    - [http://book.bionumbers.org/wp-content/uploads/2020/04/SARS-CoV-2\\_BTN\\_0401.pdf](http://book.bionumbers.org/wp-content/uploads/2020/04/SARS-CoV-2_BTN_0401.pdf)

# Page 156 – Fit Test

## Fit Test

### 3M Health Care Particulate Respirator and Surgical Masks

- Summary

- At the 26:33 mark of this YouTube video is the fit test of the N95 mask, specifically *Sweet & Bitter Fit Test Solutions*.
- Source
  - 3M Worker Health and Safety
    - 30 Sep 2013
    - <https://www.youtube.com/watch?v=LHHwVdcZPbs>

N95	N99	N100
R95	R99	R100
P95	P99	P100

### *NIOSH-Approved Particulate Filtering Facepiece Respirators*

- Summary
  - Technical details on mask variations:
    - N
      - N95 N99 N100
    - R
      - R95 R99 R100
    - P
      - P95 P99 P100
- Source
  - NIOSH / NPPTL
    - 15 Sep 2021
    - [https://www.cdc.gov/niosh/npptl/topics/respirators/disp\\_part/](https://www.cdc.gov/niosh/npptl/topics/respirators/disp_part/)

# Page 157 – Quick Brown Fox

### *Masks Under the Microscope - Viewed under a microscope, mask fabrics are complex, varied and beautiful.*

- Summary
  - These are electron microscope images of the fibers that make different masks.
  - In the 3<sup>rd</sup> image are 2 different masks. On the left is a **cotton flannel mask** (feels smooth to the touch), and on the right a **polyester mask**.
  - The 8<sup>th</sup> image is an **N95 mask**.
- Verbatim re: the 8<sup>th</sup> image which is an N95 mask.
  - While cotton is best for the fabric masks that the general public uses, medical-grade masks are a different story. This false-color image shows a cross section of one layer of an N95 respirator mask, including **filtering material, shown in purple**, and protective material around it. This layered structure then repeats for added protection. **The filtering material is made by melting and then air-blowing polypropylene, a type**

of plastic, into a chaotic web. The fibers are far smaller and have much greater surface area than **cotton fibers**, which is one reason this is an especially effective filtering material.

- Source
  - National Institute of Standards and Technology (NIST)
    - NIST sets reference standards for a huge number of things in science, for example the official time in the USA, via an atomic clock. NIST is a branch of the **US Department of Commerce**.
    - 9 March 2021
    - <https://www.nist.gov/feature-stories/masks-under-microscope>
- Author
  - Rich Press

### Filter Pore Size and Aerosol Sample Collection

- Summary
  - Technical information on the pores (opening) of filters. It's pretty dry stuff but I liked their formula.
  - Estimation of pore size
    - $D = (4 \gamma \cos \theta / P) \times 10^6$
    - Where:
      - $D$  = pore diameter ( $\mu\text{m}$ )
      - $P$  = bubble-point air  $P$  (Pa)
      - $\gamma$  = surface tension of the liquid (N/m)
      - $\theta$  = contact angle b/w liquid and filter.
    - Take home from the formula:
      - Decreased pore size  $\rightarrow$  Increased air pressure required to get air to 'bubble' through the filter.
- Source
  - National Institute for Occupational Safety and Health (NIOSH)
    - *NIOSH Manual of Analytical Methods (NMAM), 5th Edition*
    - April 2016
    - <https://www.cdc.gov/niosh/docs/2014-151/pdfs/chapters/chapter-fp.pdf>
- Author
  - William G. Lindsley, PhD, NIOSH

# Page 158 – Uncle Walter & Guinea Pigs Who Died for Your Sins

### William F. Wells

- Bio
  - American scientist.
  - Born in 1886 in Boston.
  - No formal education mentioned in Wikipedia.
  - Wife Mildred is a physician. They have a son.

- Serves in WW1. Dies in 1963.
- Science
  - William F. Wells shows that **TB** is transmitted by **respiratory droplets**.
    - As per our modern understanding, **TB** is and airborne via droplets that are kept aloft in normal air currents for a prolonged (never defined how long in CDC article) period of time.
- Source
  - [https://en.wikipedia.org/wiki/William\\_F.\\_Wells](https://en.wikipedia.org/wiki/William_F._Wells)

### *What Nobody Needs to Know About Airborne Infection*

- Summary
  - **Author Richard Riley**
    - He personally knew **Wells** and calls him an **eccentric genius**. Even that Wells was annoying to **Riley's wife** with constant phone calls to his home. He also says to his "**eternal shame**" he did not mention **Wells** in his **seminal paper** on the topic; maybe his wife insisted he not be mentioned.
    - He is very complimentary towards **Cretyl Mills**, saying this of her work after **Wells** was out of commission with (unexplained) leg paralysis:
      - She knew where in the exposure chamber every infected guinea pig was housed and where in the lungs every tubercle was located.
- Experiment #1
  - **1954**
  - These are preparatory experiments and my sense from this paper is they occurred in 1954 also.
  - **Rabbits (in patient rooms!)** could be infected with **bovine TB** atomized into the ventilation system.
- Experiment #2
  - **1954**
  - These were experiments by **William Firth Wells**, **Richard Riley** (the author of this paper), and a woman named **Cretyl Mills** (great name).
  - **150 guinea pigs** are connected to **TB pts** at **VA Hospital, Baltimore**
  - **6** hospital rooms with **1 bed** for **TB+ human pts**.
  - **2 years** of data collection.
    - **Wells** is **seldom** in the hospital. Maybe **Riley** is bitter about this, as his language suggests:
      - Cretyl Mills was the one on the spot, feeding and caring for the guinea pigs, tuberculin testing all 150 in the exposure chamber every month, keeping all the records, and fending off people with complaints.
    - Riley says all this was stressful on the hospital admin. I get the sense he puts the blame on Wells.
  - Results
    - **3 guinea pigs / month catch TB**.
      - But here, **Riley** is **complimentary**: It was an example of **Wells'** **uncanny ability** to foresee the quantitative implications of the droplet nucleus concept.
- Experiment #3
  - **Basically the same experiment on a different set of 150 guinea pigs but the air is irradiated.**
    - **On the way to this control chamber the air was disinfected by ultraviolet irradiation, so that no animal could be infected by air.**
  - The **guinea pigs** do NOT get sick.
    - And, of course, she found no infections in the control chamber receiving disinfected air.

- **Cretyl Millis** does this bc Wells is out of commission.
  - This shows the uv killed the **TB** and that the **air** was the source of the transmission.
- Results
  - **1962** - The results appear in **1962** (while **Wells** is still alive):
  - **Riley, Mills, O'Grady, Sultan, Willstadt, Shivpuri**, *Infectiousness of air from a tuberculosis ward*. **Am Rev Respir Dis** **1962**;85:511–525
    - Notice that **Wells** name is not there.
    - It's a paper that is **1/2** laudatory, **1/2** complaint about **Wells**. Odd.
- Source
  - **American Journal of Respiratory and Critical Care Medicine**
    - **2001**
    - This is Ref 1 in Wik – Wells
    - <https://www.atsjournals.org/doi/full/10.1164/ajrccm.163.1.hh11-00>

### *The size and the duration of air-carriage of respiratory droplets and droplet-nuclei.*

- Summary
    - The author of this paper takes Wells's falling droplet measurements to the next level.
  - Findings
    - He studies 21,000 droplets from  $\frac{1}{4}$   $\mu\text{m}$  (250 nanometer) to 42  $\mu\text{m}$  diam.
    - 100+  $\mu\text{m}$  droplets fall to ground in 1-2 seconds.
    - 20  $\mu\text{m}$  droplets stay a lot for hours.
    - **Droplet nuclei** (and that is the term he uses) stay aloft for hours to days.
    - He points out that Wells experiments were on pure water.
    - *Streptococcus viridans*
      - It's a round bacteria.
      - *Streptococcus viridans* in droplet nuclei took 26 hours to die. (p472ii (it's one big paragraph))
      - 10 million – 100 million *Streptococcus viridans* / milli-liter of saliva.
        - He uses an average of 30 million for estimates.
        - So what is diameter of a 1 ml droplet?
        - $V = \frac{4}{3} \pi r^3$
        - $1 \text{ ml} = \frac{4}{3} \pi r^3$
        - $1 = \frac{4}{3} \pi r^3$
        - $0.25 = r^3$
        - $r = 0.63 \text{ cm} = 6.3 \text{ mm}$
        - $d = 1.3 \text{ cm}$ .
          - Yes, a sphere 1.3 cm in diameter.
          - Whereas a sugar cube is 1 cm per edge.
      - So how man *Strep viridans* in a droplet the size of a period?
    - He also calculates the number of droplet nuclei for a:
      - Cough with mouth closed: 751
      - Speaking loudly 100 words: 36
- Source
  - Epidemiology & Infection
    - 1946
    - This is ref no 2 in Wik – Wells curve
    - <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2234804/?page=1>
- Author
  - **J. P. Duguid** - Department of Bacteriology, Edinburgh University

# Page 159 – My personal uv light drone

Experiment #2 – see page 158

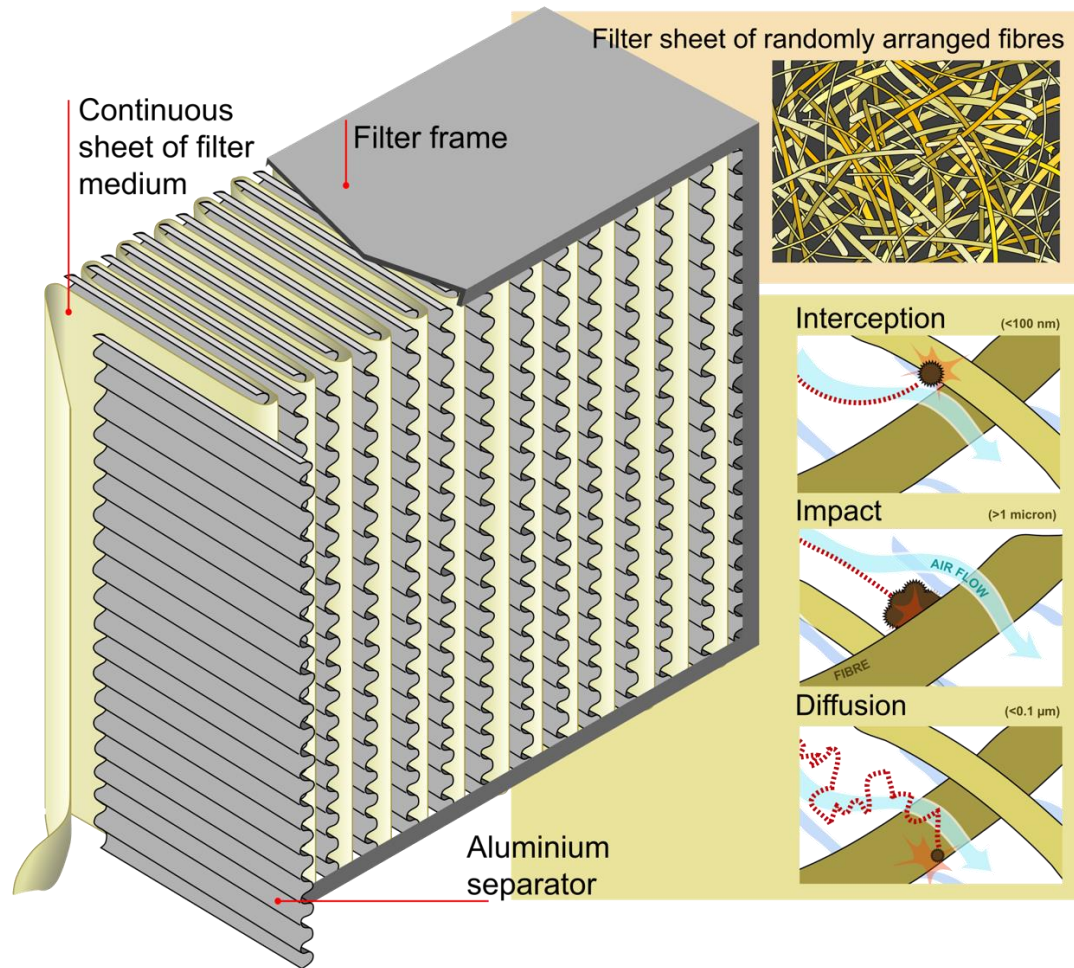
Experiment #3 – see page 158

# Page 160 – Negative Pressure Room

## Isolation Rooms & HEPA filters

*Expedient Patient Isolation Rooms - Engineering Controls To Reduce Airborne, Droplet and Contact Exposures During Epidemic/Pandemic Response*

- Summary
  - This has drawings of bed arrangements in hospital **isolation rooms**. And lots of semi-boring details.
- Source
  - National Institute of Occupational Safety and Health (NIOSH)
    - <https://www.cdc.gov/niosh/topics/pandemic/rooms.html>

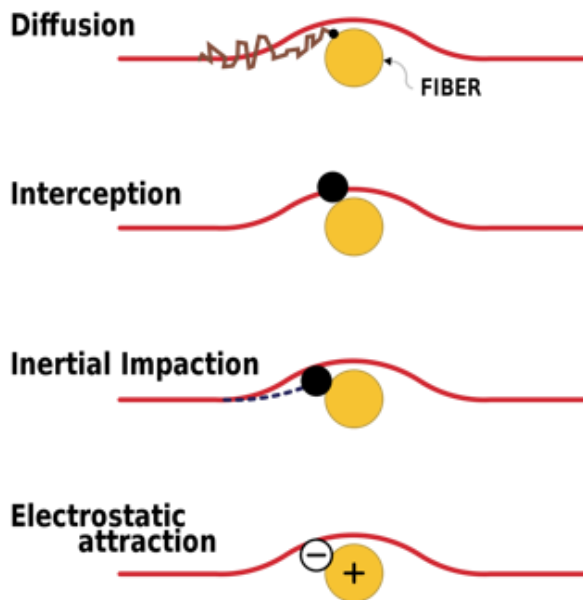


## HEPA

- Summary
  - That's a **High Efficiency Particulate Air (HEPA) filter**.
  - The standards that must be met are:
    - **Must remove 99.97% of 300 nm particles** (US Department of Energy standard).
      - So that is exactly like an N100 mask.
    - **Must remove 99.95% of 300 nm particles** (European standard).
- Source
  - <https://en.wikipedia.org/wiki/HEPA>



## Filtration Mechanisms

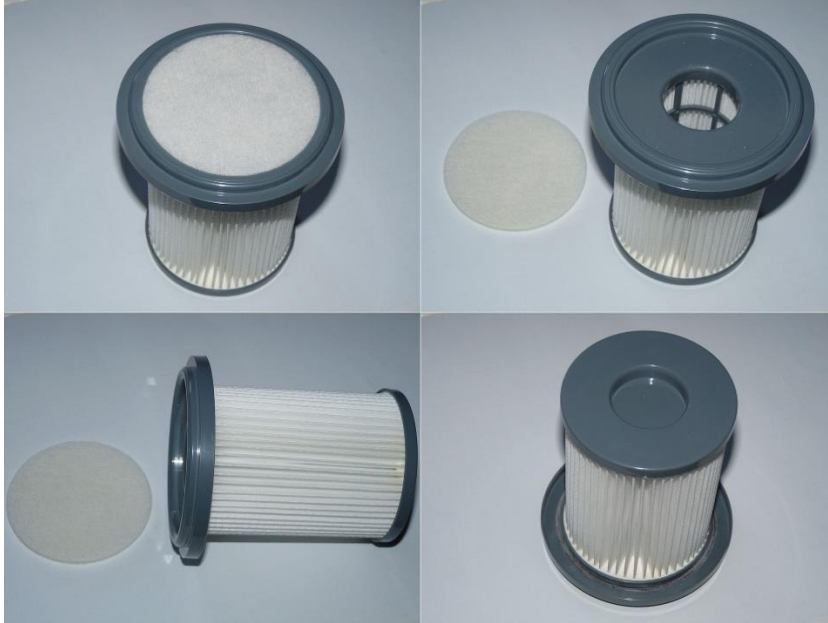


### HEPA

- Summary
  - The **HEPA filter** traps particles by 4 mechanisms:
    - **Diffusion**
      - Particle is delayed in its path through the filter.
      - Works for particles 0.3  $\mu\text{m}$  (300 nm).
    - **Interception**
      - Particle in the air stream comes within 1 radius of fiber and it intercepted.
      - Predominates for particles 0.4  $\mu\text{m}$  (400 nm).
    - **Impaction**
      - Particle embeds directly into the fiber.
      - Predominates for particles 0.4  $\mu\text{m}$  (400 nm).
    - **Electrostatic attraction**
      - Opposites attract.
- Source
  - <https://en.wikipedia.org/wiki/HEPA>

### Filter Pore Size and Aerosol Sample Collection

- Summary
  - Section 4 has details on **diffusion, interception, impaction, and electrostatic attraction.**
  - This article was mentioned also on page 157.
- Source
  - National Institute for Occupational Safety and Health (NIOSH)
    - *NIOSH Manual of Analytical Methods (NMAM), 5th Edition*
    - April 2016
    - <https://www.cdc.gov/niosh/docs/2014-151/pdfs/chapters/chapter-fp.pdf>
- Author
  - William G. Lindsley, PhD, NIOSH



That's the HEPA filter in a vacuum cleaner ... seems much less exotic now.

- <https://en.wikipedia.org/wiki/HEPA>

# Page 161 – The 5-micron dividing line you've never heard of: Droplet / Airborne

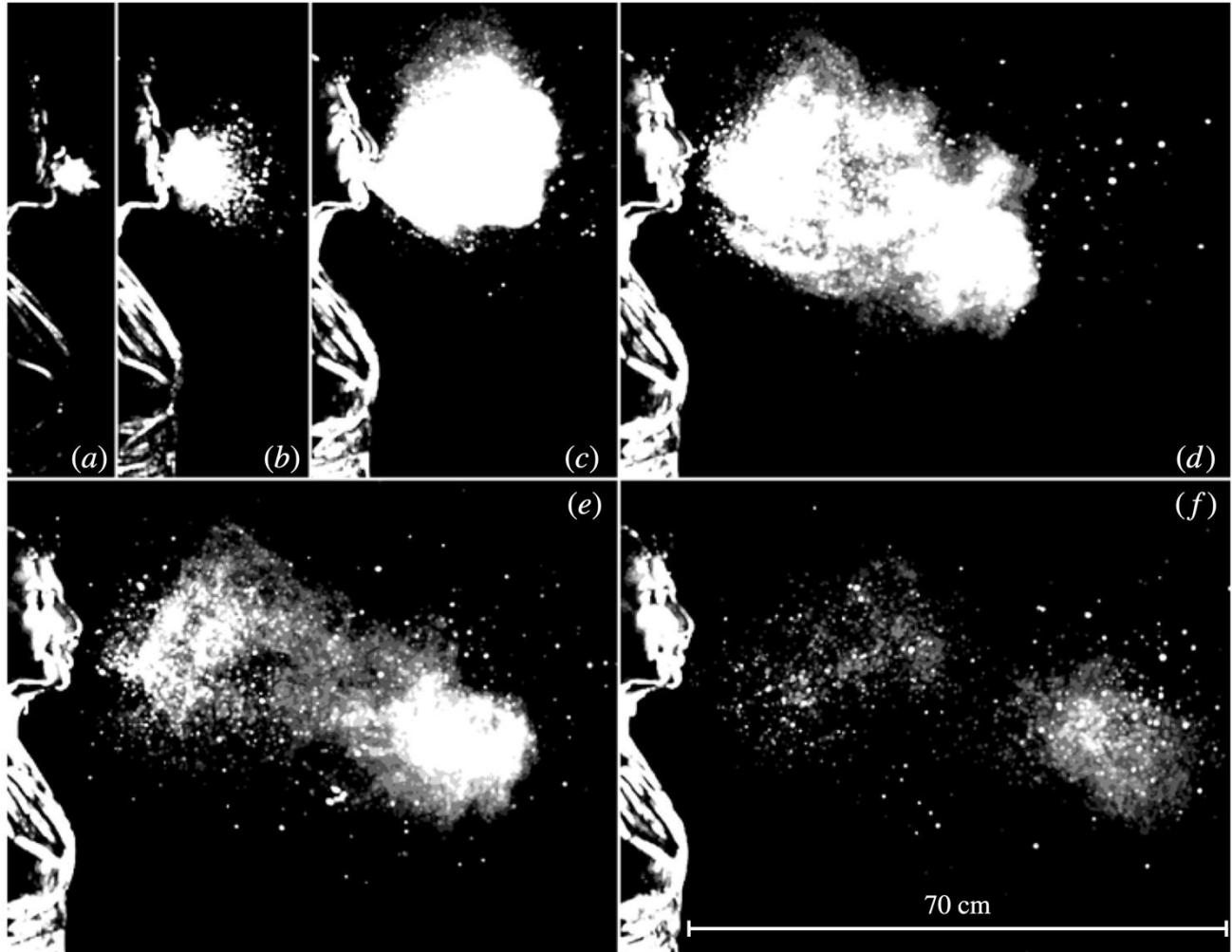
## Droplets

Think, diameter greater than 5 microns (5  $\mu\text{m}$ ).



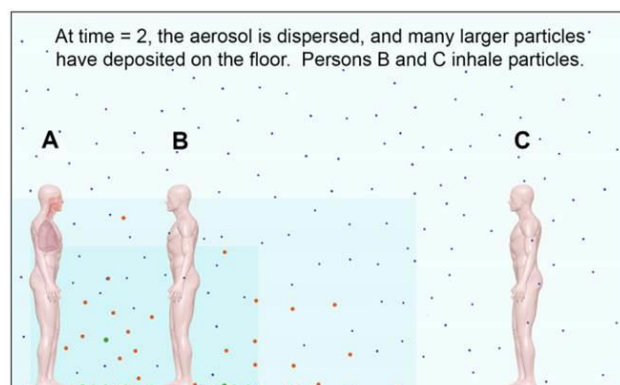
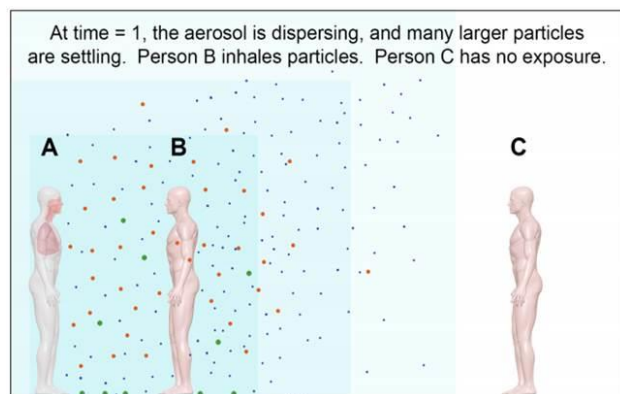
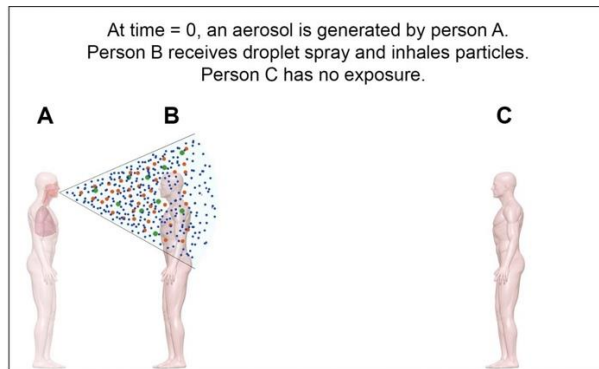
### Visualizing Speech-Generated Oral Fluid Droplets with Laser Light Scattering

- Summary
  - This is pretty cool. It's a 41-second video clip of laser light illuminating the **respiratory droplets** of a person saying "Stay healthy," with and without a mask. There are far fewer droplets when wearing mask.
- Source
  - New England Journal of Medicine (NEJM)
    - This is a top-tier medical journal.
    - 15 April 2020
    - [https://www.nejm.org/doi/full/10.1056/NEJMc2007800?query=recirc\\_mostViewed\\_railB\\_article](https://www.nejm.org/doi/full/10.1056/NEJMc2007800?query=recirc_mostViewed_railB_article)
- Authors
  - **Philip Anfinrud, Ph.D.** - National Institutes of Health, Bethesda, MD
  - **Valentyn Stadnytskyi, Ph.D.** - National Institutes of Health, Bethesda, MD
  - **Christina E. Bax, B.A.** - Perelman School of Medicine - University of Pennsylvania, Philadelphia, PA
  - **Adriaan Bax, Ph.D.** - National Institutes of Health, Bethesda, MD



*Violent expiratory events: on coughing and sneezing*

- Summary
  - There are high-speed photos at 1000 - 4000 frames per second (fps) of the droplets produced by people coughing and sneezing. See Figures 3, 4 and 5.
- Source
  - Journal of Fluid Mechanics
    - 2014
    - <https://thales.mit.edu/bush/wp-content/uploads/2014/04/Sneezing-JFM.pdf>
- Authors
  - Lydia Bourouiba – Massachusetts Institute of Technology (MIT)
  - Eline Dehandschoewercker – Massachusetts Institute of Technology (MIT)
  - John W. M. Bush – Massachusetts Institute of Technology (MIT)



**COMMENTARY: COVID-19 transmission messages should hinge on science**

- Source
  - Figures 1, 2, and 3 have nicely drawn, intuitive diagrams showing the dispersal of droplets and aerosols (which are simply droplets less than 5 microns in diameter).
- Source
  - **Centre for Infectious Disease Research and Policy (CIDRAP)**
    - This is at the University of Minnesota.
    - **Dr. Michael Osterholm** is director.
    - Drawings by **Absolute Science Illustration**.
    - 16 March 2020
    - <https://www.cidrap.umn.edu/news-perspective/2020/03/commentary-covid-19-transmission-messages-should-hinge-science>
- Author
  - **Dr. Lisa Brosseau**

## Cough & Sneeze

- 1 – 10  $\mu\text{m}$  = avg size of droplets produced by cough/sneeze = ((Chief of ID Loma Linda))
  - 1  $\mu\text{m}$  Cough / Sneeze avg size upper limit ((Chief of ID Loma Linda))
  - 10  $\mu\text{m}$  cough / sneeze avg size upper limit ((Chief of ID Loma Linda))
  - \* Fact: Masks can filter larger particles in the air, but carbon dioxide can easily be exhaled through the filters. Coronavirus particles are 120 nanometers, oxygen is 0.120 nanometers and carbon dioxide is 0.232 nanometers. The pore size in N95 masks is generally 100 to 300 nanometers, meaning the average single pore will allow 1667 oxygen molecules in and 862 carbon dioxide molecules out. Other masks have even larger pore sizes, so a mask can't restrict oxygen or carbon dioxide flow. It doesn't mean that the wearer does not feel restricted. However, the math and physics are not consistent with that feeling.
  - The mask is quite effective at blocking the droplets you are exhaling, coughing or sneezing. The average size of those droplets is 1,000 to 10,000 nanometers, so by wearing the mask, you prevent the droplets from entering into the air for someone else to inhale.
    - Jennifer Veltman MD, Chief of ID, Loma Linda Univ
    - <https://news.llu.edu/health-wellness/infectious-disease-physician-breaks-down-coronavirus-mask-myths>
- Cough (WHO)
  - Produces 300 droplet nuclei.
- Sneeze (WHO)
  - 0.5 – 12  $\mu\text{m}$  droplets x 40,000 at 100 m/s (WHO references Wells 1955 whereas droplet expt was 1934)
- WHO Verbatim
  - Published data have suggested that sneezing may produce as many as 40 000 droplets between 0.5–12  $\mu\text{m}$  in diameter (Cole & Cook, 1998; Tang et al., 2006) that may be expelled at speeds up to 100 m/s (Wells, 1955; Cole & Cook, 1998),
  - whereas coughing may produce up to 3000 droplet nuclei, about the same number as talking for five minutes (Cole & Cook, 1998; Fitzgerald & Haas, 2005; Tang et al., 2006). Despite the variety in size, large droplets comprise most of the total volume of expelled respiratory droplets. Further data on the behaviour of droplet dispersion in naturally generated aerosols are needed.
    - Natural Ventilation for Infection Control in Health-Care Settings.
    - WHO Guidelines 2009
    - <https://www.ncbi.nlm.nih.gov/books/NBK143281/>

## Droplet vs droplet nuclei

- CDC definition
  - "Cloud of infectious particles" > 5  $\mu\text{m}$  expose people within 3 feet.
  - When droplets are produced during a sneeze or cough, a cloud of infectious particles >5  $\mu\text{m}$  in size is expelled, resulting in the potential exposure of susceptible persons within 3 feet of the source person.
  - Source
    - CDC – Environmental Infection Control Guidelines: Background C: Guidelines for Environmental Infection Control in Health-Care Facilities (2003)
      - When droplets are produced during a sneeze or cough, a cloud of infectious particles >5  $\mu\text{m}$  in size is



- Drop
- Droplet
  - <500  $\mu\text{m}$ , as a *very loosely applied generality* because later on they refer to 3 mm droplets.
  - A water droplet cannot be cut in  $\frac{1}{2}$  with a knife. It just reforms due to surface tension. Wow.
- Terminal velocity
  - < 1 mm
    - Terminal velocity achieved within 2 m. Hmmm.
  - < 3 mm
    - Terminal velocity of 8 m/s
- Example (mine)
  - Drop from a leaky faucet
- [https://en.wikipedia.org/wiki/Drop\\_\(liquid\)](https://en.wikipedia.org/wiki/Drop_(liquid))

### Droplet infection

- Naturally produced droplets from humans:
  - Breathing, talking, sneezing, coughing
- Defintion based on 5  $\mu\text{m}$  size.
  - Small
    - < 5 $\mu\text{m}$
    - Droplet nuclei
      - It's the convention to call it this.
    - Potential to be inhaled into LRT ... where there are lots of Rc for entry.
    - Travel > 1m
    - Stay aloft for minutes to hours (CIDRAP)
      - Long-range inhalation possible.
      - "Viability decreases with time, not distance."
      - 3 hours was viability for SARS-Co-V and MERS-CoV.
  - Big
    - > 5  $\mu\text{m}$
    - Droplet
      - It's the convention to call it this.
    - Stay trapped in URT
    - Travel < 1m
    - Stay aloft for several minutes (CIDRAP)
- More definitions
  - Droplet nuclei <10  $\mu\text{m}$
  - Small droplet 10 – 60  $\mu\text{m}$
  - Large droplet 60+  $\mu\text{m}$
- Source – WHO book 2009
  - <https://www.ncbi.nlm.nih.gov/books/NBK143281/>

### Droplet transmission

- Defn
  - = Respiratory droplets carrying infectious pathogens.
  - = They travel directly from RT of infected person → susceptible mucosual surfaces of recipient, usually over short distances.
- Verbatim - CIDRAP
  - Droplet transmission is usually defined as "respiratory droplets carrying infectious pathogens [that] transmit infection when they travel directly from the respiratory tract of the infectious individual to susceptible mucosal surfaces of the recipient, generally over short distances, necessitating facial protection."<sup>3</sup>
  - <https://www.cidrap.umn.edu/news-perspective/2020/03/commentary-covid-19-transmission-messages-should-hinge-science>



- His reference 3 is [CDC](#)
- <https://www.cdc.gov/infectioncontrol/guidelines/isolation/>

## Droplets in Tokyo – who knew?



I took this photo in the elevator at the [Tokyo Metropolitan Government Building](#), basically Tokyo City Hall.



That's the [Tokyo Metropolitan Government Building](#) a.k.a. Tokyo City Hall. It's supposed to look like a computer chip in the shape of the [Notre Dame Cathedral](#) in Paris. Perhaps with imagination.

## Aerosol

Think, diameter less than 5 microns (5  $\mu\text{m}$ ).

### *A review of saliva: Normal composition, flow, and function*

- Summary
  - Saliva is 99% water and 0.3 – 1.5% solid matter (Duguid p475ia)
- Source
  - Journal of Prosthetic Dentistry
    - 2001
    - This is ref. 6 in Wik – Wells curve

### *Airway Mucus Function and Dysfunction*

- Summary
  - Airway mucous is 97% water.
  - And 3% solids: mucins, non-mucin proteins, salts, lipids, cellular debris.
  - I will assume mucous from nose is the same.

- Verbatim
  - Normal mucus is 97% water and 3% solids (mucins, non-mucin proteins, salts, lipids, and cellular debris).
- Source
  - New England Journal of Medicine
    - 2010
    - <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4048736/>

## Aerogel

- Defn
  - It's a suspension of *solid particles* or *liquid droplets* in the air.
  - It's a big, comprehensive definition, including everything from:
    - floating viruses
    - meningococcus in dust storms
    - smoke from a forest fire
    - aerosolized protonated nicotine
- Dope - Atmospheric scientist Molina terminology
  - This article, distinctly like Dr Osterholm, says:
    - Droplet > 5 um
    - Aerosol < 5 um
  - These are his exact words:
    - "Human atomization" of viruses arises from coughing or sneezing producing ...
      - [Virus-containing] "aerosols" (<5 um)
        - Aerosols are "efficiently dispersed" in air
        - "Inhaled airborne viruses" ... "deposit directly" into the human RT.
      - Virus-containing "droplets" (>5 um)
        - "Large droplets" ... "mainly settle" out of air.
  - Verbatim
    - "Transmission of COVID-19. Human atomization of viruses arises from coughing or sneezing of an infected person, producing virus-containing droplets (>5 μm) and aerosols (<5 μm). Virus transmission from person to person occurs through direct/indirect contact and airborne aerosol/droplet routes. Large droplets mainly settle out of air to cause person/object contamination, while aerosols are efficiently dispersed in air. Direct and airborne transmissions occur in short range and extended distance/time, respectively. Inhaled airborne viruses deposit directly into the human respiration tract."
  - More interesting words
    - "residence time" – that refers to how long a thing stays airborne.
  - Nasal breathing
    - 1 m/s
  - PM 2.5
    - "fine aerosols" = PM 2.5 "penetrate deeply" into RT.
      - In particular, fine aerosols (i.e., particulate matter smaller than 2.5

$\mu\text{m}$ , or  $\text{PM}_{2.5}$ ) penetrate deeply into the respiratory tract and even reach other vital organs.

- WHO advice on masks
  - WHO advice on **6 April 2020** was:
    - Masks *important* to filter **droplets**.
    - Masks *unimportant* for **aerosols**.
  - This is Molina ref no. 1
  - Advice on the use of face masks was not issued until April 6, 2020 by the WHO (**1**), claiming that it is *important* only to prevent infected persons from viral transmission by filtering out **droplets** but that it is *unimportant* to prevent uninfected persons from breathing **virus-bearing aerosols**. (**Molina's comment** re: WHO advice)
  - WHO List of Situation reports
    - <https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports/>
  - WHO Situation Report 77, 6 April 2020
    - I did not find that advice in here.
    - The words 'droplet' and 'aerosol' are not in the report but maybe in the numerous links.
    - [https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200406-sitrep-77-covid-19.pdf?sfvrsn=21d1e632\\_2](https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200406-sitrep-77-covid-19.pdf?sfvrsn=21d1e632_2)
- Airborne Tx is important but ignored by WHO and CDC
  - He says, **Airborne tx is highly significant but ignored by WHO and CDC**.
    - "Specifically, while the WHO and the US Centers for Disease Control and Prevention (CDC) have emphasized the prevention of contact transmission, both WHO and CDC have largely ignored the importance of the airborne transmission route."
  - My thoughts
    - I don't get the sense he is basing his conclusion on experiments. It seems very **retrospective**.
- Open air
  - Airborne virus is *diluted* but can virus can *accumulate* due to *stagnation* in **polluted urban conditions**.
  - Transmission of airborne viruses in open air is subject to dilution, although virus accumulation still occurs due to stagnation under polluted urban conditions
- Size v Settling velocity v residence time
  - **1  $\mu\text{m}$  virus-bearing particle**
    - $2.8 \times 10^{-5} \text{ m/s}$ 
      - $\times 10^6 = 28 \text{ mm/s}$
  - **10  $\mu\text{m}$  virus-bearing particle**
    - $1.4 \times 10^{-3} \text{ m/s}$ 
      - $\times 10^6 = 140 \text{ mm/s}$
  - **Wind**
    - Indoors
      - $1 - 3 \text{ m/s}$
    - Stable air (I take that to mean outdoors)
      - $1 \text{ m/s}$  *horizontally*
      - $0.1 \text{ m/s}$  *vertically*
  - **Residence time**
    - **Hours**

- Removal of virus-bearing particles from human atomization via deposition is strongly size dependent, with the settling velocities ranging from  $2.8 \times 10^{-5} \text{ m}\cdot\text{s}^{-1}$  to  $1.4 \times 10^{-3} \text{ m}\cdot\text{s}^{-1}$  for the sizes of 1 and 10  $\mu\text{m}$ , respectively (7). For comparison, typical wind velocity is about  $1 \text{ m}\cdot\text{s}^{-1}$  to  $3 \text{ m}\cdot\text{s}^{-1}$  indoors (23) and is  $\sim 1 \text{ m}\cdot\text{s}^{-1}$  horizontally and  $0.1 \text{ m}\cdot\text{s}^{-1}$  vertically in stable air (7, 22). Under those indoor and outdoor conditions, the residence time of virus-bearing aerosols reaches hours, due to air mixing (7).
- Mask utility
  - He calls it “face covering.”
  - The function is:
    - Prevent airborne Tx by:
      - blocking atomization
      - blocking inhalation of virus-bearing aerosols.
    - Prevent contact Tx by:
      - Blocking viral shedding of droplets.
  - Face covering prevents both airborne transmission by blocking atomization and inhalation of virus-bearing aerosols and contact transmission by blocking viral shedding of droplets.
- MERS
  - 64% of MERS-CoV was infectious 60 min after atomization at 25 C and 79% RH.
  - 5% of MERS-CoV was infectious 60 min after atomization at 38 C and 24% RH.
    - For example, airborne coronavirus MERS-CoV exhibited strong capability of surviving, with about 64% of microorganisms remaining infectious 60 min after atomization at 25 °C and 79% relative humidity (RH) (9). On the other hand, rapid virus decay occurred, with only 5% survival over a 60-min procedure at 38 °C and 24% RH, indicative of inactivation. Recent experimental studies have examined the stability of SARS-CoV-2, showing that the virus remains infectious in aerosols for hours (12) and on surfaces up to days (12, 13).
- *Identifying airborne transmission as the dominant route for the spread of COVID-19*
  - **PNAS 30 June 2020**
  - Authors
    - Mario Molina
      - Department of Chemistry and Biochemistry, UCSD, La Jolla, CA 92093
    - Renyi Zhang
      - Department of Atm Sciences, Texas A&M University
    - Yixin Li
      - Department of Chemistry, Texas A&M University
    - Annie Zhang
      - Department of Chemistry, Univ of Texas at Austin
    - Yuan Wang
      - Division of Geological and Planetary Sciences, Caltech (CIT), Pasadena, CA 91125
  - 1 reviewer from Turkey.
  - <https://www.pnas.org/content/117/26/14857>
- WHO loose definition
  - The concept is that the naturally and artificially produced aerosols will contain a range of droplet sizes, ...
    - See the Droplet definition below for the 2009 WHO document.
- Origin
  - Natural aerosols

- I think these are all liquid droplets.
  - Fog
  - Mist
  - Dust
  - Geyser steam
  - Forest exudate
    - What?
    - I think that means a forest mist.
- Man-made aerosols
  - Air pollutants
  - Smoke
- Engineer Linsey Marr, Virginia Tech
  - This engineer de-emphasizes cleaning surfaces.
  - "It's become clear that transmission by inhalation of aerosols – the microscopic droplets – is an important if not dominant mode of transmission," says Marr, who studies airborne disease transmission.
  - Nature 29 Jan 2021
  - [https://www.nature.com/articles/d41586-021-00251-4?utm\\_source=Nature+Briefing&utm\\_campaign=65657f8ef0-briefing-dy-20210201&utm\\_medium=email&utm\\_term=0\\_c9dfd39373-65657f8ef0-43234521](https://www.nature.com/articles/d41586-021-00251-4?utm_source=Nature+Briefing&utm_campaign=65657f8ef0-briefing-dy-20210201&utm_medium=email&utm_term=0_c9dfd39373-65657f8ef0-43234521)

# Page 162 – Blast Zone – A bit of melodrama

## Aerosol-transmissible diseases

- coronavirus
  - MERS
  - SARS
- Influenza virus

## Bacteria – some airborne some not

- For the record, I'm working on this part of the bibliography at the 32<sup>nd</sup> floor cafeteria of Tokyo Metropolitan Government Building (basically, Tokyo City Hall).
- G NEG bacteria
  - Gram Neg bacteria need a moist environment so tend NOT to be airborne. Interesting.
    - The exception is *Acinetobacter spp.*
- Legionella
  - Showers and faucets can produce an aerosol.
  -
- Source
  - CDC – *Environmental Infection Control Guidelines: Background C: Guidelines for Environmental Infection Control in Health-Care Facilities (2003)*
    - <https://www.cdc.gov/infectioncontrol/guidelines/environmental/background/air.html>

**TB**

- Infectious particles
  - Airborne particles
  - Droplet nuclei
- Size
  - 1-5 um
- Generation
  - Sneeze / cough / speak / sing
- Transmission
  - Normal air currents keep them airborne for 'prolonged' periods of time.
  - Amazingly, taken up by alveolar macrophages and then spread throughout body. What a burn. If I recall, Pott's Disease is when TB disseminates to spine? Yes. Verified just now.
- CDC verbatim
  - M. tuberculosis is carried in airborne particles, or droplet nuclei, that can be generated when persons who have pulmonary or laryngeal TB sneeze, cough, speak, or sing (6). The particles are an estimated 1-5 um in size, and normal air currents can keep them airborne for prolonged time periods and spread them throughout a room or building (7). Infection occurs when a susceptible person inhales droplet nuclei containing M. tuberculosis, and these droplet nuclei traverse the mouth or nasal passages, upper respiratory tract, and bronchi to reach the alveoli of the lungs. Once in the alveoli, the organisms are taken up by alveolar macrophages and spread throughout the body. Usually within 2-10 weeks after initial infection with M. tuberculosis, the immune response limits further multiplication and spread of the tubercle bacilli; however, some of the bacilli remain dormant and viable for many years. This condition is referred to as latent TB infection. Persons with latent TB infection usually have positive purified protein derivative (PPD)-tuberculin skin-test results, but they do not have symptoms of active TB, and they are not infectious.
  - Guidelines for Preventing the Transmission of Mycobacterium tuberculosis in Health-Care Facilities, 1994
    - <https://www.cdc.gov/mmwr/preview/mmwrhtml/00035909.htm>

# Page 163 – Location, Location, Location

**Distance travelled**

- "Tens of meters"
  - Airborne transmission of SARS-CoV-2: The world should face the reality
    - I think this distance is based on the author's 2009 study ... which can only read 1 paragraph in Google Scholar.
    - <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7151430/#b0075>

- No distance given (MIT)
  - *Violent expiratory events: on coughing and sneezing. Journal of Fluid Mechanics, 2014*
    - MIT Applied Mathematics professor **Lydia Bourouiba**
    - <https://math.mit.edu/~bush/wordpress/wp-content/uploads/2014/04/Sneezing-JFM.pdf>
    - See Pix – MIT above.
    - M&M
      - High-speed camera 1000 – 4000 fps
    - Verbatim
      - Large droplet transmission may arise through the spring of infected droplets directly onto the conjunctiva or mucus of a susceptible host via coughing or sneezing.
      - Airborne transmission may arise through inhalation of relatively small infected droplets or the pathogen bearing solid residues of size less than 5 to 10  $\mu\text{m}$ , referred to as droplet nuclei, that can form from the small droplets via evaporation.
      - The first two modes are termed direct short range routes of pathogen transmission, both requiring the close proximity of individuals, while the third is indirect long range route of transmission.
    - This is their summary of Wells
      - " it remains a common belief that most contamination of new individuals occurs via direct contact with large droplets emitted by infectious individual. Wells (1934, 1955) challenge this view and was the first to examine the role of airborne transmission of respiratory disease transmission. He compared the time for complete evaporation to the settling time of various droplets ranging in diameter from 1 to 1000  $\mu\text{m}$ .
      - He reported the drops with a diameter  $D$  greater than 100  $\mu\text{m}$  settled to the ground in less than one second, without significant evaporation (wells 1934).
      - Well evaporation rates will in general depend on ambient temperature and humidity, drops with diameter less than 100  $\mu\text{m}$  will typically become droplet nuclei before settling (Wells 1955).
      - Droplets with diameter less than 5 to 10  $\mu\text{m}$  rapidly evolve into droplet nuclei with settling speeds less than 3 mm/s, and so may be readily suspended and advected by the cloud of air emitted by the coffer, or resuspended by any ambient flow as mayor rise, for example, through air conditioning. Thus, suspended droplet nuclei are expected to be critical elements in long range airborne transmission.
    - The findings of the study:
      - "Smaller droplets (less than 50  $\mu\text{m}$  diameter) can remain suspended in the cloud long enough to reach heights were ventilation systems can be contaminated (4 to 6 m).
      - Droplet of diameter - The findings of the study  $d = 10 \mu\text{m}$  Evaporates in 0.027 seconds, during which it would fall a distance of approximately 0.08 mm at a settling speed of approximately 3 mm/s. It was us clearly remain suspended in a cough or sneeze cloud meters away from the coffer. Evaporates in 0.027 seconds Evaporates in 0.027 seconds, during which it



- Indeed, the cloud model presented in the study predicts that the range of droplets of diameter  $D$  less than or equal to  $100\ \mu\text{m}$  would be extended by a factor of five to more than 200 SD decreases from 100 to  $10\ \mu\text{m}$ .”
  - There is nothing in this article about 45 m or 160 feet. Maybe one of the authors said that in a different setting.
- Volcano
    - Wind blows volcanic ash 10s - 1000s of kilometers away from volcano.

# Page 164 – Anvil How Long Does it Take for an Anvil to Fall One Mile from the Sky?

William Firth Wells droplet experiment

## ON AIR-BORNE INFECTION.\*

## STUDY II. DROPLETS AND DROPLET NUCLEI.

By

W. F. WELLS.†

(Received for publication June 14, 1934.)

The infective range of droplets expelled from the nose or mouth depends primarily upon the time interval spent in the atmosphere. The unresisted falling time from mouth to ground can be readily shown by Newton's Law to be less than a second. Air resistance becomes a negligible factor in determining the time of fall of droplets larger than a tenth millimeter through the height of a man. As droplets decrease in diameter the volume and weight, or gravitational pull, decrease more rapidly than the surface area which determines the resistance to fall through air. Particles smaller than a tenth millimeter diameter soon reach a velocity which remains constant. This fact is expressed by Stokes' Law ‡ which says that the velocity is proportional to the surface area of the droplet or to the square of its diameter. In moisture-saturated air all but very small

\* In 1931 an instrument for the bacterial examination of air was developed by the Department of Public Health Administration of the Harvard School of Public Health. The application of this instrument in the present studies has been made possible through the facilities and assistance of several Departments of Harvard University. The technical assistance of Mr. Stone, graduate student in the Department of Sanitary Engineering of the Harvard Engineering School, the use of the experimental chamber of the Department of Industrial Hygiene of the School of Public Health and the advice and cooperation of the Departments of Bacteriology and Preventive Medicine of the Harvard Medical School are here gratefully acknowledged.

No claim is made that the results presented are final in character. They are presented as found in order that they may stimulate wider and more thorough studies into this important subject of air-borne infection. The experiments were conducted during the spring and summer of 1933 and were presented to the Medical Section of the American Association for the Advancement of Science on December 27, 1933, under the title, "Viability of Bacteria in Air."

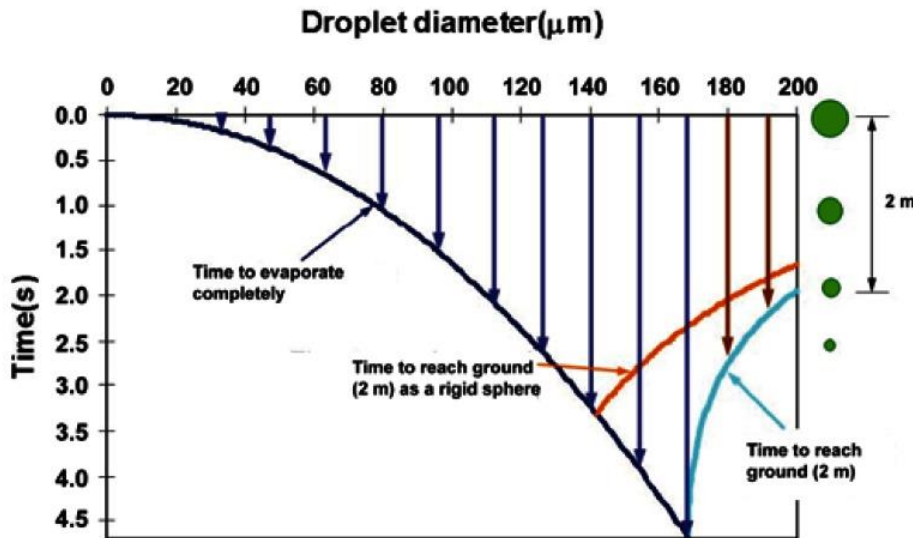
† Instructor in Sanitary Science, Harvard School of Public Health, Boston, Mass.

‡ Stokes' Mathematical and Physical Papers, 1901, vol. 3, page 60.

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## ON AIR-BORNE INFECTION – STUDY II. DROPLETS AND DROPLET NUCLEI.

- Summary
  - This is droplet aficionado William Firth Wells's original paper in 1934.
  - His official title was: Instructor in Sanitary Science, Harvard School of Public Health, Boston, Mass.
- Verbatim
  - "The infective range of droplets expelled from the nose or mouth depends primarily upon the time interval spent in the atmosphere. The unresisted falling time from mouth to ground can be readily shown by Newtons' Law to be less than a second."
- Source
  - American Journal of Epidemiology
    - Volume 20, Issue 3, Pages 611–618
    - 01 November 1934
    - <https://doi.org/10.1093/oxfordjournals.aje.a118097>
    - <https://academic.oup.com/aje/article-abstract/20/3/611/280025?redirectedFrom=fulltext>



### Natural Ventilation for Infection Control in Health Care Settings

- Summary
  - That graph is a colored version of Well's **evaporation-falling curve** from 1934.
  - It requires a little bit of coffee to understand this graph.
- Axis
  - The x-axis (horizontal) is droplet diameter in microns ( $\mu\text{m}$ ).
  - The y-axis (vertical) is time in seconds.
- Legend
  - The curves are all time.
  - **Black curve**
    - Time to evaporate completely.
  - **Red curve**
    - Time to reach ground as 'rigid sphere' (bearing in mind, it's a liquid droplet).
  - **Blue curve**
    - Time to reach ground.
    - 2 meter (6 feet, 6 inches) distance.
- Results
  - 80  $\mu\text{m}$  droplet
    - Evaporates completely in about 1.0 seconds. Does not reach the ground.
    - 🖐 Start on the x-axis at the '80' → then move *down* to the black curve → then draw an imaginary horizontal line to the *left* to the y-axis → it will *intercept* at about 1.0 seconds ... which is the time it took the 80 micron drop to evaporate completely.
  - 100  $\mu\text{m}$  droplet
    - Evaporates completely in about 1.5 seconds. Does not reach the ground.
  - 170  $\mu\text{m}$  droplet
    - 170 is not labelled. It's between the 160 and 180.
    - It hits ground in 4.5 seconds. It has just barely completely evaporated.
  - 190  $\mu\text{m}$  droplet
    - It hits ground in about 2 seconds (the red curve). It has not evaporated.
- Source
  - Research Gate
    - January 2009
    - The image is on page 80 of this free downloadable pdf.
    - [https://www.researchgate.net/publication/235950106\\_Natural\\_Ventilation\\_for\\_Infection\\_Control\\_in\\_Health\\_Care\\_Settings](https://www.researchgate.net/publication/235950106_Natural_Ventilation_for_Infection_Control_in_Health_Care_Settings)
- Publisher

- World Health Organization (WHO), Geneva
- Authors
  - WHO Technical Guideline Development Group
    - Adrian C Sleigh - Australian National University
    - Derek John Clements-Croome - University of Reading
- Editors
  - James Atkinson, Yves Chartier, Carmen Lúcia Pessoa-Silva, Paul Jensen, Yuguo Li and Wing-Hong Seto

$$\text{Anvil}$$

$$d = \frac{1}{2} at^2$$

### Free Fall Calculator

- Summary
  - This is a calculator that figures out the **free fall** time of objects, using the formula  $d = \frac{1}{2} at^2$  ("d equals one half a t squared"). Plus lots of understandable information.
  - There is also a 3-minute video called *Free Fall calculator(s): with & without air resistance*.
- Source
  - Bogna Szyk
    - Reviewed by Dominik Czernia, PhD and Jack Bowater
    - Last updated: Jan 18, 2024
    - <https://www.omnicalculator.com/physics/free-fall>

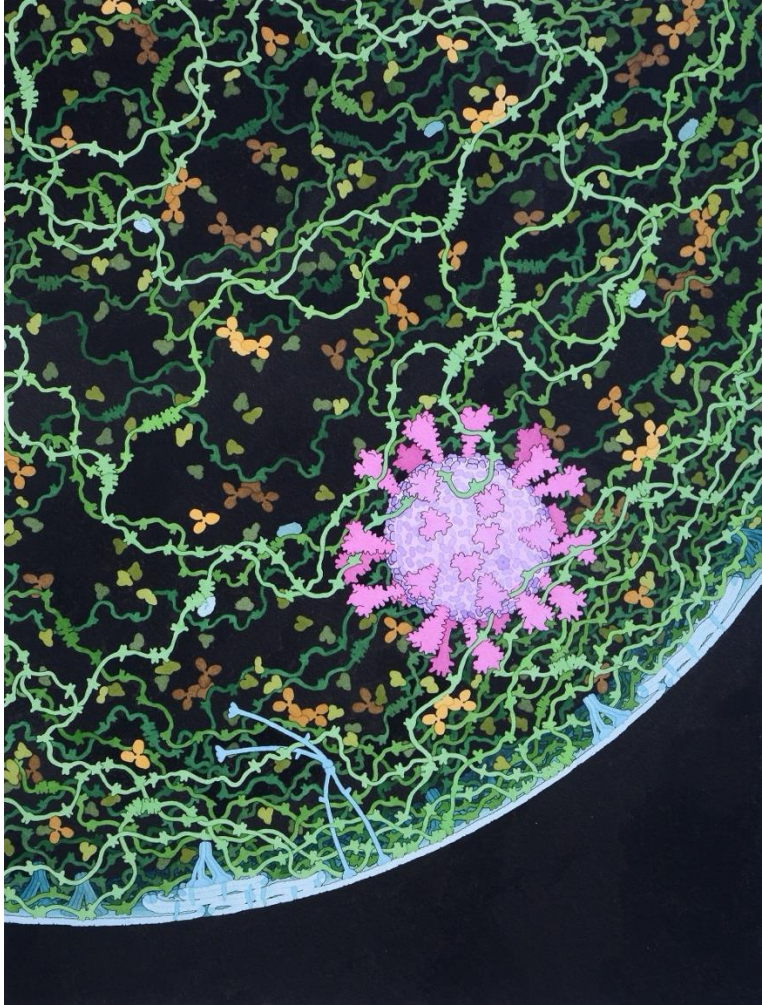
# Page 165 – Droplets

## Size inventory

- 0.120 nm O2 (Loma Linda ID)
- 0.232 nm CO2 (Loma Linda ID)
- 100 nm *coronavirus* 0.1 um (100 nm)  
atm dust lower limit (Engineering Toolbox)  
Radioactive fallout lower limit (Engineering Toolbox)
- 200 nm burning wood lower limit (Engineering Toolbox)  
Cloud Condensation Nuclei (CCN) (100 x smaller than cloud droplet)
- 300 nm N95 95% efficiency
- <1 um Sediment in alveoli, requiring removal by pulmonary macrophage
- 1 um small aerosol particle (Univ Corp Atm Research) (UCAR)  
**Cough / Sneeze average size lower limit** (Loma Linda ID)  
**Cough droplet**  
*Staph aureus*
- 2 um **fungus spores**
- 2.5 um This is a reference standard particle (EPA)
- 3 um burning wood upper limit (Engineering Toolbox)

- 4 um Cement dust (lower limit) (Engineering Toolbox)
  - <5 um Volcanic ash that can get into alveoli, and if high [silica] can cause Silicosis.
  - 5 um **droplet nuclei**
    - small droplet ... it will evaporate into droplet nuclei and remain suspended.
    - E.g., *Measles virus*
    - bronchodilator particle (1-5 um is the goal)
    - Fuel injection
    - Water drop = 100 b H<sub>2</sub>O molecules (PHYSICS & CHEM: *mole of water*)
  - 5+ um "droplet" for a **droplet infection** in medicine.
  - 10 um **Cough / Sneeze avg size upper limit** ((Chief of ID Loma Linda))
  - 20 um Radioactive fallout upper limit (Engineering Toolbox)
  - 40 um cloud droplet. 1,000,000 to make a raindrop.
  - 60+ um atm dust upper limit (Engineering Toolbox)
  - 62.5 um large droplet
  - 80 um ash from volcano
  - 80 um **Well's droplet 1.2 sec evap.**
  - 100 um Large aerosol particle
    - Cement dust (upper limit) (Engineering Toolbox)
    - hair diam
    - naked eye limit
    - N95 pore size - lower limit (Chief of ID Loma Linda)
      - 1667 O<sub>2</sub> molecules IN
      - 863 CO<sub>2</sub> molecules OUT
    - Pollen
    - **Sneeze** produces this very large droplet.
  - 200 um **Well's droplet 2 sec hits ground.**
  - 300 um Alveolus diameter.
  - 300 um N95 pore size – upper limit\* (Chief of ID Loma Linda)
  - 500 um Period at end of this sentence.
  - 500 um salt grain
  - 2000 um raindrop
  - Smallest classic snowflake (2-4 mm)
- **Tobacco smoke**
    - 0.1 – 4 um (Engineering toolbox)

Coronavirus



### Respiratory tract

- Summary
  - What a pretty illustration. That's a single **coronavirus** inside a **droplet** produced by your **respiratory tract** (think, nasal cavity, back of the throat, and lungs).
- Source
  - [https://en.wikipedia.org/wiki/Respiratory\\_tract](https://en.wikipedia.org/wiki/Respiratory_tract)

## Atmospheric dust

### Atmospheric dust

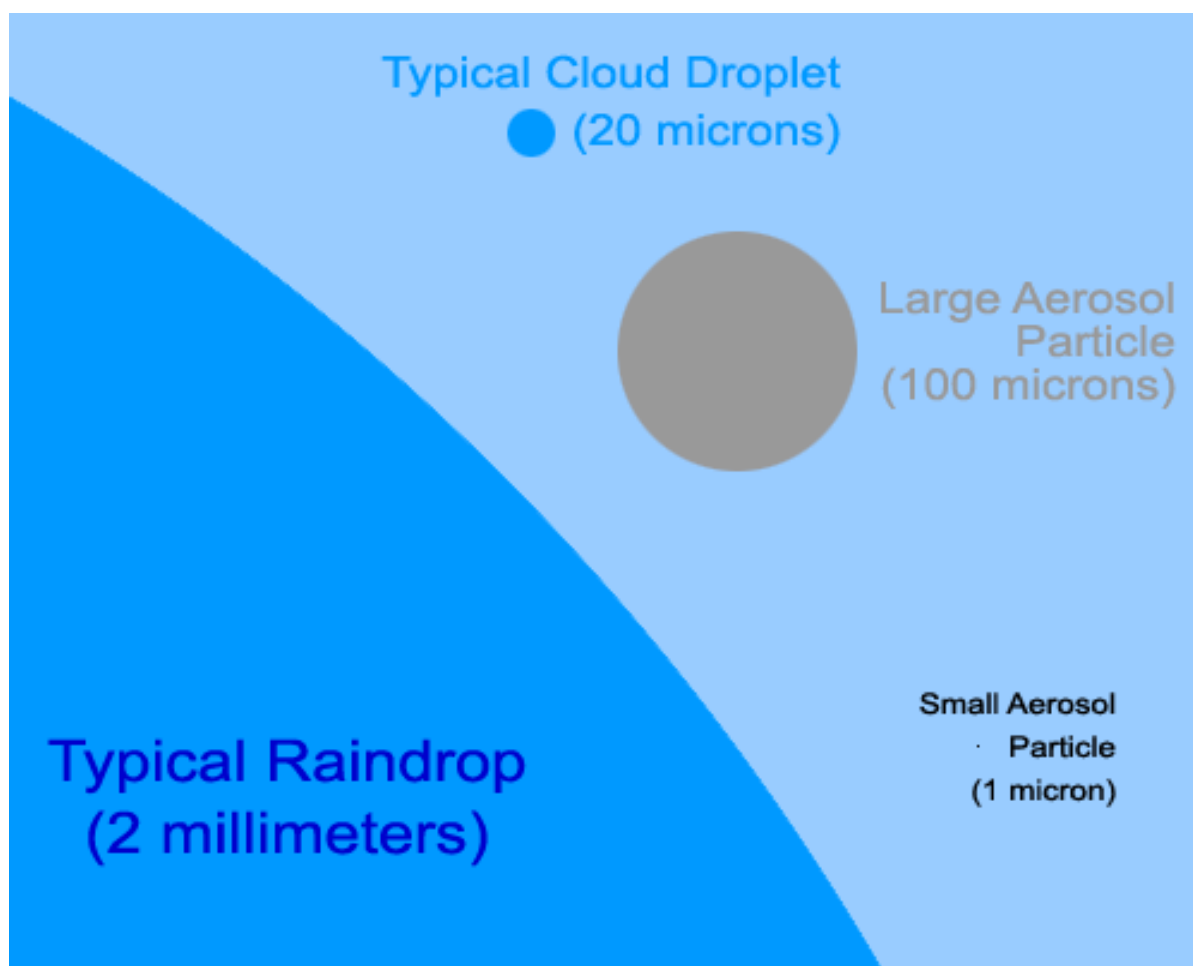
- 0.001  $\mu\text{m}$  – 40  $\mu\text{m}$  (1 nm – 40  $\mu\text{m}$ )
- **Engineering Toolbox**
  - [https://www.engineeringtoolbox.com/particle-sizes-d\\_934.html](https://www.engineeringtoolbox.com/particle-sizes-d_934.html)

## Cloud condensation nuclei

*Cloud condensation nuclei* (CCN)

- 0.2  $\mu\text{m}$  = condensation nuclei a.k.a. Cloud Condensation Nuclei (CCN)
  - = 100 x smaller than cloud droplet.
  - [https://en.wikipedia.org/wiki/Cloud\\_condensation\\_nuclei](https://en.wikipedia.org/wiki/Cloud_condensation_nuclei)
- Atmospheric Chemistry & Physics
  - If there were no particles, clouds could not form.
  - A cloud droplet forms from this, usually 10+  $\mu\text{m}$  (he does not give an upper limit)
  - CCN *minimum* diameter 0.05  $\mu\text{m}$  (50 nm) – 0.14  $\mu\text{m}$  (140 nm)
  - CCN lifetime is 1 week, on average.
  - Air parcel
    - Air parcel spends a few hours *inside* cloud then a few days *outside* the cloud. Wow.
    - That means the CCN “experiences” 5 – 10 cloud activation / cloud evaporation cycles before being removed from atmosphere in precipitation. Wow.

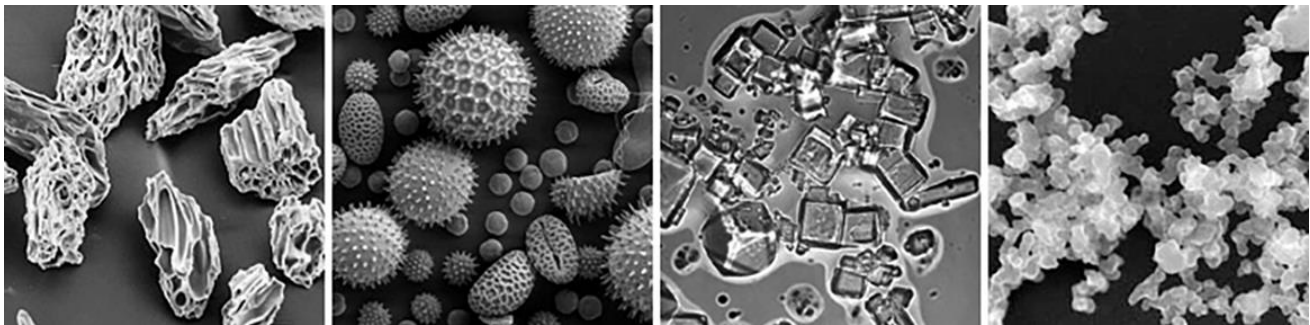
## Rain



Sizes of Aerosols, Raindrop and Cloud Droplets

Size (microns)	Name	
0.2 $\mu\text{m}$ (200 nm)	Cloud Condensation Nuclei (CCN)	= It is too small for this diagram ... yet this is where the cloud starts!
1 $\mu\text{m}$	Small Aerosol Particle	= It is the tiny dot – almost easy to miss – in the lower right.
20 $\mu\text{m}$	Typical Cloud Droplet	= 1 million of these droplets coalesce into 1 raindrop.
100 $\mu\text{m}$	Large Aerosol Particle	= Same diameter as human hair.
2000 $\mu\text{m}$ (2 mm)	Typical raindrop	= This falls due to gravity.

- Source
  - **University Corporation for Atmospheric Research (UCAR) Center for Science Education**
    - This seems to be an organization worth joining. Here is their description:
      - The **UCAR Center for Science Education (UCAR SciEd)** serves the geoscience community by amplifying and complementing the work of the **U.S. National Science Foundation (NSF) National Center for Atmospheric Research (NCAR)** and **University Corporation for Atmospheric Research (UCAR)** member universities by reaching our audiences: K-12 educators, university faculty, students, and the public through excellence in educational programs and experiences.
    - <https://scied.ucar.edu/aerosols-raindrop-cloud-droplets-sizes>



These scanning electron microscope images (not at the same scale) show the wide variety of aerosol shapes. From left to right: volcanic ash, pollen, sea salt, and soot. Images: NASA, compiled from USGS, UMBC (Chere Petty), and Arizona State University (Peter Buseck)

### Aerosols: Tiny Particulates in the Air

- Summary
  - There are electron microscope (EM) photographs of atmospheric aerosols: volcanic ash, pollen, sea salt, and soot.
  - I love EM images ... this is where life actually takes place.
- Source
  - **University Corporation for Atmospheric Research (UCAR) Center for Science Education**
    - This is the same source as the previous diagram.
    - <https://scied.ucar.edu/aerosols>

## Fungal spores

### Air Quality

- Counts taken by MAARA show fungal spores in the air exceeded 50 000 spores per cubic metre of air during this time - mainly *Cladosporium*, *Sporobolomyces* and *Basidiospores* but also *Aspergillus/Penicillium* and *Alternariaspores*. This can far exceed the numbers of pollen grains in the same amount of air.
- Fungal spores (2-30 micrometers) tend to be far smaller than pollen grains (10-100 micrometers) and this has an important influence on their pathogenicity. *Aspergillus* spores can be 2-3 micrometer in diameter which enables them to penetrate deep into our lungs, even as far as individual alveoli. As a consequence pollen tends to cause symptoms in our sinus's and upper airways, some fungal spores can go much deeper into our lower



respiratory tract. Fungal spores are also 'seeds' for growth of entire fungal colonies and thus once they manage to get a foothold in our lungs they can grow and be very difficult to eradicate. In contrast pollen grains have a very limited lifespan as they are only intended to grow a short way into a flower before they die!

- Source
  - [Aspergillus.org.uk](https://www.aspergillus.org.uk)
    - <https://www.aspergillus.org.uk/content/air-quality-3>

## PM 2.5

- **PM 2.5**
  - **PM 2.5 means a particle 2.5 um in diameter.**
  - Very detailed explanation on **PM 2.5** by the **smartfilters guy**
    - He was part of this bc of **air pollution** in **Beijing**.
    - <https://www.quora.com/What-does-PM-2-5-mean-in-air-pollution-and-how-is-it-measured/answer/Thomas-Talhelm>
- **PM 2.5 (EPA)**
  - **PM**
    - It's a broad EPA definition.
    - **PM = Particulate Matter** a.k.a. **Particle Pollution**
      - = mixture of:
        - **Solid particles**
          - dust
          - soot
          - smoke
        - **Liquid droplets**
    - PM stands for particulate matter (also called particle pollution): the term for a mixture of solid particles and liquid droplets found in the air. Some particles, such as dust, dirt, soot, or smoke, are large or dark enough to be seen with the naked eye. Others are so small they can only be detected using an electron microscope.
  - **PM<sub>2.5</sub>**
    - = 2.5 um
    - **This is a fine inhalable particle and is considered hazardous (EPA).**
    - Verbatim (**EPA**)
      - **Some particles less than 10 micrometers in diameter can get deep into your lungs and some may even get into your bloodstream. Of these, particles less than 2.5 micrometers in diameter, also known as fine particles or **PM<sub>2.5</sub>**, pose the greatest risk to health.**
      - <https://www.epa.gov/pm-pollution/particulate-matter-pm-basics>

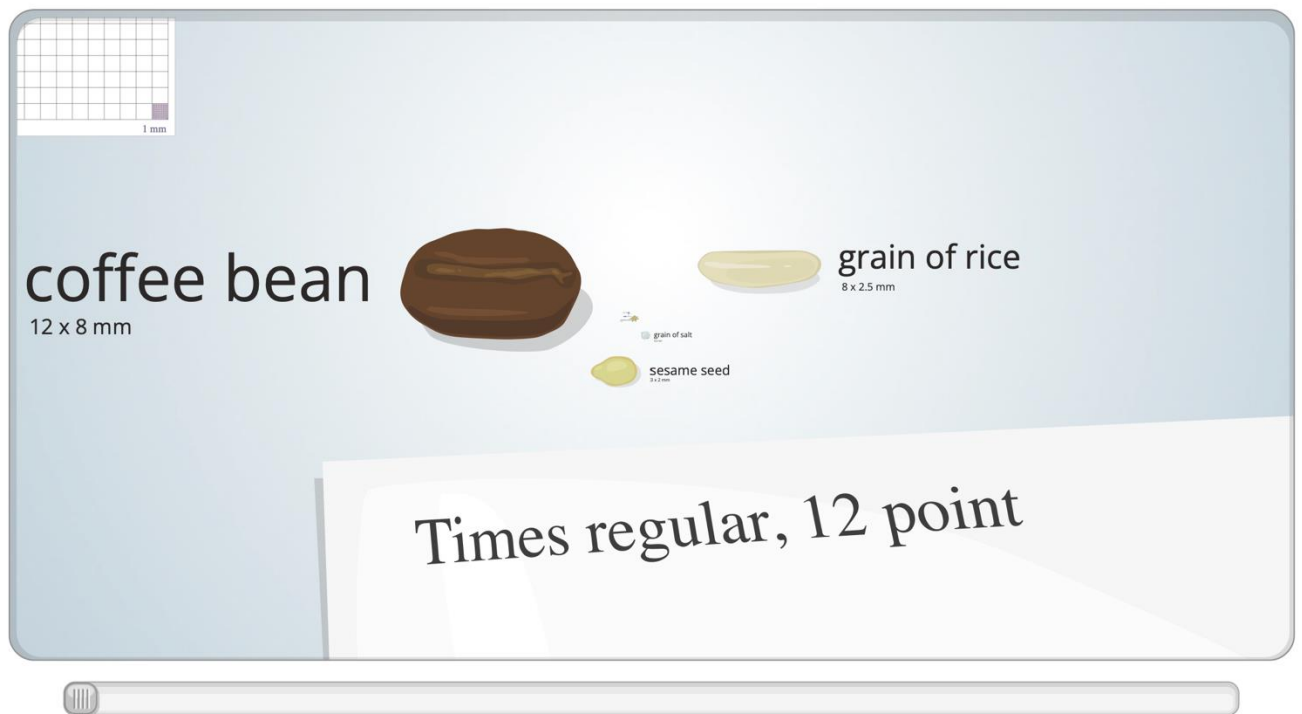
## Fuel injection

Fuel injection

- **BMW engine has 5 micron fuel injected drops.** (the all-knowing **Dave Heidelbrecht** of Performance BMW, St. Catharines, Ontario).


## Cell Size and Scale

### Cell Size and Scale



Meter	Centimeter	Millimeter	Micrometer	Nanometer	Angstrom	Picometer
$10^0$ m	$10^{-2}$ m	$10^{-3}$ m	$10^{-6}$ m	$10^{-9}$ m	$10^{-10}$ m	$10^{-12}$ m
1 m	0.01 m	0.001 m	0.000001 m	0.000000001 m	0.0000000001 m	0.000000000001 m
	1/100 m	1/1,000 m	1/1,000,000 m	1/1,000,000,000 m	1/10,000,000,000 m	1/1,000,000,000,000 m
	hundredth of a meter	thousandth of a meter	millionth of a meter	billionth of a meter	ten billionth of a meter	trillionth of a meter

### Cell Size and Scale

- Summary
  - **This is a phenomenal site showing the relative size of small things.**
  -  Move the scroll bar Left – Right to zoom in or out.
  - It starts with a **coffee bean** and **grain of rice**. About 1/3 the way along is the **X chromosome**.
- Source
  - Learn.Genetics
    - **Genetic Science Learning Center, University of Utah**
    - [https://learn.genetics.utah.edu/content/cells/scale/?\\_sm\\_au\\_=iVVRT4nPJR0sPnTs](https://learn.genetics.utah.edu/content/cells/scale/?_sm_au_=iVVRT4nPJR0sPnTs)

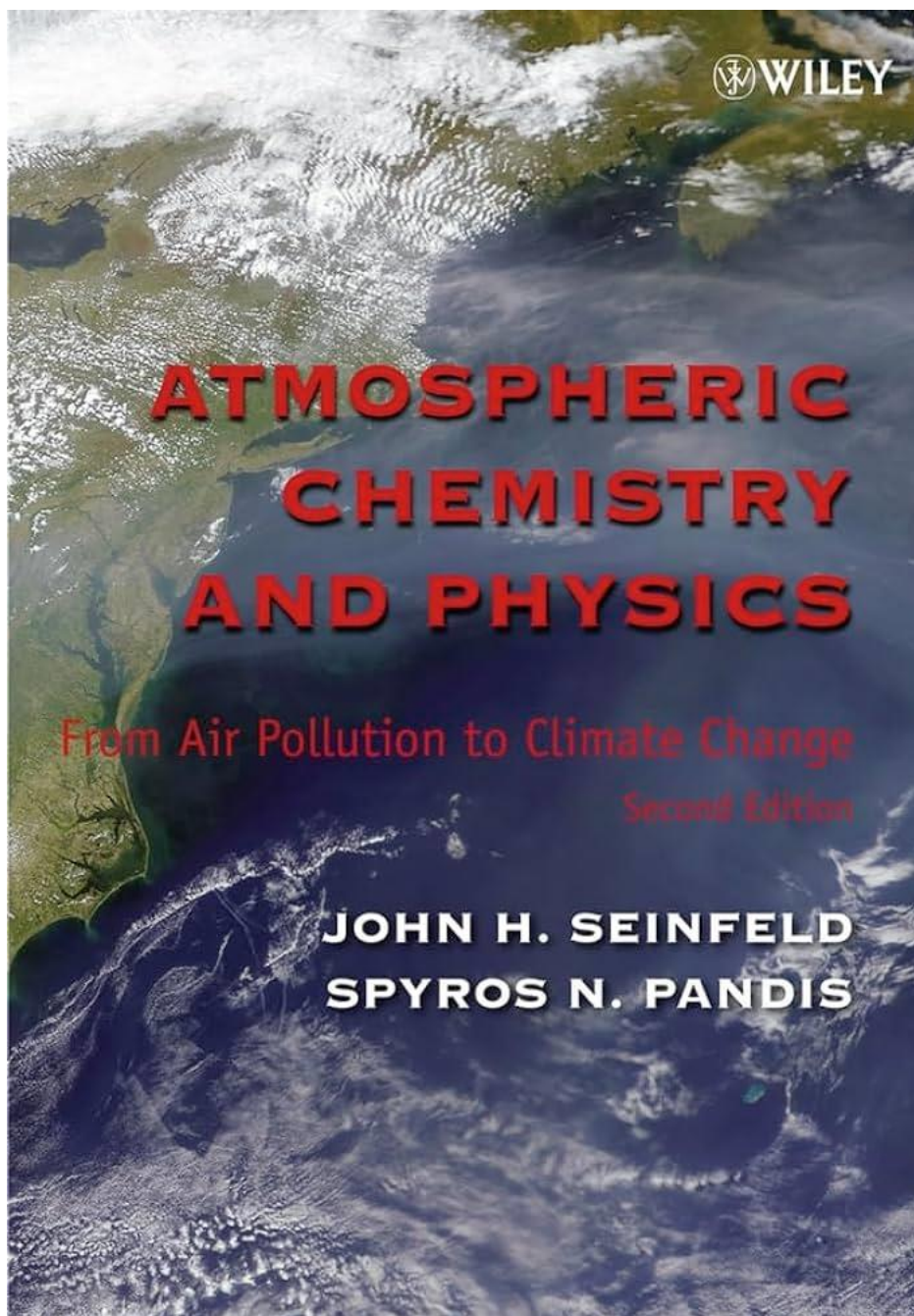
Extras

- **E-cig**
  - Vaper inhales aerosolized **protonated nicotine**.

# Page 166 – Atmosphere

*Atmospheric Chemistry and Physics – From Air Pollution To  
Climate Change*

It's a textbook.



*Atmospheric Chemistry and Physics – From Air Pollution to Climate Change – 2<sup>nd</sup> Edition*

- Summary
  - This book, *Atmospheric Chemistry and Physics*, is all about the atmosphere. And we all know the atmosphere contains *gas*. It is 21% oxygen gas ( $O_2$ ) and 78% nitrogen gas ( $N_2$ ). We breathe in both gases but we live on the oxygen. That's the start point.
  - It's pretty technical.
- Authors
  - **John Seinfeld** PhD – Caltech
  - **Spyros Pandis** PhD – Carnegie Melon Univ
- This book is reference no. 3 in Wikipedia – Particulates
  - <https://en.wikipedia.org/wiki/Particulates>
- I borrowed the book for **1 hour** from the **Internet Archive** (link below) then I bought it.
  - <https://archive.org/details/atmosphericchemi0000sein/page/n5/mode/2up>

- amazon.ca
  - 1232 pages
  - 1.9 kg. Whoa.
  - Wiley-Interscience
  - [https://www.amazon.ca/Atmospheric-Chemistry-Physics-Pollution-Climate/dp/0471720186/ref=sr\\_1\\_1?dchild=1&field-datemod=0&field-dateop=before&field-dateyear=2015&mysubmitbutton1.x=0&mysubmitbutton1.y=0&qid=1603561734&refinements=p\\_27%3Aseinfeld%2Cp\\_28%3Aatmospheric+chemistry&s=books&select-author=field-author-like&select-subject=field-subject&select-title=field-title&sr=1-1](https://www.amazon.ca/Atmospheric-Chemistry-Physics-Pollution-Climate/dp/0471720186/ref=sr_1_1?dchild=1&field-datemod=0&field-dateop=before&field-dateyear=2015&mysubmitbutton1.x=0&mysubmitbutton1.y=0&qid=1603561734&refinements=p_27%3Aseinfeld%2Cp_28%3Aatmospheric+chemistry&s=books&select-author=field-author-like&select-subject=field-subject&select-title=field-title&sr=1-1)

## Notes I made from the book

### Abbreviation

- Atm = atmosphere
- $\mu\text{m}$  = micron =  $1/1000^{\text{th}}$  of a milli-meter
- nm = nano-meter =  $1/1000^{\text{th}}$  of a micron = crazy small

### Aerosols

- Suspension of fine solids or liquid particles in a gas.
- Common usage
  - Refers to only the particle.
  - Verbatim
    - Whereas an aerosol is technically defined as a suspension of fine solids or liquid particles in a gas, common usage refers to the aerosol as the particulate component only.
- Primary aerosol
  - Emitted directly as particles.
- Secondary aerosol
  - Formed in atm by gas-to-particle conversion process.
- Size range (diameter)
  - Range
    - Few nm to tens of microns
  - There are 2 basic divisions (page 101: figure 2.15)
    - $< 2.5 \mu\text{m}$  diameter
      - "Fine" particles.
      - There are 2 'modes' to fine particles:
        - Nuclei mode
          - 0.005  $\mu\text{m}$  (5 nm) – 0.1  $\mu\text{m}$  (100 nm)
          - This is most of the fine particles in *number*.
          - Formed by condensation of hot vapors during combustion.
        - Accumulation mode
          - 0.1  $\mu\text{m}$  (100 nm) – 2.5  $\mu\text{m}$  (2500 nm)
          - This is most of the fine particles in *surface area*.
    - $> 2.5 \mu\text{m}$  diameter
      - "Course" particles.
      - Formed mechanically.
  - That's not just a random parsing.
    - The 2 size sets have different:
      - Origin
      - Transformation

- Removal from atm
  - Chemical composition
  - Optical properties
  - **Deposition pattern in respiratory tract.**
- Concentration
  - < 1µm diameter
    - 10 – few 1000 / cm<sup>3</sup>
  - > 1µm diameter
    - Less than 1 / cm<sup>3</sup>
    - Hence, way less [concentration].
- Removal from atm is by 2 processes
  - 1. **Deposition** on Earth surface a.k.a. dry deposition.
  - 2. **Incorporated** into cloud droplets a.k.a. wet deposition.
  - **This results in short residence time for tropospheric aerosols.**
- **Stratospheric aerosols**
  - Aqueous Sulfuric acid solution
    - Globally distributed.
    - Insoluble in water.
    - **Long tropospheric lifetime → Diffuses into stratosphere → then photo-dissociation (uv) → sulfuric acid which is a stratospheric aerosol → can have sulfuric acid aerosol clouds.**
  - Mt Pinatubo
    - 1991 eruption
    - **Increased stratospheric aerosols for 2 years.**
      - Author not referring to sulfuric acid, rather whatever particles emitted by the volcano.
- **Tropospheric aerosols**
  - Significant portion is due to man a.k.a. anthropogenic.
  - What are the aerosols up here?
    - Sulfate
    - Ammonium
    - Nitrate
    - Sodium
    - Chloride
    - Trace metals
    - Carbonaceous material
      - 2 types
        - **Elemental carbon** a.k.a. **Free carbon** a.k.a. **Black carbon** a.k.a. **Graphitic carbon** a.k.a. **Soot**
          - **Emitted directly into atm by combustion.**
        - **Organic carbon**
          - Polycyclic Aromatic Hydrocarbons (PAHs) are carcinogenic in animals.
    - Crustal elements
    - Water
- **Cloud Condensation Nuclei (CCN)**
  - These are aerosols.
  - **If there were no particles, clouds could not form.**
  - A cloud droplet forms from this, usually 10+ µm (author does not give an upper limit).
  - CCN *minimum* diameter 0.05 µm (50 nm) – 0.14 µm (140 nm).
  - **CCN lifetime is 1 week**, on average.
  - **Air parcel**
    - **Air parcel** spends a **few hours** in cloud then a **few days** outside the cloud. Wow.
    - That means the CCN “experiences” 5 – 10 **cloud activation / cloud evaporation cycles** before being removed from atm in precipitation. Wow.

**Aerosols / aerocolloids / aerodisperse systems**

- = tiny particles dispersed in gases.

**Dust**

- = Suspension of solid particles produced by mechanical disintegration.
  - Crushing
  - Grinding
  - Blasting
- Diameter > 1  $\mu\text{m}$

**Fog**

- Loose term.
- Visible aerosols.
- Dispersed phases is a liquid.
- Close to ground.
- Diameter: not stated

**Fugitive particles**

- = particles not emitted from a definable point (definable would be a smoke stack).
- Great name.
- Examples
  - Wind erosion of:
    - storage piles
    - unpaved plant roads (what's a plant road? I cannot find easily with Google search).
  - vehicle traffic over plant roads
- 3 broad sources are:
  - Mineral products
  - Food and agriculture
  - Primary metals
- Automotive sources
  - **Engine exhaust**
    - Lead halides
    - Sulfates
    - Carbonaceous
    - Diam < 1  $\mu\text{m}$  (yes, less than one  $\mu\text{m}$ )
  - **Vehicle wear and tear** produces particles from:
    - **Tire**
      - Diam < 10  $\mu\text{m}$  (yes, less than 10  $\mu\text{m}$ )
    - **Clutch**
    - **Brakes**
      - Diam < 1  $\mu\text{m}$  (yes, less than one  $\mu\text{m}$ )

**Fume**

- Solid particles
- Generated by condensation from vapor state
- Volatilization of melted substance
- Often noxious
- Diameter < 1  $\mu\text{m}$

**Haze**

- = Aerosol that impedes vision.
- Water droplets + pollutants + dust
- Diameter < 1µm

### Mist

- Liquid water suspended in atm near the ground
- Small water droplets floating or falling
- Distinguished from fog by having particles perceptibly moving downward
- Diam < 1µm

### Particle

- It is referred to as an "aerosol particle".
- Solid or liquid.
- Held together by intermolecular forces.
- Larger than a molecule.
- Diam at least 0.001+ µm (100+ nm) or larger.
- Verbatim
  - An aerosol Particle may consist of a single continuous unit of solid or liquid containing many molecules held together by intermolecular forces and primarily larger than molecular dimensions (greater than 0.001 µm).
  - Particle may also be considered to consist of two or more such unit structures held together by interparticle adhesive forces such that it behaves as a single unit in suspension or upon deposit.

### Smog

- smoke + fog = smog.
- Extensive contamination by aerosols.
- Loose used for any air contamination

### Smoke

- Small gas-borne particles resulting from incomplete combustion of primarily carbon and other combustible materials.
- Diam > 0.01 µm (10 nm) (yes, greater than 10 nm)

### Soot

- Agglomeration of particles of carbon impregnated with "tar" (not defined).
- Resulting from incomplete combustion of carbonaceous material.

### Sources of particles in atmosphere

- Windborne dust
- Sea spray
- Volcanoes
- Forest fires
- Man
  - Combustion of fuels.

More notes



### Particle

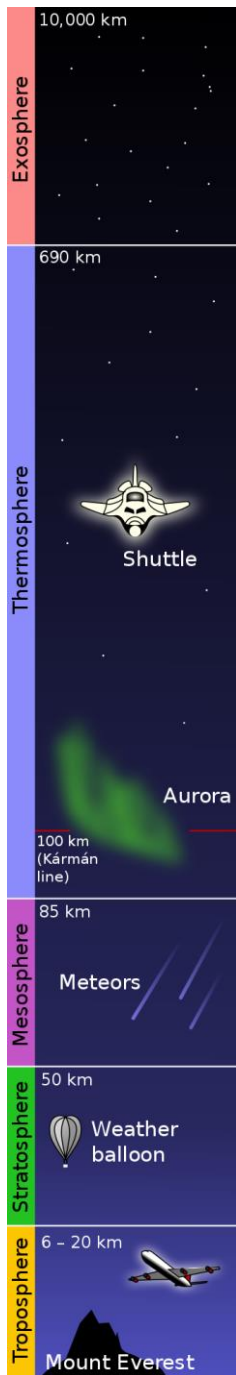
- This is a great description.
- Particle is refined/defined as needed by each scientific field.
- Particulate has become annexed by atmospheric science to mean pollutants.
- Verbatim
  - The term 'particle' is rather general in meaning, and is refined as needed by various scientific fields. Anything that is composed of particles may be referred to as being particulate.<sup>[4]</sup> However, the noun 'particulate' is most frequently used to refer to pollutants in the Earth's atmosphere, which are a suspension of unconnected particles, rather than a connected particle aggregation.<sup>i</sup>
  - <https://en.wikipedia.org/wiki/Particle>

### Particulates

- Lots of stuff in this umbrella.
- Names
  - Particulate
  - Particulate matter (PM)
  - Suspended Particulate matter (SPM)
  - Atmospheric aerosol particle
  - Atmospheric particulate matter.
- Particulate v Aerosol (Wik)
- Defn (Wik)
  - Particulate
    - = Microscopic particles of solid or liquid suspended in the air.
  - Aerosol
    - The particulate / air mixture as opposed to the particulate matter alone.
  - Wik ref no. 3 – Have to sign into Internet Archive and borrow for 1 hour.
- Verbatim
  - **Particulates** – also known as **atmospheric aerosol particles, atmospheric particulate matter, particulate matter (PM), or suspended particulate matter (SPM)** – are microscopic particles of solid or liquid matter suspended in the air.
  - The term *aerosol* commonly refers to the particulate/air mixture, as opposed to the particulate matter alone.<sup>[3]</sup> Sources of particulate matter can be natural or anthropogenic.<sup>[4]</sup> They have impacts on climate and precipitation that adversely affect human health, in ways additional to direct inhalation.
- Categories
  - Biological contaminants
    - Viruses
    - Cat allergens
    - Bacteria
    - Dust mite allergens
    - Mold spores
    - Pollen
    - [ *Wheater Histology* says nasal mucosa purpose is to trap “particulate matter” (*Wheater p223: Fig 12.3 Nasal mucosa*). ]
  - Dust
    - Atmospheric dust
    - Settling dust
    - Heavy dust
  - Particulate contaminants
    - Soot

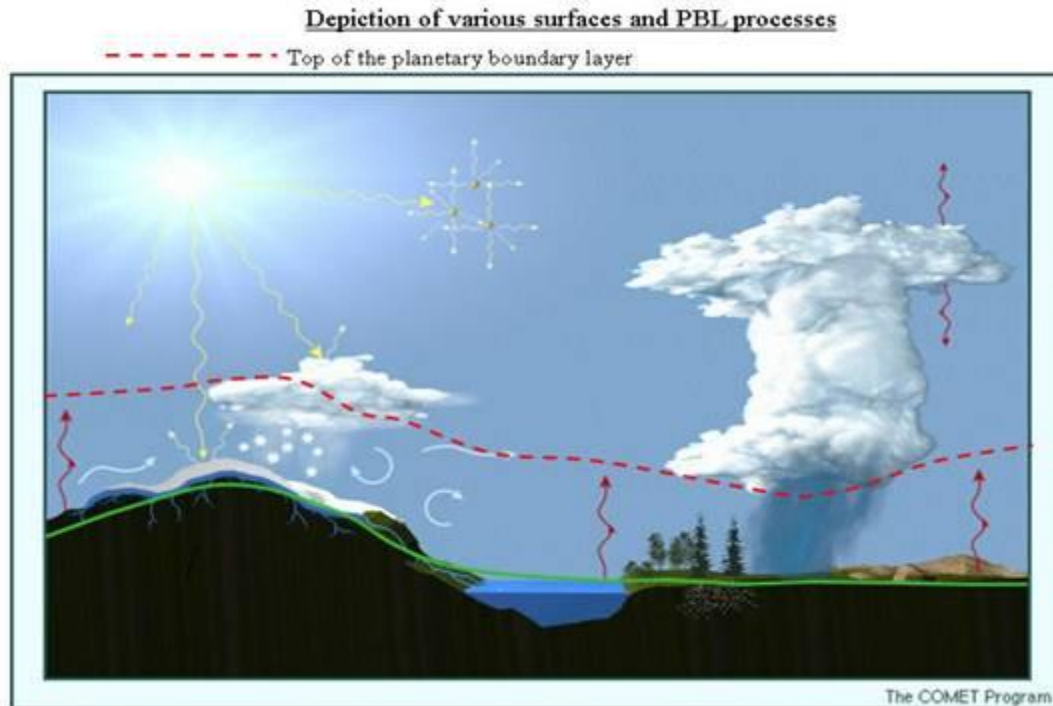
- a.k.a. black carbon
    - Tobacco smoke
    - Smog
    - Oil smoke
    - Fly ash
    - Cement dust
  - Gas molecules
    - Gaseous contaminants
      - CO<sub>2</sub>
      - CCl<sub>4</sub>
      - CH<sub>4</sub>
- General
  - Solid or liquid
  - WHO classifies some as Class I carcinogen
  - Can clog plant stomata
  - Global dimming has occurred.
- Dust
  - Wind-blown mineral dust
- Air quality
  - PM 2.5 seems to be used as index for air quality.
  - Canada
    - PM 2.5 allowed limit is 28 ug / m<sup>3</sup>
- <https://en.wikipedia.org/wiki/Particulates>

## Atmosphere layers



### Atmosphere layers

- Summary
  - The way to remember 5 layers (from lowest to highest) is the **first letter** of each word in the sentence:
    - **T**en **S**atellites **M**ap **T**he **E**arth.
    - **T**ropo-sphere **S**trato-sphere **M**eso-sphere **T**hermo-sphere **E**xo-sphere.
  - Kennelly-Heaviside
    - **Ionosphere** is part of Meso / Thermo / Exo.
    - **Kennelly-Heaviside** is part of Ionosphere.
- Source
  - <https://en.wikipedia.org/wiki/Troposphere>



### Planetary boundary layer

- Bio-aerosols concentrate in the **Planetary Boundary Layer (PBL)** which is the dotted red line - - - - -.
- [https://en.wikipedia.org/wiki/Planetary\\_boundary\\_layer](https://en.wikipedia.org/wiki/Planetary_boundary_layer)

## Smoke

### Smoke

- Defn
  - = **airborne gases and particulates** released by **combustion**.
  - = **aerosol** of **particles**
  - **Air** is **entrained** into the mass.
- O<sub>2</sub> and T
  - **More O<sub>2</sub>** means **burn hotter**.
  - **High T** → **nitrogen oxides**
- What's in the smoke depends on what's burning
  - **Partial oxidation of C** → **CO**
  - **Sulfur** → **sulfur dioxide**
  - **N** → **HCN, NH<sub>3</sub>**
  - **Cl-halogens** → **chlorine<sub>(g)</sub>, phosgene<sub>(g)</sub>**
  - **Fluoro-carbons** → **HF**
  - **Transformer oil PCB** → **2,3,7,8-tetra-choro-di-benzo-dioxin** (**potent carcinogen**)
- What's visible?
  - This is usually **soot** a.k.a. **black carbon**.
  - **If it's visible** it's usually **7+ um** and is called **'smoke.'**
    - **NO WAY.** **100 um** is our **naked eye** resolution.
  - **If it's invisible** it's **gas** or **fumes**.
    - **Ionization smoke detectors** detect this stuff.
      - It detects **gas/fumes** from **burning toast** → **FALSE ALARM.**

- Examples
  - Burning leaves in **bonfire**.
  - **Soot** from **diesel truck** without **particulate filters**
- Uses
  - Pest control
  - Controlled burn
- Smoke inhalation
  - This occurs primarily in **indoor fires**.
  - **Death**.
- <https://en.wikipedia.org/wiki/Smoke>

## Radioactive fallout

### Radioactive fallout

- **Radioactive dust**
  - Seems to be a loose synonym (**EPA**).
- **0.1 – 10 um**
  - **Engineering Toolbox**
  - [https://www.engineeringtoolbox.com/particle-sizes-d\\_934.html](https://www.engineeringtoolbox.com/particle-sizes-d_934.html)
- Fallout particles vary in size from thousandths of a millimeter to several millimeters.
  - Weapon debris
  - Fission products
  - Radiated soil if ground burst
  - <https://www.atomicarchive.com/science/effects/radioactive-fallout.html>
- **50 miles into atm**
  - Verbatim (**EPA**)
    - **Detonating nuclear weapons above ground sends radioactive materials as high as 50 miles into the atmosphere.** Large particles fall to the ground near the explosion-site, but lighter particles and gases travel into the upper atmosphere. The particles that are swept up into the atmosphere and fall back down to Earth are called fallout. **Fallout can circulate around the world for years** until it gradually falls down to Earth or is brought back to the surface by precipitation. The path of the fallout depends on wind and weather patterns.
    - <https://www.epa.gov/radtown/radioactive-fallout-nuclear-weapons-testing>
- **Mushroom cloud**
  - Verbatim
    - As the fireball increases in size and cools, the vapors condense to form a cloud containing solid particles of the weapon debris, as well as many small drops of water derived from the air sucked into the rising fireball.
    - Depending on the height of burst, a strong updraft with inflowing winds, called "afterwinds," are produced. These afterwinds can cause varying amounts of dirt and debris to be sucked up from the earth's surface into the cloud. In an air burst with a moderate (or small) amount of dirt and debris drawn up into the cloud, only a relatively small proportion become contaminated with radioactivity. **For a burst near the ground, however, large amounts of dirt and debris are drawn into the cloud during formation.**
    - **The color of the cloud is initially red or reddish brown, due to the presence of nitrous acid and oxides of nitrogen. As the fireball**

cools and condensation occurs, the color changes to white, mainly due to the water droplets (as in an ordinary cloud).

- The cloud consists chiefly of very small particles of radioactive fission products and weapon residues, water droplets, and larger particles of dirt and debris carried up by the afterwinds.
- The eventual height reached by the radioactive cloud depends upon the heat energy of the weapon and upon the atmospheric conditions. If the cloud reaches the tropopause, about 6-8 miles above the Earth's surface, there is a tendency for it to spread out. But if sufficient energy remains in the radioactive cloud at this height, a portion of it will ascend into the more stable air of the stratosphere.
- <https://www.atomicarchive.com/science/effects/mushroom-cloud.html>

## Bio-aerosols

### Bio-aerosol

- What are they?
  - **Bacteria**
    - If it's **marine**, they are usually #1.
    - Water source when airborne is **water vapor** in **cloud** and **fog**.
  - **Fungi**
    - I take it this means fungal **spores**.
      - Aspergillus spore = 2  $\mu\text{m}$
    - **Desiccate** and **die** at **higher ALT** (not stated how high)..
    - Some **survive** despite **severe uv**.
  - **Pollen**
    - 100  $\mu\text{m}$
    - They are the **largest**.
    - Stay suspended the **shortest**.
  - **virus**
    - 10  $\text{nm}$
- Features
  - **Planetary Boundary Layer (PBL)**
    - **PBL** is directly influenced by **contact** with **Earth surface**.
    - **Greatest concentration** of **bio-aerosols** is the **planetary boundary layer (PBL)**.  
What?
    - **Concentration dec** with **ALT**. That makes sense.
  - **Dust plumes**
    - **Dust storms** → **dust plumes** that can rise to 5 km.
    - **Africa / Australia / Asia deserts**
    - **Meningo-coccus**
      - **Meningococcus** outbreak in **SSA** was due to **dust storm**. Wow.
      - **1988** – Outbreak of **Meningococcal meningitis** in **Chad**
        - <https://cmr.asm.org/content/cmr/2/supplement/S118.full.pdf>
      - **J Allergy Clin Immunol, 2017**
        - They don't say the **dust storm** **carried** the **MC**, rather dust seems to **decrease pulmonary macrophage** ability and more likely to get **Meningococcus** from **local** spread. That was my sense of it.
        - <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5338876/>
  - **Clouds**
    - The **bioaerosols** act as **condensation nuclei**. Wow. Makes total sense.
- <https://en.wikipedia.org/wiki/Bioaerosol>

- [https://en.wikipedia.org/wiki/Planetary\\_boundary\\_layer](https://en.wikipedia.org/wiki/Planetary_boundary_layer)
- <http://revistes.iec.cat/index.php/IM/article/viewFile/142193/141128>
  - This is detailed

# Page 167 – PM<sub>2.5</sub> & Colloids

## Atomization: Aerosol spray can and inhaler (puffer)

### Aerosol spray can

- Contents of spray can
  - Payload
    - It boils high above RT.
    - At time of manufacture, it is simply poured into the can before the can is sealed.
    - Left behind as:
      - Droplets
      - Very fine particles
    - That is to say, it is atomized. See Atomize below.
  - Propellant
    - It is pumped into the can under high P after the can is sealed. It has no room to expand as a gas so stays in liquid phase.
    - Droplets evaporate quickly outside the can.
      - It boils well below RT.
    - If it was compressed gas, then would need a way more robust container bc P would be dangerously high. Hmm.
    - It is a liquid miscible with the payload.
    - Computer dusters
      - The propellant is the payload.
    - CFCs
      - They used to be the propellant until *Montreal Protocol* of 1989.
- Can
  - Aluminium
  - Curved bottom bc:
    - a) easier for remaining contents to be sucked up
    - b) stronger
      - All the force spread out equally.
- [https://en.wikipedia.org/wiki/Aerosol\\_spray](https://en.wikipedia.org/wiki/Aerosol_spray)
- <https://science.howstuffworks.com/innovation/everyday-innovations/aerosol-can3.htm>

### Atomization

- Atomization = “separating something into fine particles” (Wik – atomization)
- Examples
  - Aerosol spray can
    - When the liquid flows through the nozzle, the propellant rapidly expands into gas. In some aerosol cans, this action helps to atomize the product, forming an extremely fine spray. In other designs, the evaporating propellant forms bubbles in

- the product, creating a foam. (How Stuff Works – link is in Aerosol spray can)
- Perfume bottle
    - Perfume liquid → evaporation\* into vapor → high rate of diffusion → olfactory Rc
  - Fuel injection
    - Fuel injectors atomize fuel (the all-knowing Dave Heidelbrecht of Performance BMW, St. Catharines, Ontario).
  - e-cigarette
  - nebulizer
  - Atmospheric scientist Molina
    - “Human atomization” of viruses arises from coughing or sneezing producing ... aerosols <5µm and droplets > 5µm.
    - See link in pix (Molina PNAS)
- \* A note of Evaporation
- Water vapor ie water<sub>(gas)</sub> from the tea has condensed into water<sub>(liquid)</sub> on CCN.
  - What’s seen here is droplets (due, basically, to CCN) but I don’t think it technically an aerosol any longer.
  - Aerosol of microscopic water droplets suspended in the air above a hot cup of tea after that water vapor has sufficiently cooled and condensed. Water vapor is an invisible gas, but the clouds of condensed water droplets refract and disperse the sun light and so are visible.
  - <https://en.wikipedia.org/wiki/Evaporation>

### broncho-dilator

- Aerosol droplets are produced by a nebulizer.
  - See, it’s all jargon.
- Indications: Asthma, COPD, CF
- Size of the inhaler particles
  - 0.5 – 3 µm alveolar deposition
  - 2 – 6 µm Tracheobronchial deposition
  - 5+ µm Upper airways deposition
- Goal
  - The goal is to make particles 1 – 5 µm (article says this)
  - The goal is to get to bronchial SM. (my conclusion)
  - The goal is NOT to get into alveoli. (my conclusion)
- Verbatim
  - Many studies reported that aerodynamic diameter in the range from 0.5 to 3 µm will result in alveolar deposition;
  - aerodynamic diameter in the range from 2 µm to 6 µm will result in tracheobronchial deposition;
  - aerodynamic diameter greater than 5 µm will result in deposition in the upper airways.
  - Therefore, to ensure the drug to be deposited in the lung and the range for majority of drug aerodynamic diameter must be controlled from 1 to 5 µm.
  - <https://www.alliedacademies.org/articles/investigation-of-influence-factors-on-particle-size-measurement-with-pmdi-9310.html>
    - Investigation of influence factors on particle size measurement with pMDI
    - Biomedical Research 2017
    - Authors from Guangdong Province (SARS outbreak started here 2003)

Lung penetration: Volcanic ash





### Volcanic ash

- Summary
  - That is a **glass shard** (fragment) – it is **volcanic ash** from **Mount St. Helens** which erupted in Washington state in 1980. How big is it? About 1/10<sup>th</sup> the distance between the tips of this letter 'u'. So that fragment of glass can go into your lungs (the effects of this are described a bit lower down).
  - Math
    - The scale bar is **30 microns (μm)** and it fits about 3 – 4 times across the piece of glass so it's about **100 microns wide**. How wide is that? The distance between the vertical parts of this letter 'u' is 1000 microns (1 mm) ... so the 100 micron shard is about 1/10<sup>th</sup> of that.
- Summary
  - [https://en.wikipedia.org/wiki/Volcanic\\_ash](https://en.wikipedia.org/wiki/Volcanic_ash)

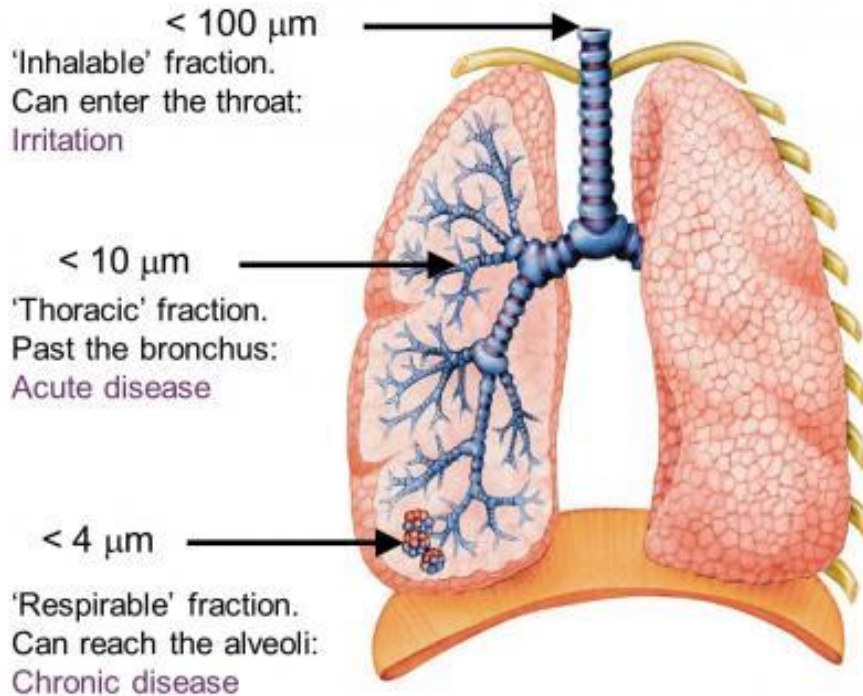


*1980 eruption of Mount St. Helens*

- Summary
  - That is the moment that Mount Saint Helens erupted on May 18, 1980 at 8:32 a.m. The photographer **Austin Post** did not die. He was a research scientist with the **US Geological Survey (USGS)**.
- Source
  - [https://en.wikipedia.org/wiki/1980\\_eruption\\_of\\_Mount\\_St.\\_Helens](https://en.wikipedia.org/wiki/1980_eruption_of_Mount_St._Helens)

*Kilauea's lava is now spilling into the ocean. Here's why that's dangerous*

- Summary
  - This gives a brief description of the hazards of volcanic ash and gases from the **Kilauea volcano on the big island of Hawaii**. The volcano is a cool place to visit! Lots to do on the big island!
- Source
  - **PBS**
    - 21 May 2018
    - <https://www.pbs.org/newshour/science/kilaueas-lava-is-now-spilling-into-the-ocean-heres-why-thats-dangerous>



### Respiratory Effects

- Summary
  - 10-100  $\mu\text{m}$  Inhalable fraction  $\rightarrow$  trachea.
  - 4-10  $\mu\text{m}$  Thoracic fraction  $\rightarrow$  bronchi.
  - $< 4 \mu\text{m}$  Respirable fraction  $\rightarrow$  alveoli (air sacs).
- Verbatim
  - Penetration of ash particles into the respiratory tract is largely dependent on particle size. Larger particles (10-100  $\mu\text{m}$  diameter) lodge in the upper airways, while those in the 4-10  $\mu\text{m}$  size range deposit in the trachea and bronchial tubes. Very fine ( $< 4 \mu\text{m}$  diameter) particles may penetrate deeper into the lungs, into the alveolar region.
  - Comprehensive studies of population exposure to respirable crystalline silica have suggested that the majority of the population are not exposed to sufficiently high airborne concentrations to be at risk of developing **silicosis**, but a smaller group of individuals (such as outdoor workers) may be at risk of developing mild **silicosis**.
- Source
  - Volcanic Ash Impacts Working Group of the US Geological Survey (USGS)
    - The US Geological Survey (USGS) is synonymous with really solid science. I have their earthquake app on my iPhone.
    - 14 December 2014
    - [https://volcanoes.usgs.gov/volcanic\\_ash/respiratory\\_effects.html](https://volcanoes.usgs.gov/volcanic_ash/respiratory_effects.html)

### Traumatic Inhalation due to Merapi Volcanic Ash

- Summary
  - This is a **case report** which is a summary of what happened to a single patient.
  - This 35 year old male was exposed to volcanic ash in Indonesia and the resulting damage to the lungs is called **Pneumonoultramicroscopicsilicovolcanoconiosis** which is the longest word in the English language.
  - Here is what the Oxford English Dictionary (OED) has to say about the word.

- "A facetious word alleged to mean 'a lung disease caused by the inhalation of very fine silica dust' but occurring chiefly as an instance of a very long word."
- Yes, **Pneumono-ultra-microscopic-silico-volcano-niosis** was allegedly invented just so it could claim the title of longest word. Nevertheless, the effects of the ash are real and fall under a kind of umbrella term called **Silicosis** where **silica dust** gets into the lungs. Our lungs are normally quite elastic – they expand when you inhale, and then contract because of their elastic properties. Silica dust inside the lungs restricts this so it's (eventually, as disease progresses) called **Restrictive Lung Disease**. That the simple version of things.
- Let's try some hyphens:
  - **Pneumono-ultra-microscopic-silico-volcano-niosis**
  - Lung-ultra-microscopic-silicon-volcano-niosis
- By the way, silica dust is "inorganic" dust whereas grain dust in a grain silo is "organic" dust. Both can be inhaled can cause problems in the lungs.
- Verbatim
  - **Pneumonoultramicroscopicsilicovolcanoconiosis** is fibrotic lung diseases of the pulmonary parenchyma following chronic inhalation of inorganic dusts containing crystalline silicon dioxide. The acute manifestations observed after heavy ashfalls include attacks of asthma and bronchitis, with an increased reporting of cough, breathlessness, chest tightness, and wheezing due to irritation of the lining of the airways. The chronic health condition of most concern is silicosis, a diffuse nodular fibrosis of the lungs, develops slowly, usually appearing 10 to 30 years after first exposure. A 35 years old male was admitted to Sardjito Hospital, Yogyakarta with complaints of progressive dyspnoea, right side chest pain since last 3 month and periodic episodes of dry cough. He had history of exposure to volcanic ash at the location around volcano eruption for about 10 month. Examination revealed hyperresonant note, diminished vesicular breath sounds in lower right side of the chest. The chest X-ray presence leads to bleb. Based on the clinical and radiological suspicion of pneumoconiosis the patient was submitted to computed tomography of the chest and revealed bilateral multiple bullae mainly at the right lung field. The biopsy specimen verified the diagnosis of anthrocosilicosis. There is no proven specific therapy for any form of silicosis. Symptomatic therapy should include treatment of airflow limitation with bronchodilators, aggressive management of respiratory tract infection with antibiotics, and use of supplemental oxygen (if indicated) to prevent complications of chronic hypoxemia.
- Source
  - Acta Medica Indonesia
    - July 2015
    - <https://www.pbs.org/newshour/science/kilaueas-lava-is-now-spilling-into-the-ocean-heres-why-thats-dangerous>
- Authors
  - Ika Trisnawati, Eko Budiono, Sumardi, Andang Setiadi. Department of Internal Medicine, Faculty of Medicine, Gadjah Mada University - dr. Sardjito Hospital, Yogyakarta, **Indonesia**.

## Restrictive Lung Disease

- Summary
  - If you reaaaaaaaaaally want to go down the rabbit hole, this is a highly technical breakdown of things that cause **Restrictive Lung Disease**. This is the type of thing that a **lung specialist (respirologist) (pulmonologist)** has to know. **Silicosis** is about ¼ down the page (use Ctrl-F on PC or CMD-F on Mac to find it).
- Source
  - StatPearls
    - 25 July 2023

- <https://www.ncbi.nlm.nih.gov/books/NBK560880/>
- Authors
  - Pedro J. Martinez-Pitre - Wyckoff Heights Medical Center
  - Bhanusivakumar R. Sabbula - Nassau University Medical Center
  - Marco Cascella - Istituto Nazionale Tumori - IRCCS - Fondazione Pascale, Via Mariano Semmola 80100, Napoli. Italy

## Volcano – more detail

### Volcano

- Materials ejected
  - Sizes
    - < 62.5 microns = dust
    - 62.5 microns - 4 mm = ash
    - 4 - 32 mm = lapilli
    - > 32 mm (c. 1") = bombs (volcanic bombs)
  - **USGS #1**
    - Small to big
      - < 4um **Respirable fraction** → alveoli
        - Volcanic ash that can get into alveoli, and if high [silica] can cause **Silicosis**.
      - 4-10 um **Thoracic fraction** → bronchi
      - 10-100 um **Inhalable fraction** → trachea
    - Verbatim
      - Penetration of ash particles into the respiratory tract is largely dependent on particle size. Larger particles (10-100 µm diameter) lodge in the upper airways, while those in the 4-10 µm size range deposit in the trachea and bronchial tubes. Very fine (< 4 µm diameter) particles may penetrate deeper into the lungs, into the alveolar region.
      - Deposition of relatively coarse particles in the upper airways is primarily associated with symptoms such as irritation of the nose and throat. Deposition of smaller particles in the thoracic region (bronchial tubes and bronchioles) is thought to be associated with acute disease outcomes such as exacerbation of asthma and bronchitis. **Very fine particles are termed 'respirable' and may penetrate into the deep lungs where chronic, particle-related respiratory diseases, such as silicosis, are activated.**
      - The most hazardous eruptions are those generating fine-grained ash with a high content of free crystalline silica, as this mineral has the potential to cause **silicosis** (a chronic lung disease resulting in scarring damage to the lungs and impairment of their function). **Silicosis is primarily an occupational disease associated with occupations such as stone-cutting, road and building construction and quarrying.**
      - Some volcanoes mass-produce crystalline silica in lavadomes. These are viscous lava piles which grow within volcanic craters and are prone to collapse, generating airborne fine-grained ash rich in free crystalline silica. At Soufrière Hills volcano, Montserrat, West Indies, an eruption began in **1995** and was intermittently active until 2010. This eruption

generated dome collapse ash composed of up to 25 wt.% crystalline silica, prompting the UK government to implement controls to minimise population exposure. Comprehensive studies of population exposure to respirable crystalline silica have suggested that the majority of the population are not exposed to sufficiently high airborne concentrations to be at risk of developing silicosis, but a smaller group of individuals (such as outdoor workers) may be at risk of developing mild silicosis.

- To date, no longer-term diseases such as silicosis have been attributed to exposure to volcanic ash, although this may be due to inadequate case collection.
- [https://volcanoes.usgs.gov/volcanic\\_ash/respiratory\\_effects.html](https://volcanoes.usgs.gov/volcanic_ash/respiratory_effects.html)

#### ○ USGS #2

- Ash is not combustion product.
- It is glass and rock fragments.
- Range in size
  - 2 mm
    - Clay-like
  - 0.004 mm = 4 um
    - This value of 4 um totally congruent with USGS #1 above where it is the Respirable fraction.
- Distance blown
  - Wind blows volcanic ash 10's to 1000's of km away from volcano.
- Verbatim
  - Volcanic ash is not the product of combustion, like the soft fluffy material created by burning wood, leaves, or paper, but rather consists of fragments of rocks, minerals, and volcanic glass ranging in size from sand to clay-like (from 2 mm (1/12 in) to less than 0.004 mm (1/256th in) in diameter). Ash is hard, abrasive, mildly corrosive, conducts electricity when wet, and does not dissolve in water. Ash is spread over broad areas by wind.
  - Volcanic ash is formed during explosive volcanic eruptions. Explosive eruptions occur when gases dissolved in molten rock (magma) expand as the magma rises, and then escape violently into the air, or when water is heated by magma and abruptly flashes into steam. The force of the escaping, expanding gas violently shatters solid rocks and shreds the magma blasting it into the air. Once airborne, the magma solidifies into fragments of volcanic rock and glass. Wind can then blow the tiny ash particles tens to thousands of kilometers away from the volcano.
  - [https://volcanoes.usgs.gov/volcanic\\_ash/respiratory\\_effects.html](https://volcanoes.usgs.gov/volcanic_ash/respiratory_effects.html)

#### ○ Pneumonoultramicroscopicsilicovolcanoconiosis

- Pneumo-ultra-microscopic-silico-volcano-coniosis
- Longest word in English language.
- It's silicosis due to volcanic ash.
- Approved by the National Puzzler's League. Okey, dokey.
- <https://en.wikipedia.org/wiki/Pneumonoultramicroscopicsilicovolcanoconiosis>

Lung penetration – more detail

## Mammal lungs

- Airflow in mammalian lungs is bidirectional during the respiratory cycle, with highly reduced airflow in peripheral structures, i.e., bronchioles and, particularly, the gas-exchanging alveoli. Consequently, small particles (< 1  $\mu\text{m}$ ) that enter the alveoli may sediment, making a system of first line of defense necessary, comprising **alveolar macrophages** (white blood cells), SP-A, and (phospholipid) regulators of inflammatory processes (From: Bernhard et al. 2004).
  - Eastern Kentucky University (EKU): Ornithology 554/754 course
    - Phenomenal info.
    - <http://people.eku.edu/ritchisong/birdrespiration.html>

## Nitty gritty definitions

### Nitty gritty definitions

- **Suspension**
  - Multi-part definition
    - Solute does NOT dissolve.
    - Solute is suspended in the solvent.
    - Solid particles in the liquid will eventually settle.
    - It is only called a suspension while the particles have not yet settled.
  - Examples
    - Sand in water.
    - Flour in water.
    - Mud = silt / clay etc in water.
- **Colloid**
  - It is sometimes a.k.a. colloidal suspension.
  - The difference from a suspension is that in a colloid particles do not settle or take a long time to do so.
  - 1 – 1000 nm
  - Examples
    - Milk
    - ICU colloids
      - D5W
      - Albumin
- **Crystalloid**
  - It's a solution = 1 thing dissolved in another = NaCl crystals dissolved in water ... hence *crystalloid*.
  - Example – ICU crystalloids
    - 9% NaCl
- **Solution**
  - Verbatim – Wik solution
    - In chemistry, a **solution** is a special type of homogeneous mixture composed of two or more substances. In such a mixture, a solute is a substance dissolved in another substance, known as a solvent.
  - [https://en.wikipedia.org/wiki/Suspension\\_\(chemistry\)](https://en.wikipedia.org/wiki/Suspension_(chemistry))
  - <https://en.wikipedia.org/wiki/Colloid>
  - <https://en.wikipedia.org/wiki/Solution>

# Page 168 – A Dead Horse named *Equus*

## Horse taxonomy



### Horse

- Summary
  - The classification of horses, not unlike the classification of droplets, is confusing due to an abundance of synonyms. All horses are 'wild horses', even the ones that live in a barn.
  - When 2 species are very similar, a subspecies may be added.
- Wild horse classification (the simple version)
  - Domesticated horse *Equus ferus caballus*
  - Przewalski's horse *Equus ferus przewalskii*
  - European wild horse<sup>†</sup> *Equus ferus ferus*
- Wild horse classification (the synonym nightmare version)
  - *Equus ferus caballus*
    - This is your standard horse everyone thinks of when you say, 'horse.'
    - Synonyms
      - Domesticated horse



- So even though it's a domesticated horse it still falls under the umbrella of wild horse. That's why it's confusing. *How can something be domesticated and wild at the same time?* Thanks alot, zoology.
    - Modern horse
    - *Equus caballus*
      - This is Genus and species.
    - *Equus ferus caballus*
      - This is Genus, species, and subspecies.
    - Feral horse
      - This is simply a domesticated horse that escaped and now lives in the wild.
      - The Latin word *ferus* means wild or untamed. That's how we get the word feral.
        - Online Etymology Dictionary
          - <https://www.etymonline.com/search?q=ferus>
    - Feral domestic horse
  - *Equus ferus przewalskii*
    - Synonyms
      - Przewalski's horse
        - It is named after the Russian geographer Nikolay Przhevalsky. Yes, that is the correct spelling. For the horse, somebody changed the Russian name to a Polish name.
      - *Equus przewalskii*
        - Notice how an extra 'i' is added just to mess you up. That's because zoologists are tied at the hip to Latin.
      - *Equus ferus*
      - *Equus ferus przewalskii*
      - *Mongolian wild horse*
  - *Equus ferus ferus*<sup>†</sup>
    - This is extinct, last seen in 1909. It might just be a feral horse.
    - Synonyms
      - European wild horse
      - Tarpan
      - *Equus ferus ferus*
- Verbatim
  - The wild horse (*Equus ferus*) is a species of the genus *Equus*, which includes as subspecies the modern domesticated horse (*Equus ferus caballus*) as well as the endangered Przewalski's horse (*Equus ferus przewalskii*, sometimes treated as a separate species i.e. *Equus przewalskii*).
- Source
  - <https://en.wikipedia.org/wiki/Horse>
  - [https://en.wikipedia.org/wiki/Feral\\_horse](https://en.wikipedia.org/wiki/Feral_horse)
  - [https://en.wikipedia.org/wiki/Wild\\_horse](https://en.wikipedia.org/wiki/Wild_horse)
    - This is the source of the verbatim comment.
  - [https://en.wikipedia.org/wiki/Przewalski%27s\\_horse](https://en.wikipedia.org/wiki/Przewalski%27s_horse)
  - [https://en.wikipedia.org/wiki/Nikolay\\_Przhevalsky](https://en.wikipedia.org/wiki/Nikolay_Przhevalsky)
  - <https://en.wikipedia.org/wiki/Tarpan>



*Przewalski's horse*

- [https://en.wikipedia.org/wiki/Przewalski%27s\\_horse](https://en.wikipedia.org/wiki/Przewalski%27s_horse)



That's **Nikolay Przhevalsky**.

- [https://en.wikipedia.org/wiki/Nikolay\\_Przhevalsky](https://en.wikipedia.org/wiki/Nikolay_Przhevalsky)



### Tarpan

- a.k.a. European wild horse.
- It's extinct, sadly.
- <https://en.wikipedia.org/wiki/Tarpan>

Amazing horse facts



Those are horse lungs. Wow.

- Verbatim
  - "Do you really understand how big your horse's lungs are? This picture is a horse's lungs fully inflated...amazing when you think they are enclosed in a horse's body! Did you know a horse takes in 2x 5-Gallon buckets of air ever second? Think of how much that really is. So, do the best you can to help your horse breathe!"
- The Horseaholic
  - <https://thehorseaholic.com/do-you-really-understand-how-big-your-horses-lungs-are/>

### Respiratory System Overview

- Respiratory rate
  - Horse 12 – 24 breaths per minute
  - Human 12 – 20 breaths per minute

- Amazing facts
  - A horse can only breath through its nose.
  - 1 breath = 1 stride = **respiratory-locomotory coupling**. Hmmmm.
  - If it runs 2x as fast, it needs 2x as much air.
    - That seems a bit simple.
  - Apparently cannot train the respiratory system of a horse.
    - The amount of air moved in/out is the same whether a horse is unfit of when fully fit.
    - Hmm. But I think Cardiac Output must increase? i.e., increased heart rate, increased contractility.
  - **Exercise-Induced Pulmonary Hemorrhage**
    - Occurs deep in the horse lungs.
    - Capillary rupture, I get the sense.
    - Rarely will the horse bleed from the nostrils.
- Source
  - Flairstrips
    - <https://flairstrips.com/respiratory-system-overview/>

## CHAPTER 6 – DISASTER

Page 169

**Page 170 – Titanic #1 - Nice  
going, Jack**

**Titanic Museum**



That's a photo I took of the [Titanic Museum in Belfast, Ireland](https://www.titanicbelfast.com). Look how small that kid is in the foreground. It is an amazing museum. I spent the entire day there.

- There is an auditorium with a clear plexiglass floor and you basically hover over the remains of the *Titanic*. Feels like you're right there. Super cool. Go visit!!
- Here's the museum link.
- <https://www.titanicbelfast.com>



This is the shipyard where Titanic was built. Looking towards Museum.





The windows in the museum are supercool. They have a grid that fades in and out slowly, showing the location of the *Titanic* during construction. Note that the bow (front) is closest to the museum. When released, the *Titanic* stern (rear) went into the water first. Restated, it was launched backwards.

## Titanic trivia

### *Titanic Was Meant to Sink, Here's the Proof*

- Summary
  - This is a 17-minute YouTube video that compares *Titanic* with modern cruise ships.
- Source
  - **Bright Side**
    - [https://www.youtube.com/watch?v=9wxxseFDq\\_U](https://www.youtube.com/watch?v=9wxxseFDq_U)

### Encyclopedia Titanica

- Summary
  - Everything you ever wanted to know about the *Titanic*.
- Source
  - <https://www.encyclopedia-titanica.org>

### *The Sinking of the RMS Titanic*

- Verbatim – slide no. 18
  - After the *Titanic* sank from having its compartments filled with water, ships design changed.
  - Ships with double bottoms hulls were extended higher up to make it a double hull.

- Also, the height of the bulkheads on ships was raised so to make all compartments watertight.
- Source
  - Slide Player
    - 21 slides
    - <https://slideplayer.com/slide/14988271/>

### Changes in safety practices after the sinking of the Titanic

- Summary
  - This describes changes to ship design after *Titanic* sank.
  - There is information on **bulkheads** at the very end.
- Source
  - [https://en.wikipedia.org/wiki/Changes\\_in\\_safety\\_practices\\_after\\_the\\_sinking\\_of\\_the\\_Titanic](https://en.wikipedia.org/wiki/Changes_in_safety_practices_after_the_sinking_of_the_Titanic)

# Page 171 – Titanic #2 - A Gigantic, Floating Ice Cube Tray

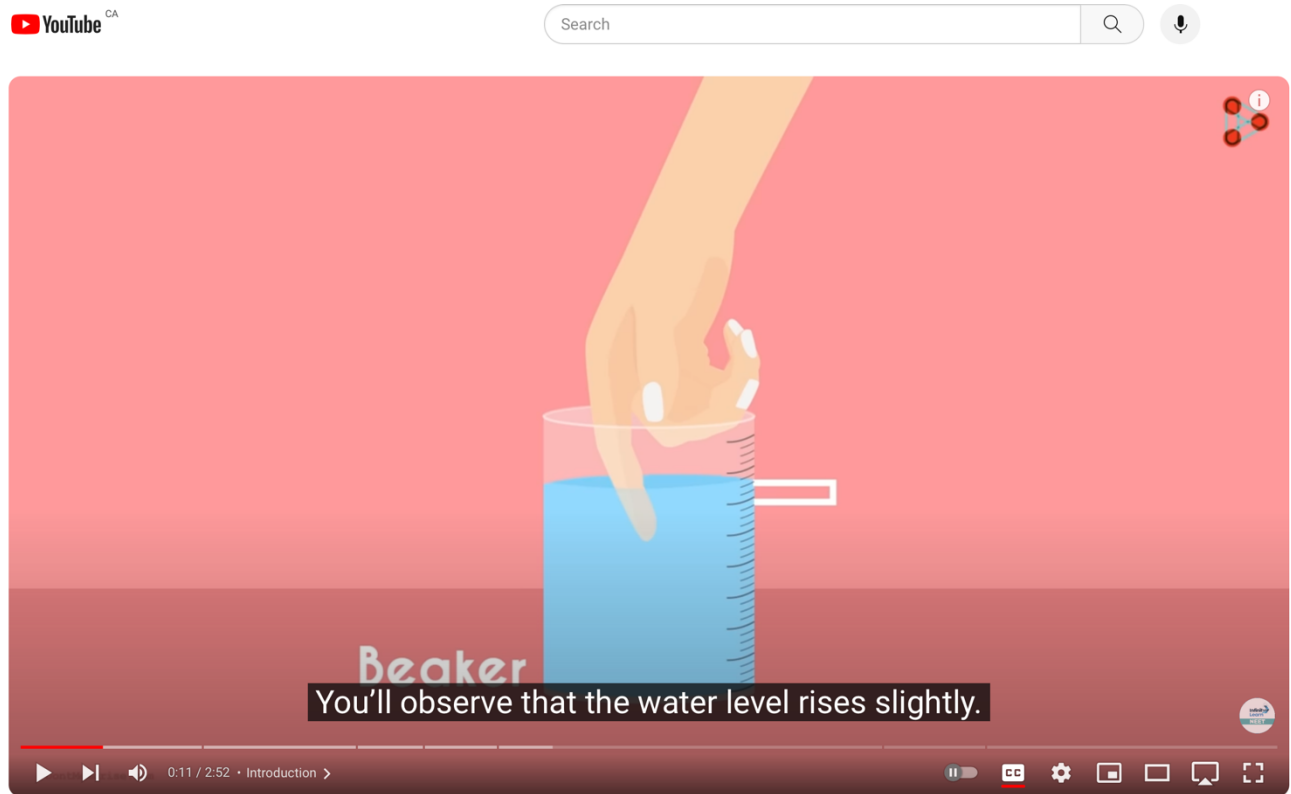
### Encyclopedia Titanica

- Summary
  - Everything you ever wanted to know about the *Titanic*.
- Source
  - <https://www.encyclopedia-titanica.org>

## Archimedes

### Archimedes

- These are my notes from a long time ago. I forget the source – probably Encyclopedia Britannica.
- **B. 287 BC** in **Syracuse, Sicily**. **D. 212 BC (age 75y)** – killed by a Roman soldier during **Siege of Syracuse** in the **Second Punic War**. So it looks like he was born and died in Sicily.
- Do not disturb my circles
  - Μη μου τους κύκλους τάραττε - *Do not disturb my circles*.
  - [http://en.wikipedia.org/wiki/Image:Archimedes\\_circles.ogg](http://en.wikipedia.org/wiki/Image:Archimedes_circles.ogg) ... this is the Greek audio clip.
  - Archimedes apparently says this to the Roman soldier. Epic. A true mathematician.
- Pythagoras
  - Pythagoras **580-500 BC** predated Archimedes. Going by birthdates, Pythagoras was born **293y earlier**.
  - Archimedes uses  $a^2 + b^2 = c^2$  in his pi-proving theorems.



### What is the Archimedes' Principle? | Gravitation | Physics | Infinity Learn



Infinity Learn NEET  
3.25M subscribers

Subscribe

25K



Share

Thanks

Clip

Save



### What is the Archimedes' Principle? | Gravitation | Physics | Infinity Learn

- Summary

- This is a 3-minute video explaining **Archimedes' Principle**. It's methodical and easy to follow along.
- There are 1.6 million views ... which goes to show how much we like to know how ships float.

- Source

- Infinity Learn NEET
  - YouTube
  - July 2017
  - <https://www.youtube.com/watch?v=05WkCPORlj4>

**How ARCHIMEDES DERIVED THE VALUE OF  $\pi$  22 CENTURIES AGO**

$\pi = \frac{C}{D}$   
 $= 3.141592654$

1. Square ABCD has what value for side a (line segments AB, BC, CD, DA)?  
i)  $\triangle ABC: A^2 + B^2 = C^2 \therefore a^2 + a^2 = 2^2$   
Pythagoras  $2a^2 = 4$   
 $a = \sqrt{2}$

2. What is a rough estimate of  $\pi$ , now?  
 $\pi = \frac{C}{D} \approx \frac{4 \times \sqrt{2}}{2} = 2\sqrt{2} = 2.828$

3. How do we improve our accuracy?  
We go from a 4 edge polygon (a square) to an 8 edge polygon (an octagon)  $\therefore$  the perimeter of the polygon more closely approximates the circumference of the circle. We bisect each edge of the square to make an octagon.

4. What will be our new estimate of  $\pi$ ?  
 $\pi = \frac{C}{D} = \frac{8 \times b}{2}$

5. Let us now derive the value of b:  
i)  $\triangle BDE: A^2 + B^2 = C^2$   
 $x^2 + (\frac{1}{2}a)^2 = 1^2$   
 $x^2 + \frac{a^2}{4} = 1$   
 $x^2 = 1 - \frac{a^2}{4}$   
 $x = \sqrt{1 - \frac{a^2}{4}}$   
ii)  $\triangle BEF: A^2 + B^2 = C^2$   
 $(\frac{1}{2}a)^2 + (1-x)^2 = b^2$   
 $\frac{a^2}{4} + (1 - \sqrt{1 - \frac{a^2}{4}})^2 = b^2$   
 $\frac{a^2}{4} + 1 - 2\sqrt{1 - \frac{a^2}{4}} + 1 - \frac{a^2}{4} = b^2$   
 $2 - 2\sqrt{1 - \frac{a^2}{4}} = b^2$   
 $2 - \sqrt{4(1 - \frac{a^2}{4})} = b^2$   
 $2 - \sqrt{4 - a^2} = b^2$

iii) Substitute  $a = \sqrt{2}$  into the eqn ( $a = \sqrt{2}$ ):  
 $b = \sqrt{2 - \sqrt{4 - (\sqrt{2})^2}}$   
 $b = \sqrt{2 - \sqrt{4 - 2}}$   
 $b = \sqrt{2 - \sqrt{2}}$  8gon (octagon)

6. Our better estimate of  $\pi$  is now what?  
 $\pi = \frac{C}{D} \approx \frac{8 \times b}{2} = \frac{8\sqrt{2 - \sqrt{2}}}{2} = 4\sqrt{2 - \sqrt{2}}$   
 $= 3.061$

7. Next we cut up the (octa) 8-gon into a 16-gon. Line segment FC is bisected at G. The  $\triangle OFH$  is  $\frac{1}{16}$ th of our 16-gon. Line segment FH is  $\frac{1}{16}$ th of the edge of the 16-gon polygon.

8. Let us now derive the value of segment FH:  
i) The goal is to derive a value for the hypotenuse of  $\triangle FGH$  (i.e., line segment FH); this is identical to the goal of Step 5 which was to derive the value of the hypotenuse of  $\triangle BEF$  (i.e., b).  
ii) The only thing that's changed is the value of a.  
  
As before:  
 $x = \sqrt{1 - \frac{a^2}{4}}$   
 $b = \sqrt{2 - \sqrt{4 - a^2}}$   
iii) Now substitute the value for (b) (from 5iii) into (a):  
 $b = \sqrt{2 - \sqrt{4 - a^2}}$   
 $b = \sqrt{2 - \sqrt{4 - (\sqrt{2 - \sqrt{2}})^2}}$   
 $b = \sqrt{2 - \sqrt{4 - (2 - \sqrt{2})}}$   
 $b = \sqrt{2 - \sqrt{2 + \sqrt{2}}}$  16gon  
9)  $\pi = \frac{C}{D} \approx \frac{16 \times b}{2} = \frac{16\sqrt{2 - \sqrt{2 + \sqrt{2}}}}{2} = 3.121$

10) We repeat the procedure for a 32 gon. (Now (a) will be the value from 8iii)  
 $b = \sqrt{2 - \sqrt{4 - a^2}}$   
 $b = \sqrt{2 - \sqrt{4 - (\sqrt{2 - \sqrt{2 - \sqrt{2}})^2}}$   
 $b = \sqrt{2 - \sqrt{4 - (2 - \sqrt{2 + \sqrt{2}})^2}}$   
 $b = \sqrt{2 - \sqrt{2 + \sqrt{2 + \sqrt{2}}}}$  32gon  
11)  $\pi = \frac{C}{D} \approx \frac{32 \times b}{2} = \frac{32\sqrt{2 - \sqrt{2 + \sqrt{2 + \sqrt{2}}}}}{2} = 3.1365$

▶ Archimedes went as far as a 96g w/o a decimal system or a hand calculator or a Cray Supercomput

▶ NOTE on the Area of a Circle:

1. Suppose there's a pentagon in a circle  
2.  $A_{\Delta} = \frac{1}{2}bh$   
 $\therefore A_{SA} = 5 \cdot (\frac{1}{2}bh)$   
 $\therefore A_{SA} = 5b \cdot \frac{h}{2}$   
 $= \text{perimeter} \times \frac{h}{2}$   
3. If you fill the circle with limitless polygons, h approaches r (i.e.,  $h=r$ ) and perimeter approaches that of the circle (i.e., perimeter =  $c = \pi D$ )  
 $\therefore$   
 $A_{\text{limitless } \Delta} = \text{perimeter} \times \frac{h}{2}$   
 $= \pi D \times \frac{r}{2}$   
 $= \pi \cdot 2r \times \frac{r}{2}$   
 $= \pi r^2$

Archimedes derived the value of pi 3.14 22 centuries ago.

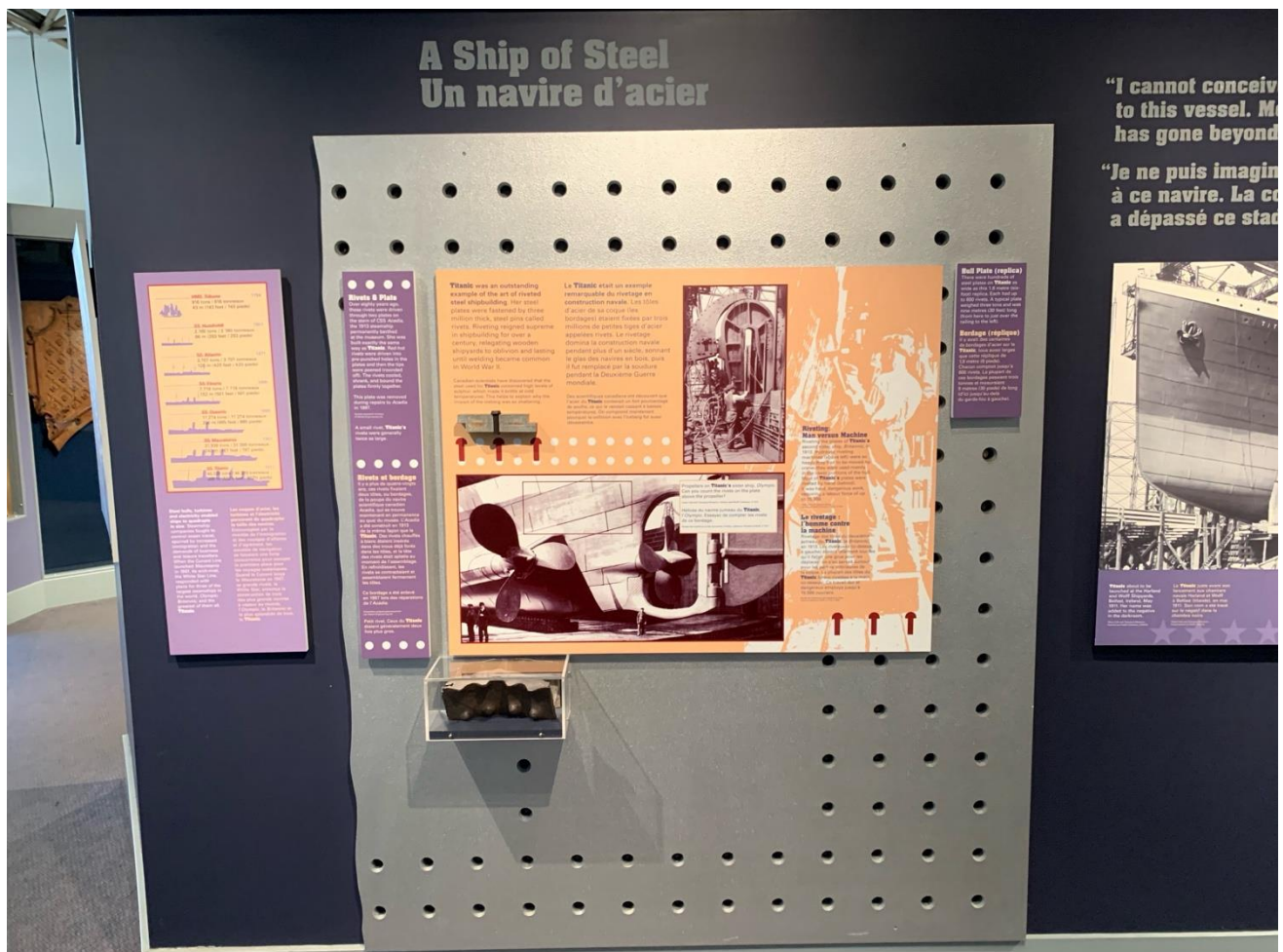
- Those are my notes. I forget the book I used to do this. It was a fantastic exercise. It's a way to cross time – not trying to sound cliché' but it does feel this way. This is doing the exact same math that Archimedes came up with. It's actually an honour.

# Page 172 -- Titanic #3 - Rivets, Rivets, Rivets

Encyclopedia Titanica

- Summary
  - Everything you ever wanted to know about the *Titanic*.
- Source
  - <https://www.encyclopedia-titanica.org>

## Rivets



This is the rivets and steel plates exhibit at the Maritime Museum of the Atlantic in Halifax, Nova, Scotia, Canada. Many Titanic victims were buried in Halifax. I took these photos.



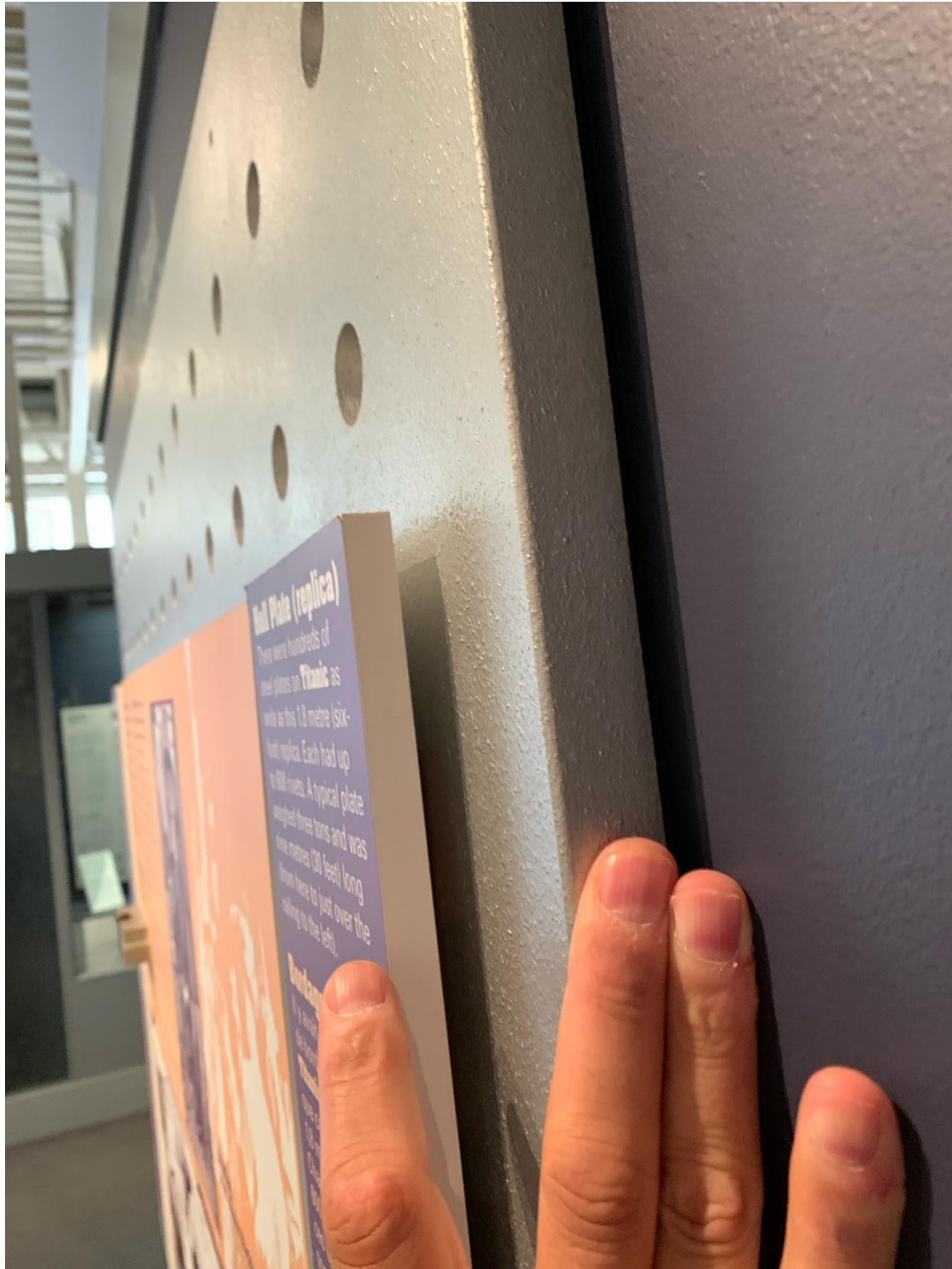
At the top left, do you see the rivet holding together 2 steel plates?

## in World War II.

Canadian scientists have discovered that the steel used for **Titanic** contained high levels of sulphur, which made it brittle at cold temperatures. This helps to explain why the impact of the iceberg was so shattering.

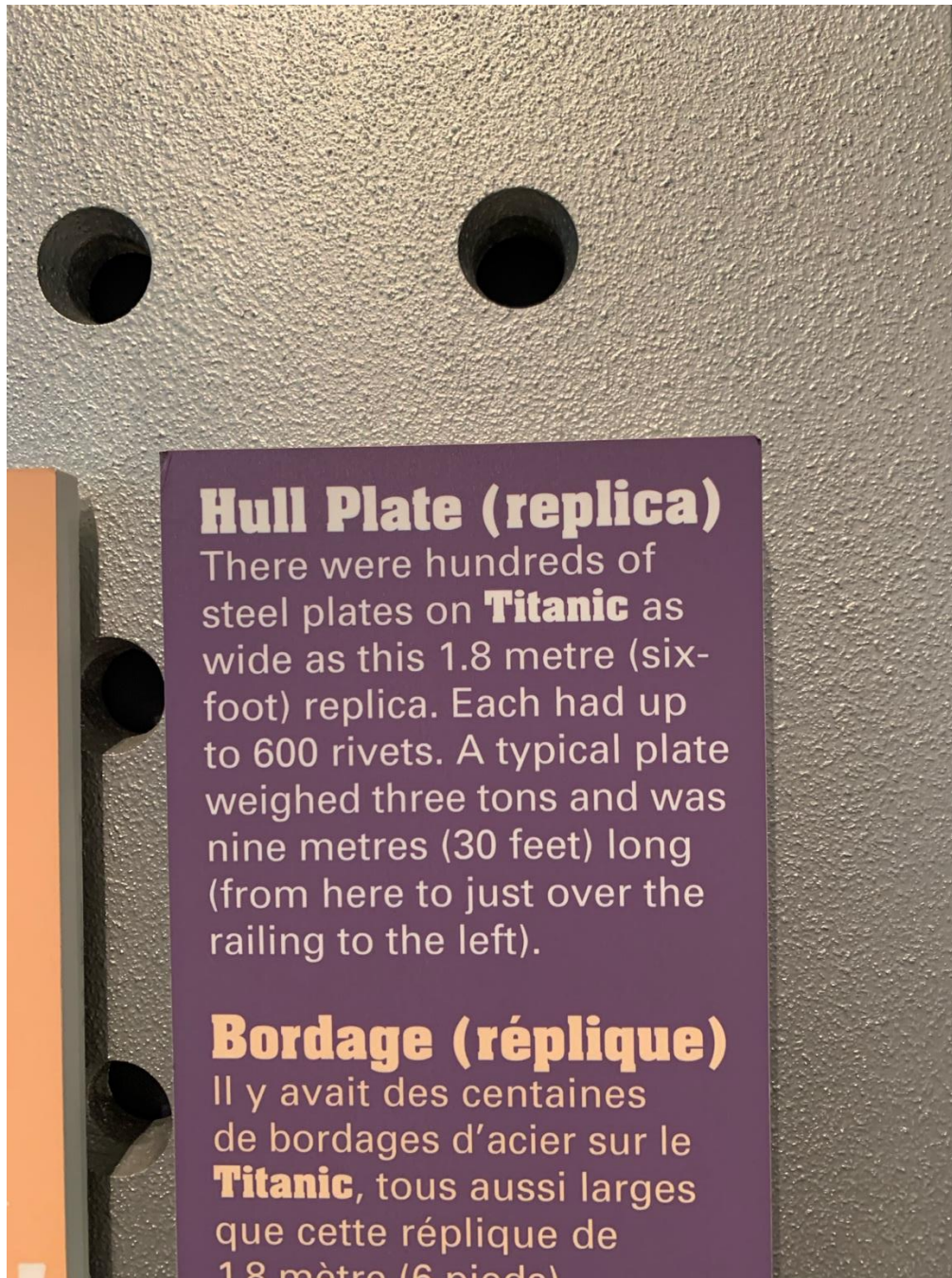


That's a rivet just like the one in *Titanic* – the same dimensions.



That is the actual thickness of the **Titanic steel plates**. My fingers.





### **Hull Plate (replica)**

There were hundreds of steel plates on **Titanic** as wide as this 1.8 metre (six-foot) replica. Each had up to 600 rivets. A typical plate weighed three tons and was nine metres (30 feet) long (from here to just over the railing to the left).

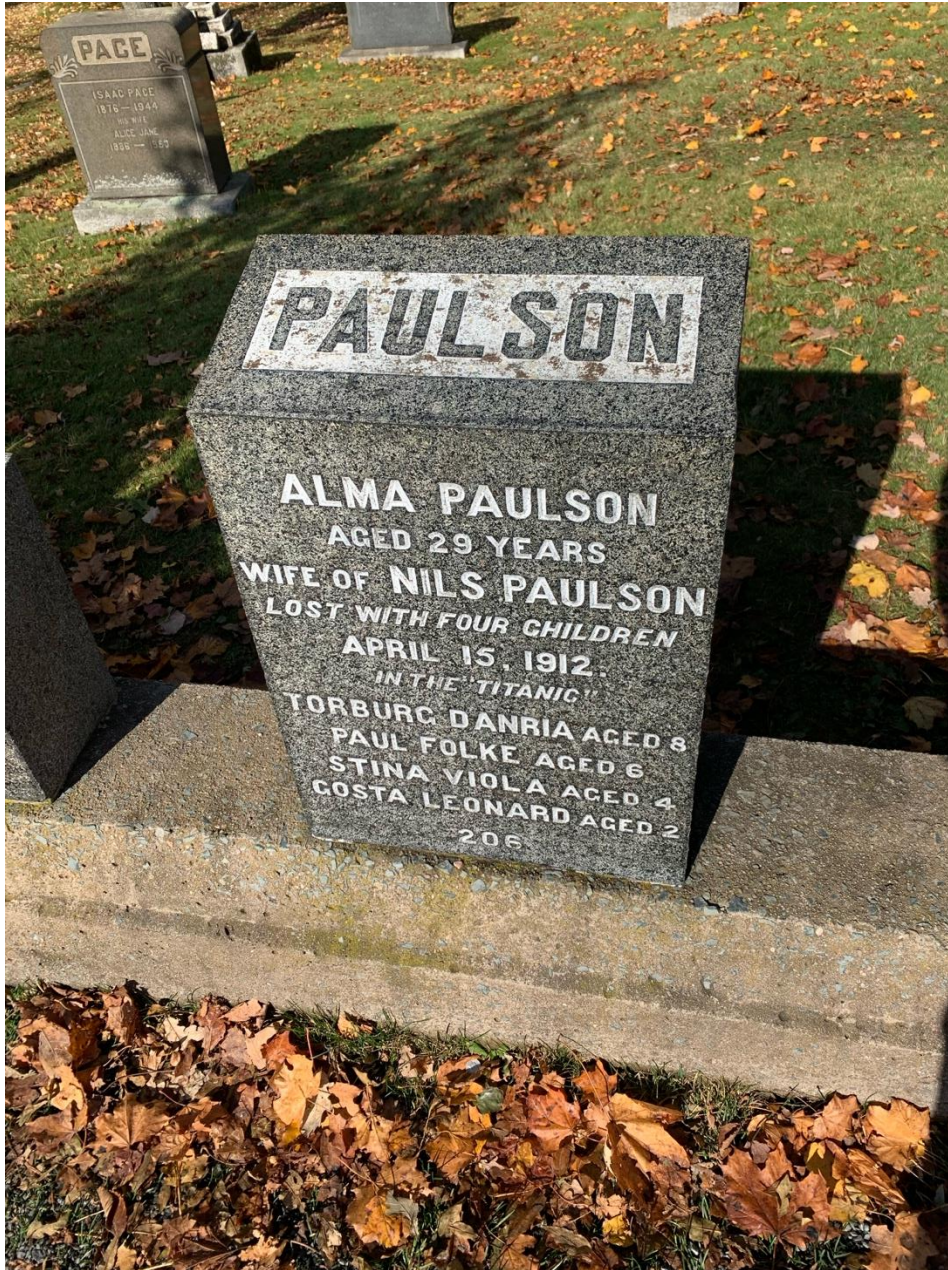
### **Bordage (réplique)**

Il y avait des centaines de bordages d'acier sur le **Titanic**, tous aussi larges que cette réplique de 1.8 mètre (6 pieds).

600 rivets per 30 foot long (9 m) steel plate.



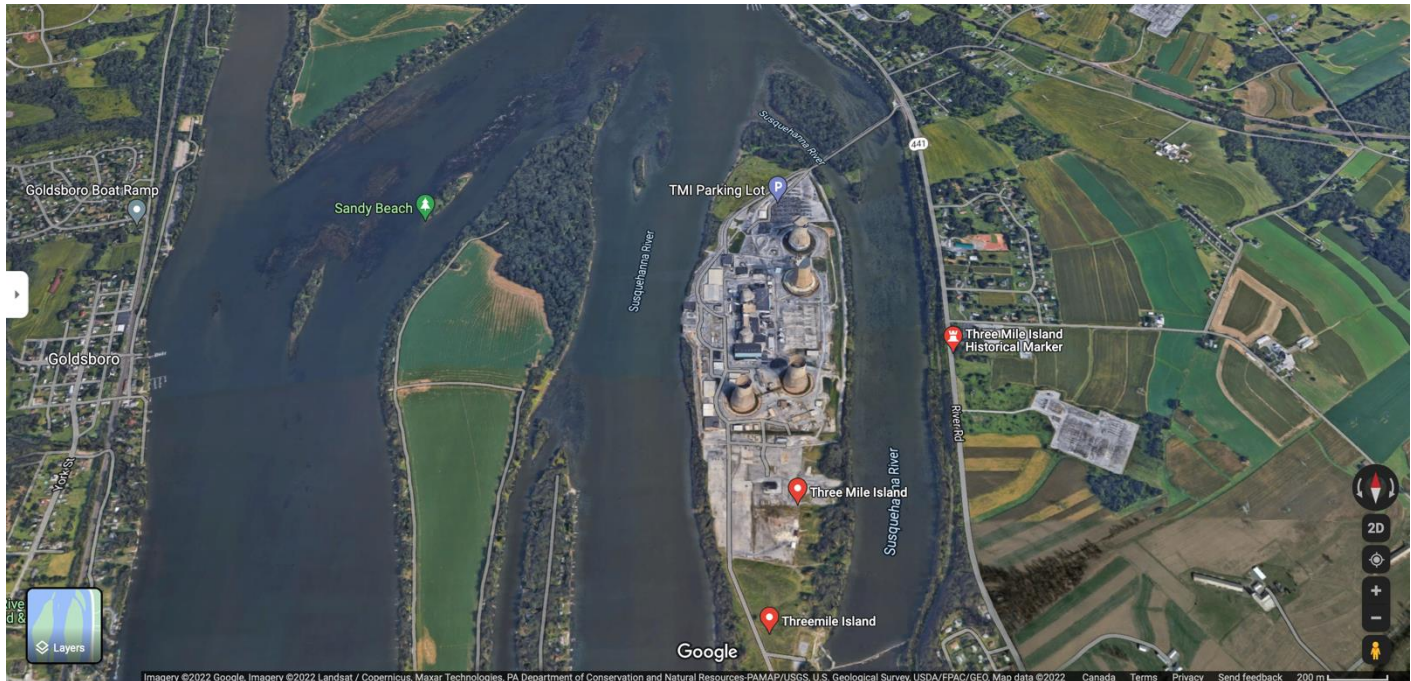
That's the **Titanic** section of the **Halifax cemetery**. It's quite surreal knowing a Titanic traveler who died of hypothermia in the cold water is just six feet under your feet. It's worth the trip. Halifax has neat museums and yummy seafood.



Surreal.

# Page 173 – Three Mile Island TMI

# Geography



That's **Three Mile Island** on the **Susquehanna River** in **Pennsylvania**.

- The green Island to the left is **Shelley Island**.
- Looks like **Susquehanna** has 2 n's but I only spelled it with 1 n in my drawing. Oops.



**Three Mile Island**

- **Reactor #2** is the one with the **sideways blue building** just **south** of it. View is to the **North**. More detail in the image below.
- [Google Maps link](#)

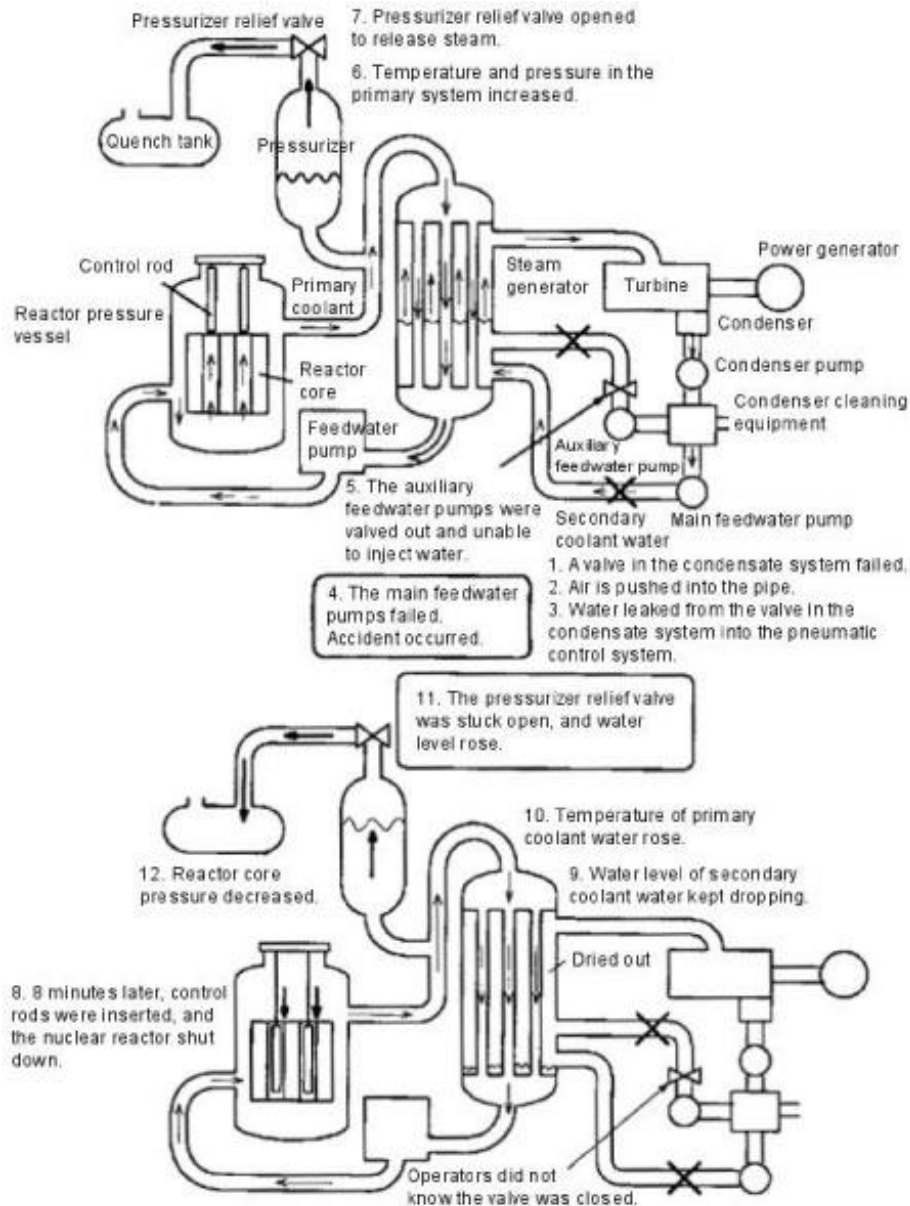
- Okay, thanks to the **Google software engineer**, whoever you are, who makes this incredible 3D zoom-in technology possible.
- <https://www.google.com/maps/place/Threemile+Island/@40.1393638,-76.7318794,14z/data=!4m6!3m5!1s0x89c89685aa0e35b3:0x25570e3035f73a70!8m2!3d40.14426!4d-76.7246908!16s%2F1hc523jh8?authuser=1&entry=ttu>



This is looking south. So the 2 cooling towers are at the *bottom* of the Google maps image above.

- **Reactor number 2** a.k.a. **TMI-2** had the meltdown.
- I added the labels in PowerPoint.
- [https://en.wikipedia.org/wiki/Three\\_Mile\\_Island\\_accident](https://en.wikipedia.org/wiki/Three_Mile_Island_accident)

## Sequence of events



### Sequence of events 1 - 12

- Dope
  - The key feature to notice is the **Pressurizer** (looks like a **plastic soda can**). The main design flaw is with the **Pressure relief valve**. The **operators** in the **control room** do not know whether it's open or closed, only if the **solenoid** is active. Hmmm, not a great design but hey, we don't think of everything on the first draft. Edison sure didn't.
  - These are my notes.

### UPPER ½ OF DIAGRAM

- 1 – **Valve** in **condensate system** fails
  - 2 – **Air** pushed into pipes
  - 3 – **Water** leaks from the **condensate valve** into **pneumatic control system**
  - 4 – **Main feedwater pump** fails in the **non-nuclear cooling system** = **Accident**.
- What should happen next is the **auxiliary pumps** kick in.

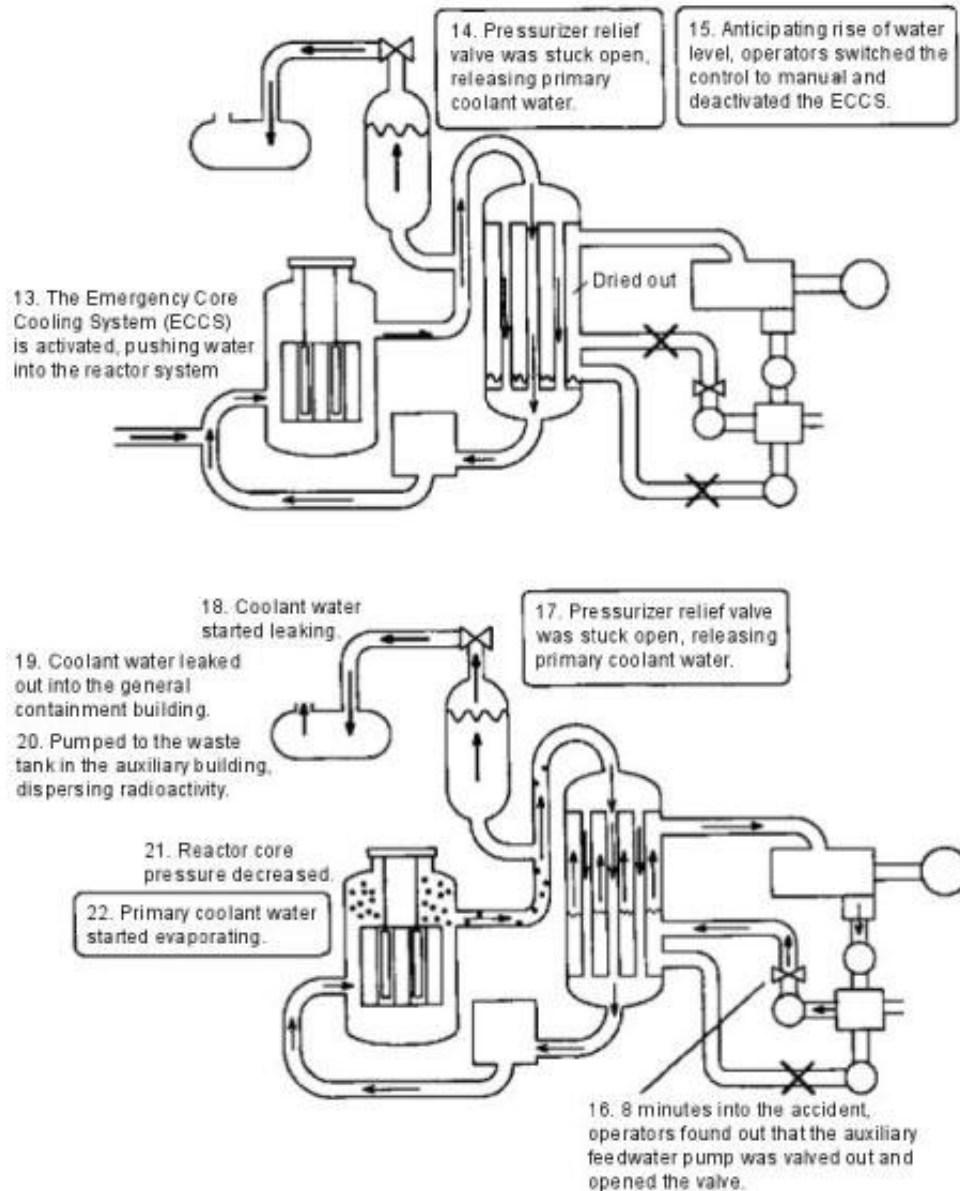
- 5 – Auxiliary feedwater pumps are 'valved out' → unable to inject water
- The auxiliary feedwater pumps in fact did kick in but the outlet valves were closed.
- 6 – T inc and P inc in the Primary System
- 7 – P relief valves opens to release steam = **This is good.**
- Key design flaw:
    - Pilot-Operated Relief Valve (PORV)
      - This was the P relief valve at the top of the pressurizer (soda can)
    - Control room warning light only indicated that solenoid of the PORV was active, not whether valve open or closed. Operators didn't know about the problem for hours. Can't blame James Floyd for a design flaw.

### LOWER ½ OF DIAGRAM

- 8 – 8 minutes later, control rods inserted (into coolant?) → reactor shuts down.
- This is because the coolant does not allow the reactions to occur bc I think the deuterium absorbs neutrons and such.
  - When reactor shuts down → P in reactor decreases → but a valve which was supposed to close when the P dropped in fact remained open for 2h 20min → 80 tons of coolant water lost from the quench tank → 100 warnings sound in control room → panic.
- 9 – Water level of secondary coolant water keeps dropping.
- 10 – T of primary coolant water rises
- 11 – P relief valve remains stuck open = **This is bad.**
- 12 – Reactor core P decreased.

### Source

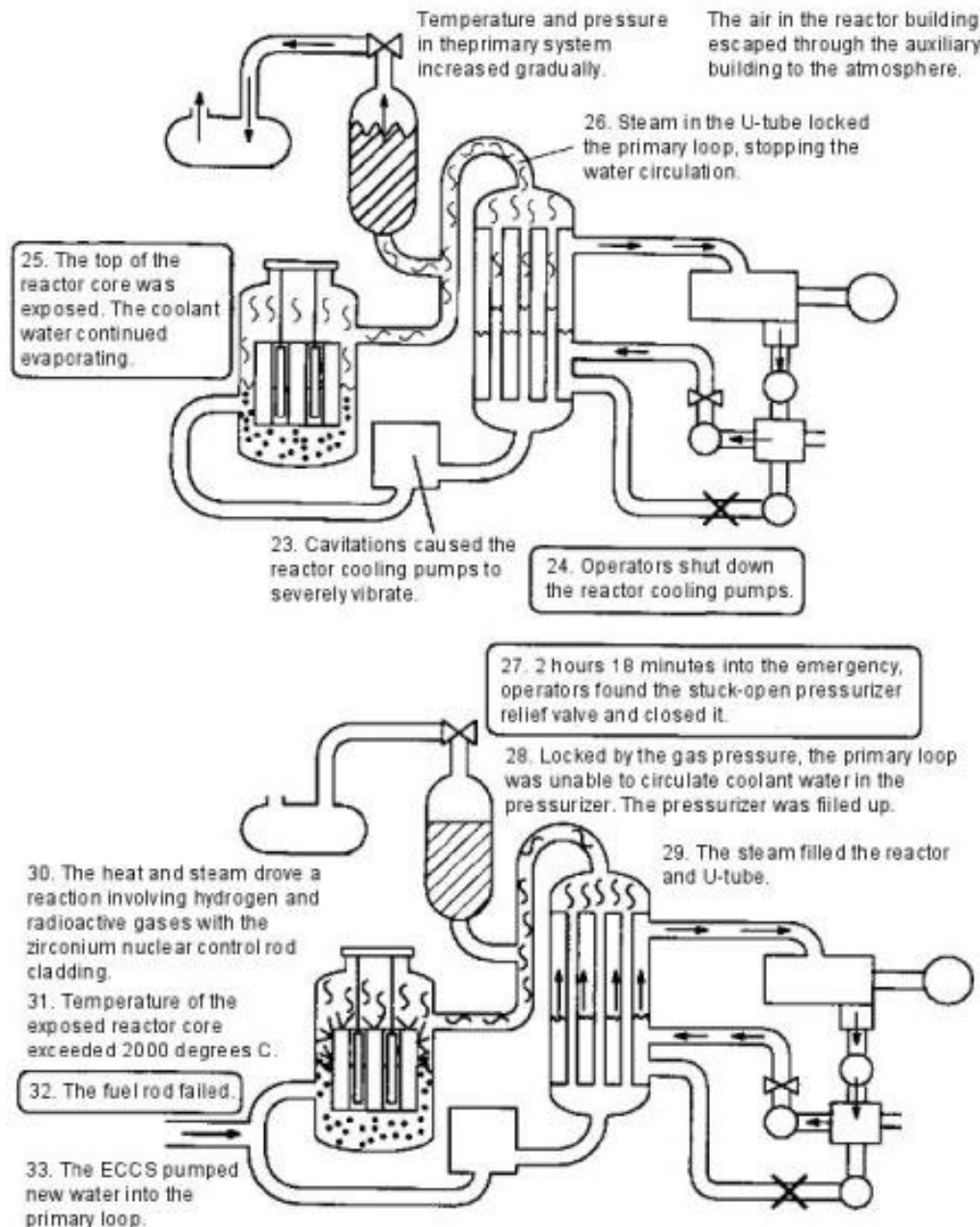
- Three Mile Island Nuclear Accident
  - This info is from the excellent Failure Knowledge Database – I describe it more on page 174.
  - The image is from the multimedia files at the bottom of the web page.
  - <http://www.shippai.org/fkd/en/cfen/CA1000404.html>



### Sequence of events 14 - 22

- 13 – **Emergency Core Cooling System (ECCS) is activated** → pushes water into the reactor.
- 14 – P relief valve stuck open → **Primary Coolant water lost** (from the pressurizer, I think; it looks like an upright plastic soda bottle curved on both ends)
- 15 – Operators *anticipate* a *rise* in water level.
- 16 – **8-minutes post**, operators find out **auxiliary feedwater pump** has valved out.
- 17 – P relief valve stuck open → Primary Coolant water lost
  - Same as described in step 14.
- 18 – **Coolant water now leaking** (out of **quelch tank?**)
- 19 – **Coolant water leaks** into **Containment Building**.
- 20 – **Coolant water** (I think) **pumped** to **waste tank** in **Auxiliary Building**.
- 21 – **Reactor core P** decreased.
- 22 – **Primary Coolant water** starts **evaporating**
  - Same problem at the **2011 Fukushima Daiichi nuclear power plant disaster**.





### Sequence of events 23 - 33

- 23 – Cavitations cause → reactor cooling pumps to severely vibrate.
- 24 – Operators shut down the reactor cooling pumps. **Uh oh, that sounds bad.**
- 25 – **Top of reactor core exposed.** Wow. Coolant water continues to evaporate.
- 26 – Steam (squiggly lines) in U-tube blocks water circulation.
- 27 – **2h 18m post: Operators find the stuck-open P relief valve and close it. This is the first major corrective step.**
- 28 – Steam in U-tube blocks water circulation → Pressurizer (soda bottle) fills up.
- 29 – Steam (squiggly lines) fills U-tube and reactor.
- 30 – **Heat + steam drive a reaction involving H + radioactive gases + Zirconium nuclear control rod cladding.**
  - I bet *that* wasn't anticipated.
- 31 – Exposed reactor core T is now 2000 C
- 32 – Fuel rods fail

33 - **Emergency Core Cooling System (ECCS) is activated** → pushes *new* water into the reactor.

#### Summary of the chronology of events

- **1979 March 28** – TMI-2 is running at 97% capacity.
- Companion reactor TMI-1 being shut down for refueling.
- Workers were cleaning 1 of 8 condensate polishers = sophisticated filters
- For unknown reasons the pumps feeding the polishers stopped.
- Bypass valve failed to open → no more steam to turbine
  - This is NOT the same steam (a.k.a. void) as used to absorb neutrons within the channels of the graphite reactor (well, that's the way the Chernobyl reactor worked)
  - This is a problem with steam in the non-nuclear portion of the plant.
- **Result is ER shutdown of the core = Control rods inserted into the core to halt the nuclear chain rxn (get it? The graphite absorbs the neutrons).**
  - This occurred within 8 seconds.
  - **So far so good in terms of fail-safe mechanisms.**
- HOWEVER ... reactor continued to generate heat → Steam was no longer being used by the steam turbine so there was nowhere for the heat to go.
- HOWEVER .... some large Nuclear Regulatory Commission (NRC) violation had occurred with the cleaning, namely auxiliary pumps were not ready to go because their valves closed for maintenance.
  - Key design flaw:
    - Pilot-Operated Relief Valve (PORV)
      - This was the P relief valve at the top of the pressurizer (soda can)
    - **Control room warning light only indicated that solenoid of the PORV was active, not whether valve open or closed. Operators didn't know about the problem for hours.** Can't blame James Floyd for a design flaw.

# Page 174 – Normal Accidents

## Normal Accidents

### *Normal Accidents – Living with High-Risk Technologies*

- Summary
  - Sociologist Charles Perrow argued that accidents are inevitable due to design complexity.
- Source
  - Princeton University Press
  - 1999
  - 464 pages.
  - You can Look inside.
  - <https://www.amazon.com/Normal-Accidents-Living-High-Risk-Technologies/dp/0691004129>
- Author
  - Charles Perrow, PhD

## Normal Accident Theory = The 4 elements of Tightly-Coupled Decisions/Systems

- Summary
  - **Charles Perrow** argued that **Three Mile Island** was not due to a specific problem like the **valves**, or the **coolant levels**. He argued in *Normal Accident Theory* that it was **inevitable** because of these **4 elements**. The criticism of Perrault's 4-element concept is that it offers **managers** no template to actually reduce the risk of a problem. Nevertheless it is useful to highlight the vulnerable parts of the system.
- Tightly-coupled system
  - These are criteria that are undesirable. It is undesirable to be tightly coupled however it may be unavoidable, e.g. rocket launch, nuclear power plant.
  - **Chronological**
    - The steps happen in a chronological sequence.
    - For example, a **shuttle launch** has a certain **launch window**.
  - **Fixed order**
    - The events happened in a fixed order.
  - **Path**
    - There is only one path.
  - **Flexibility**
    - There is very little.
    - **Engineers build redundant, fail-safe mechanisms** precisely to offer flexibility. But apparently these **redundant systems add more complexity to the system**.

## Failure

### *25 Mistakes Every Nuclear Electrical Engineer Should Avoid*

- **I hope someone at the plant reads this.**
- <https://www.nuclearelectricalengineer.com/nuclear-plant-control-room-switches-and-components/>



*Nuclear Plant Control Room Switches and Components*

- Summary
  - **This describes the switches and buttons at a nuclear power plant.**
- Source
  - **John Livingstone's The Nuclear Electrical Engineer**
    - The author is an electrical engineer.
    - <https://www.nuclearelectricalengineer.com/nuclear-plant-control-room-switches-and-components/>

Failure Knowledge Database

HOME 100 Selected Cases About Failure Mandalas JAPANESE


Search by Category

<a href="#">Machinery</a>	<a href="#">Chemistry</a>	<a href="#">Oil</a>	<a href="#">Petrochemistry</a>
<a href="#">Construction</a>	<a href="#">Electrical, Electronic, and IT</a>	<a href="#">Electric Power and Gas</a>	<a href="#">Nuclear Power</a>
<a href="#">Aerospace</a>	<a href="#">Motor Vehicles</a>	<a href="#">Railways</a>	<a href="#">Shipping and Maritime</a>
<a href="#">Metals</a>	<a href="#">Food</a>	<a href="#">Natural Disasters</a>	<a href="#">Miscellaneous</a>

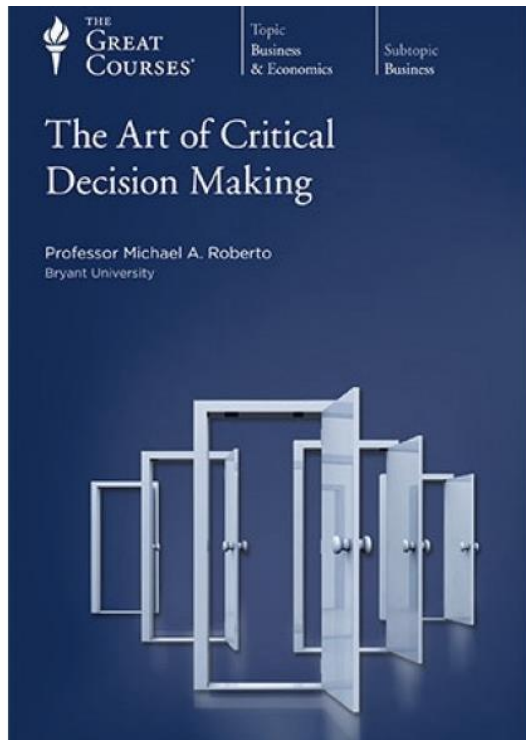
### Failure Knowledge Database

- Summary
  - There are 16 categories of engineering or design failure to explore.
- Source
  - Association for the Study of Failure
    - Somehow this name is amusing. Like if you failed to show up for a meeting, you could defend yourself.
    - <http://www.shippai.org/fkd/en/index.html>

### 100 Selected Cases

- This is a list of 100 engineering failures.  Click on a link to learn more.
- [Titanic](#) and Three Mile Island are in here.
- It's the same *Failure Knowledge Database* as above but a different page.
- [http://www.shippai.org/fkd/en/lisen/hyaku\\_lisen.html](http://www.shippai.org/fkd/en/lisen/hyaku_lisen.html)

**The Anti-Perrow School: Accidents *are* preventable**



### *The Art of Critical Decision Making*

- Summary
  - This is a (yet another) phenomenal course from *The Great Courses* that exposes many examples of errors in critical decisions made at the level of the INDIVIDUAL (e.g., **confirmation bias**), the GROUP (e.g., **groupthink**), and the ORGANIZATION (e.g., **normalization of deviance** of engineering data). Your IQ will go up 10 points (even though they say IQ is immutable).
- Anti-Perrow School
  - One of the things addressed is the nuclear disaster at **Three Mile Island**. The argument presented is that accidents are preventable, not inevitable. Hence the 'anti-Perrow' school of thought.
- Here are the notes I took on preventing accidents
  - **Complexity**, embrace it.
  - **Errors** will happen, so minimize them, be resilient, bounce back.
  - **Expertise**, seek it. The **technical experts** should not be relegated to bottom of hierarchy.
  - **Failure**, prepare for it.
    - **Mountain guide Ed Breshears**
      - Mountain climbers prepare for **FAILURE**.
      - Focusing only on **SUCCESS** can be fatal.
    - **Toyota**
      - Problems can wind deep.
      - Problems can be dealt with.
      - Problems are not the enemy.
      - **Hidden problems are the enemy**.
      - At Toyota board meetings, **Senior Managers** discuss **problems**, not **successes**.
      - **Toyota employees** are empowered on the assembly line to pull a cord to highlight a problem → **manager** comes over to assess → if employees pulls a **2<sup>nd</sup> time** the assembly line is **halted**.
      - (I love this Japanese efficiency.)
  - **Forward Operating Officer (FOO)**. The top managers must be at the front line.
- Source
  - **The Great Courses**
    - **Professor Michael A. Roberto**
    - <https://www.thegreatcourses.com/courses/art-of-critical-decision-making>



Professor Michael A. Roberto

- Master of Business Administration (MBA) & Doctor of Business Administration (DBA) at [Harvard Business School](#).
- [Why Great Leaders Don't Take Yes for an Answer](#) – this is his book about a CEO not wanting to be surrounded by Yes men.

## Page 175 – Worst Aviation Disaster in History



### What REALLY Caused the Tenerife Airport Disaster?! The WORST Aviation Accident in History



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Go to <https://curiositystream.thld.co/Mento...> and use the code MENTOURPILOT to save 25% off today!

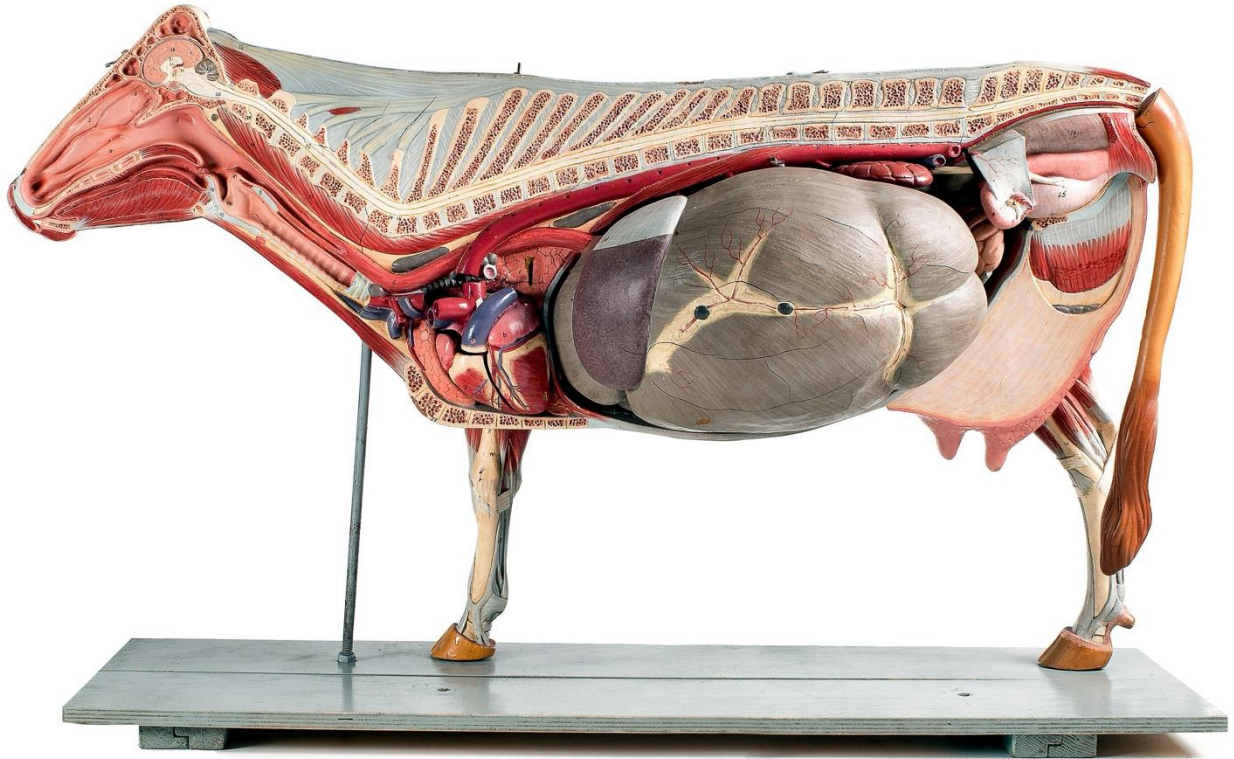
On the 27th of March, 1977, two Boeing 747 passenger Jets collided on Los Rodeos Airport, Tenerife. This video will explain the whole story about what happened this day, the day of the Tenerife ...more

### What REALLY Caused the Tenerife Airport Disaster?! The WORST Aviation Accident in History

- Summary
  - This is a 44 minute video by professional airline pilot **Petter Hörnfeldt** – you won't get a better explanation. He is amazing at explaining aviation mishaps. Great graphics and meticulous detail. And he has a cool Dutch accent.
- Source
  - **Mentour Pilot**
    - <https://www.youtube.com/watch?app=desktop&v=2d9B9RN5quA>

**Page 176 – Walkerton #1:  
The Rumen Without a View**

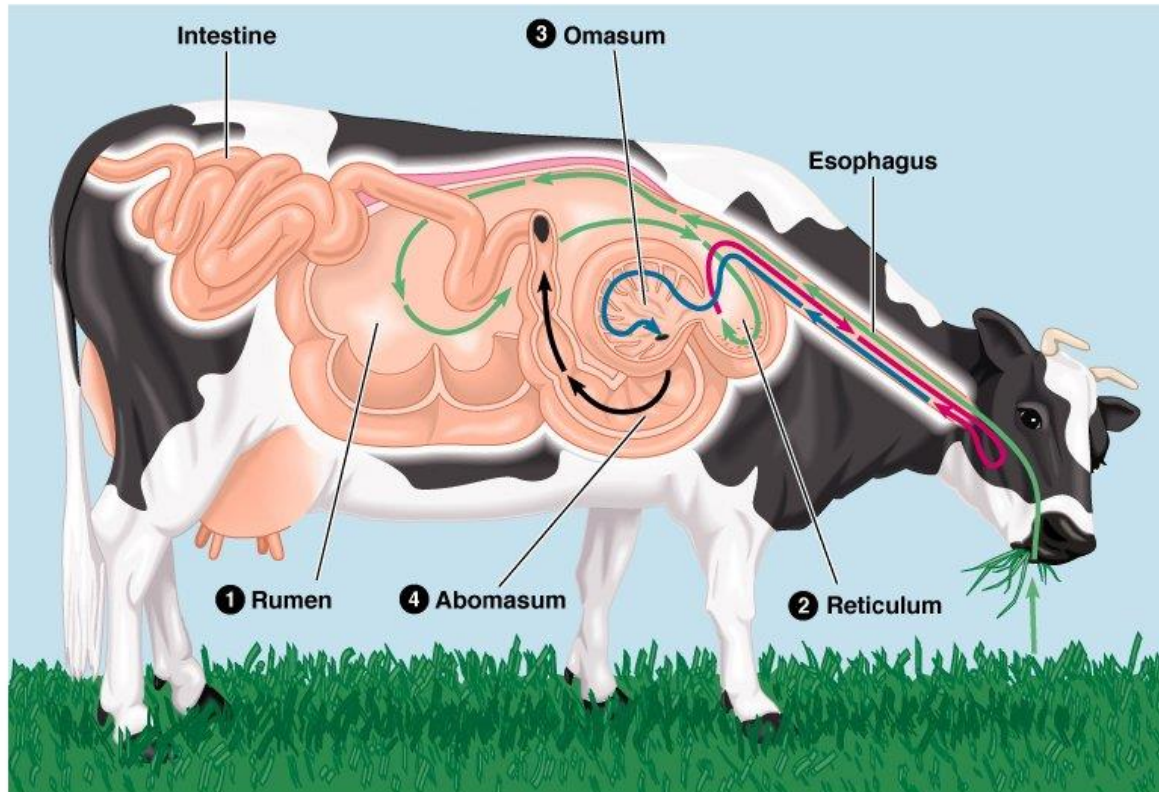
## Ruminant



That big gray thing is the cow stomach, which is actually 4 stomachs.

- A cow is a **ruminant** = 150 species of mammal which extract food by **fermentation** in a specialized stomach = **4-part stomach**, by definition. Details further down in bibliography.
- <https://en.wikipedia.org/wiki/Cattle>





©1999 Addison Wesley Longman, Inc.

### Ruminant digestion in *Bos taurus* [cow]

- Summary

- I love that drawing – it's a perfect meld of colors.
- Food goes into mouth → esophagus (foodpipe) → Rumen → Reticulum → Omasum → Abomasum → intestines.

- Verbatim

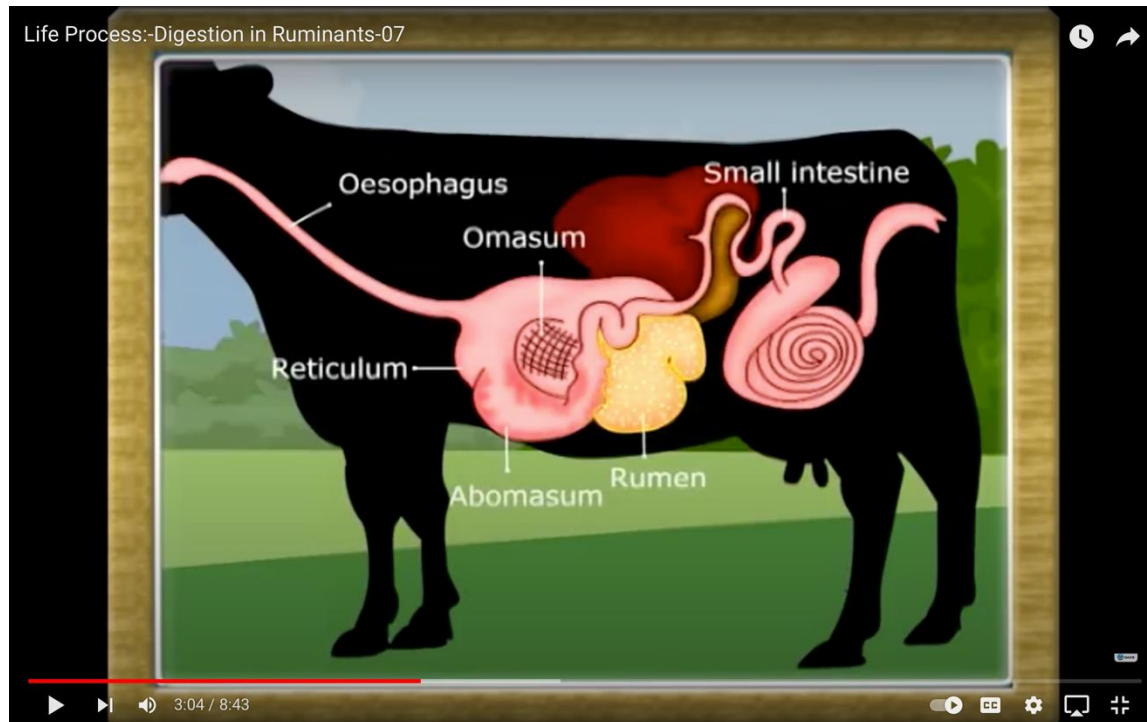
- Like other vertebrates, ruminant **Artiodactyla** (including cattle, deer, and their relatives) are unable to digest plant material directly, because they lack enzymes to break down **cellulose** in the cell walls. Digestion in ruminants occurs sequentially in a **four-chambered stomach**. Plant material is initially taken into the **Rumen**, where it is processed mechanically and exposed to **bacteria** that can break down **cellulose** (**foregut fermentation**). The **Reticulum** allows the animal to regurgitate & reprocess particulate matter ("chew its cud"). More finely-divided food is then passed to the **Omasum**, for further mechanical processing. The mass is finally passed to the true stomach, the **Abomasum**, where the digestive enzyme **lysozyme** breaks down the **bacteria** so as to release nutrients. Use of plant material is thus indirect, with primary processing by the bacterial flora maintained in the stomach.

The **Perissodactyla** (including horses, rhinoceroses, and tapirs) have evolved a less efficient form of ruminant digestion. Bacterial fermentation occurs primarily in the intestine (**hindgut fermentation**), such that extraction of nutrients from plant material is less complete. [Compare horse droppings with 'cow flops': the former contains more or less intact plant material that may be scavenged by birds, whereas the latter is essentially amorphous].

Although all mammals have lysozyme, the enzymatic properties of ruminant

lysozyme have evolved to be especially efficient. In a superb example of **convergent evolution**, some **leaf-eating monkeys** have evolved a lysozyme with similar enzymatic properties, due to selection on independent mutations to produce identical amino acids at key active sites.

- Source
  - Figure © 1999 by Addison Wesley Longman Inc
  - All text material © 2005 by Steven M. Carr
  - [https://www.mun.ca/biology/scarr/Ruminant\\_Digestion.html](https://www.mun.ca/biology/scarr/Ruminant_Digestion.html)



#### Life Process:-Digestion in Ruminants-07

- Summary
  - This 9-minute video describes how a cow digests grass. It's the Goldilocks amount of information.
- Flowchart
  - Mouth → esophagus (food going downwards) → **rumen** → esophagus (food going upwards; regurgitation) → 'chewing the cud' in the mouth → esophagus (food going downwards again) → rumen → **reticulum** → **omasum** → **abomasum** → Small Intestine → Large Intestine
- Flowchart numbering (this is my numbering, not from the video).
  1. Mouth
    - 50-80 quarts of saliva swallowed daily.
  2. Esophagus
  3. Rumen<sup>1</sup>
    - Largest stomach,
    - **Cellulase** enzyme produced by microorganisms breaks down the cellulose → monosach glucose
    - Partial digestion of grass into paste called **cud**.
  4. Esophagus
    - This is regurgitation.
  5. Mouth
    - Large amount of saliva added.

- 6. Esophagus
    - 2<sup>nd</sup> trip downwards.
  - 7. Rumen<sup>2</sup>
    - Cellulase enzyme again acts on the cellulose.
    - **Ruminococcus** here.
  - 8. Reticulum
    - More digestion.
    - Almost fully digested now.
    - Honeycomb structure.
  - 9. Omasum
    - **Water** absorbed
    - **Bicarbonate** absorbed
  - 10. Abomasum
    - **It's the true stomach because glands here produce acid.**
  - 11. Small Intestine (SI)
    - **150 FT long**
      - *How Does the Digestive System Work in a Cow: Understanding the Ruminant Digestive System*
        - ProEarth
          - Jennie Eilerts
          - 13 June 2019
          - <https://proearthanimalhealth.com/how-does-the-digestive-system-work-in-a-cow-understanding-the-ruminant-digestive-system/>
    - **20x longer than the body.**
      - In cow, the total length of the intestines is 33-63 meters of which **27-49 meters** is the small intestine, remaining is the large intestine.
        - *Caecum and Appendix in Ruminants and Man: A Comparative Study*
          - Journal of Evolution of Medical and Dental Sciences 2014; Vol. 3,
          - Issue 29, July 21; Page: 8033-8039, DOI: 10.14260/jemds/2014/300
          - C. Sreekanth, N. Shakuntala Rao, K. Manivannan, Gangadhara, H. R. Krishna Rao
          - [https://jemds.com/data\\_pdf/sreknathc.pdf](https://jemds.com/data_pdf/sreknathc.pdf)
- 12. Cecum
  - 3 FT long
  - 2 gallons
- 13. Large Intestine (LI)
  - Let's say **40 FT** on avg.
  - **23 – 41 FT – beef cow**
  - **43 – 46 FT – dairy cow**
    - The length of the large intestine of the same animals varies from **23 to 41 feet** for beef animals and from 43 to 46 feet for dairy animals.
    - This source is from **1940**. I like that. And the old-school font (in the screenshot below):

**THE LENGTH OF THE INTESTINE OF CALVES AND ITS  
BEARING ON THE ABSORPTION OF THE  
NUTRIENTS FROM THE CHYME<sup>1</sup>**

DWIGHT ESPE AND C. Y. CANNON

*Iowa State College, Ames, Iowa*

- [https://www.journalofdairyscience.org/article/S0022-0302\(40\)92833-8/pdf](https://www.journalofdairyscience.org/article/S0022-0302(40)92833-8/pdf)

- Some digestion.
  - Absorb water = lary function
  - ***E coli O157:H7***
    - Colonization is mostly in Large Intenstine.
    - Verbatim.
      - Cattle are a major reservoir of ***Escherichia coli 0157:H7***, an important zoonotic pathogen that causes **hemorrhagic colitis** and **hemolytic uremic syndrome (HUS)**. Colonization of cattle occurs predominantly in the large intestine, and may especially target follicle-associated epithelium (FAE) in the terminal rectum.
      - *Escherichia coli 0157:H7: an update on intestinal colonization and virulence mechanisms*
        - **Animal Health Research Review 2004**
        - **Rodney A Moxley** - Department of Veterinary and Biomedical Sciences, University of Nebraska-Lincoln, Lincoln, NE 68583-0905, USA
        - <https://pubmed.ncbi.nlm.nih.gov/15460538/>
- 13. Anus
- Source - video
  - **OAKS Online Adaptive Knowledge System**
    - 9 min YouTube video.
    - 2014
    - <https://www.youtube.com/watch?v=kK7IWjNYwxI>

Everything below is my notes.

### Ruminant

- = 150 species of mammal which extract food by fermentation in a **specialized stomach**.
- **4-part stomach**, by definition.
- Teeth
  - Large silica content in forage therefore teeth grow **continuously**.

### Who is a ruminant?

- Cow
- Goat
- Sheep
- Giraffe
- Yak
- Deer

### Who is NOT a ruminant?

- Horse
- Rabbit
- Rhino

### 4-part stomach, by definition

#### 1. **Rumen**

- 1<sup>st</sup> part of stomach
  - The rumen, also known as the "paunch," is the first area of the cow's stomach, connected to the cattle's esophagus.

- Largest stomach.
    - 84% of volume of stomachs.
    - 25 gallons = 100 liters
  - It's on the left.
  - 1-2 contractions / minute.
  - Rumen also seems to be synonymous with **rumen fluid**.
  - **Cellulase** produced by **microorganisms** breaks down the **cellulose** → **monosach glucose**
  - **Partial digestion** of grass into paste called **cud**.
  - **1 mL of rumen fluid contains:**
    - **10 – 50 billion bacteria**
    - **1 million protozoa**
  - **Food mixed with saliva.**
  - **Food mixed with saliva → layers of solid and liquid → clumps = cud**
    - Cow produces 100 – 150 L of **saliva** / day.
  - **Cellulose broken down by microbes.**
  - **Ruminococcus** here.
  - Fermentation → **Volatile Fatty Acids (VFA)** → **VFA** are **abs** in the **rumen**. Hmm.
  - Good **water supply** prevents **Rumen Impaction**.
2. **Reticulum**
- Close to heart.
  - Aids in **regurgitation**.
  - 5 gallons.
  - **Honeycomb** structure catches **nails** et al stuff which is bad → **Hardware Disease**.
  - **Food mixed with saliva.**
  - **Cellulose broken down by microbes.**
3. **Omasum**
- A.k.a. Butcher's Bible. Why? I think bc many folds for absorption here.
  - **Cud enters here now.**
  - Absorbs excess fluid, i.e., the 150 L of saliva.
  - **Water** absorbed
  - Bicarbonate **absorbed**
4. **Abomasum**
- It's the **true stomach** bc **glands** here produce **HCl** → proteolysis.
  - **Nitrogen et al nutrients reclaimed by digesting the bacteria who stole it.**

## Microbiology

- Venn diagram
  - **Ruminants** are **mammals**.
  - **Ruminants** are **vertebrates**.
  - **Vertebrates CANNOT** break the **Beta [1-4] glycosidic bond of cellulose** because they lack **cellulase**.
- Micro-organisms
  - **1 mL of rumen fluid contains 10 – 50 billion bacteria and 1 million protozoa.**
    - **Anaerobic** environment in rumen so obligate / facultative anaerobes.
- The cow figures it out
  - **Bacteria in rumen consume 10% Carbon, 60% Phosphorus, 80% Nitrogen ... therefore the cow digests the bacteria downstream in the abomasum!**
    - **Bovine Lysozyme**
    - **Bovine Pancreatic ribonuclease**
      - **Degrades bacterial RNA to obtain Nitrogen**. Wow.
      - This does not seem the best deal for bacteria. Pretty short life?
- Hydrolysis of cellulose has these end products:
  - **Methane**

- CO<sub>2</sub>
- Acetate
- Lactate
- Propionate
- butyrate

### Rumen physiology

- Microbes in rumen
  - *Ruminococcus*
  - *Megasphaera*
  - *Fibrobacter*
  - *Streptococcus*
  - *Escherichia*
  - *Chytridiomycetes fungi*
  - Methanogens
  - 70% unidentified
- Ruminococcus
  - Which species do the digesting?
    - *Ruminococcus albus*
    - *Ruminococcus flavifaciens*
  - Gram POS coccus
  - Class Clostridia
  - Association with **Crohn's Disease**. Hmm.
    - Experts think microbes may be important in the immune response because certain bacteria, such as *Ruminococcus gnavus*, are found in higher proportions in people with the disease than without. *R. gnavus* can become the most common species of bacteria in the gut when the disease flares up. Plus, *R. gnavus* lives in the mucus layer of the intestine, where the immune system may be more likely to react to it.
      - NIH
      - <https://www.nih.gov/news-events/nih-research-matters/gut-microbe-provokes-release-inflammatory-substance>
  - Action
    - Cellulose → monosach glucose
  - Symbiosis
    - Cow genome does not need to code for additional enzymes. Not that that seems particularly onerous to me.
  - Verbatim – Microbewiki kenyon
    - Ruminants have a four-chambered gut, and these microorganisms live primarily in the rumen. One particularly important bacterial genus that takes part in the degradation of cellulose is gram positive *Ruminococcus* (Figure 1). *Ruminococcus* bacteria break down the plant fiber into the monosaccharide glucose, which can then be further broken down through glycolysis. This symbiotic relationship enables ruminants to digest this fiber without having to encode for more enzymes in their own genomes to do this job. The relationship with microbes provides ruminants with about 15% of their caloric intake. The *Ruminococcus* genus, which includes *Ruminococcus albus* and *Ruminococcus flavifaciens*, is just one of many microbes living in the rumen. Others include *Megasphaera*, *Fibrobacter*, *Streptococcus*, *Escherichia*, *Chytridiomycetes fungi*, and methanogens. It is predicted that 70% of microbes in the rumen have yet to be identified.<sup>1</sup> The proportions of microbes present vary greatly depending upon the diet of the ruminant. For this reason,

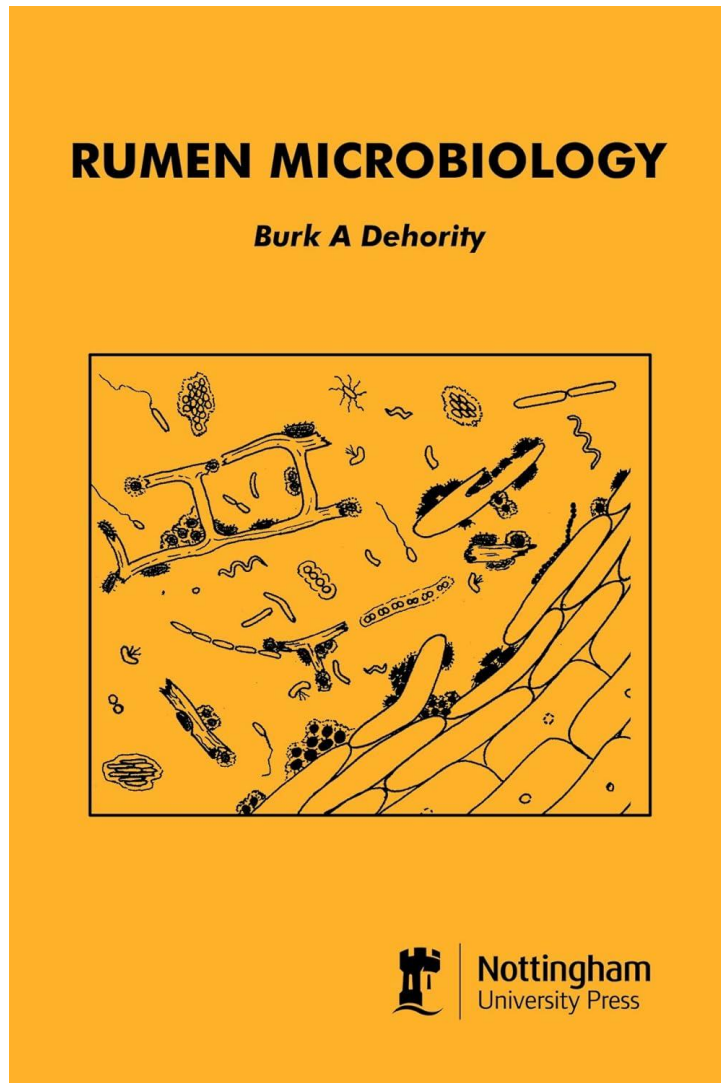
the diets of the animals greatly impact their own health, and also effects consumers of their meat and the environment as a whole.

- [https://microbewiki.kenyon.edu/index.php/Cellulose\\_Degradation\\_in\\_the\\_Rumen](https://microbewiki.kenyon.edu/index.php/Cellulose_Degradation_in_the_Rumen)

#### Source

- <https://en.wikipedia.org/wiki/Ruminant>
- [https://microbewiki.kenyon.edu/index.php/Cellulose\\_Degradation\\_in\\_the\\_Rumen](https://microbewiki.kenyon.edu/index.php/Cellulose_Degradation_in_the_Rumen)
- <https://en.wikipedia.org/wiki/Ruminococcus>
- <https://www.nih.gov/news-events/nih-research-matters/gut-microbe-provokes-release-inflammatory-substance>
- <https://extension.umn.edu/dairy-nutrition/ruminant-digestive-system#stomach-compartments-1000460>
  - Good detail here e.g. Volatile Fatty Acids
- ProEarth
  - They make animal feed.
  - Good detail
  - <https://proearthanimalhealth.com/how-does-the-digestive-system-work-in-a-cow-understanding-the-ruminant-digestive-system/>

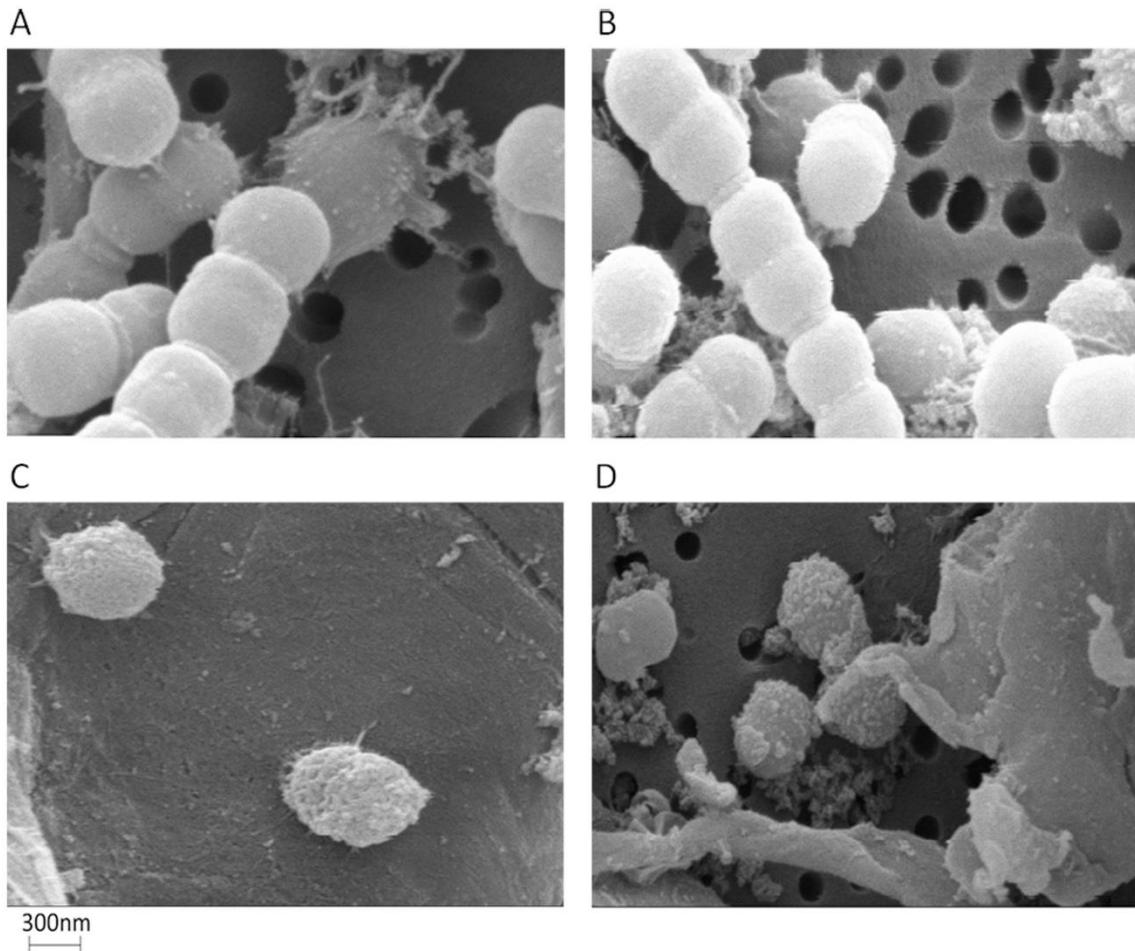
Rumen organisms



### *Rumen Microbiology*

- Summary
  - This book describes the various organisms that inhabit the rumen. It's about as specific as you can get in a book topic.
- Source
  - Nottingham University Press
  - 2003
  - 372 pages
  - Amazon.ca <https://www.amazon.ca/Rumen-Microbiology-Burk-Dehority/dp/1897676999>
- Author
  - Burk A Dehority, PhD
    - An interesting man. He studied the protozoa (think, amoeba cousins) in the guts of kangaroos, moose, wildebeest and alpacas. That's about as specific as you can get for a hobby.
    - Here is his biography. <https://ansci.osu.edu/node/4675>



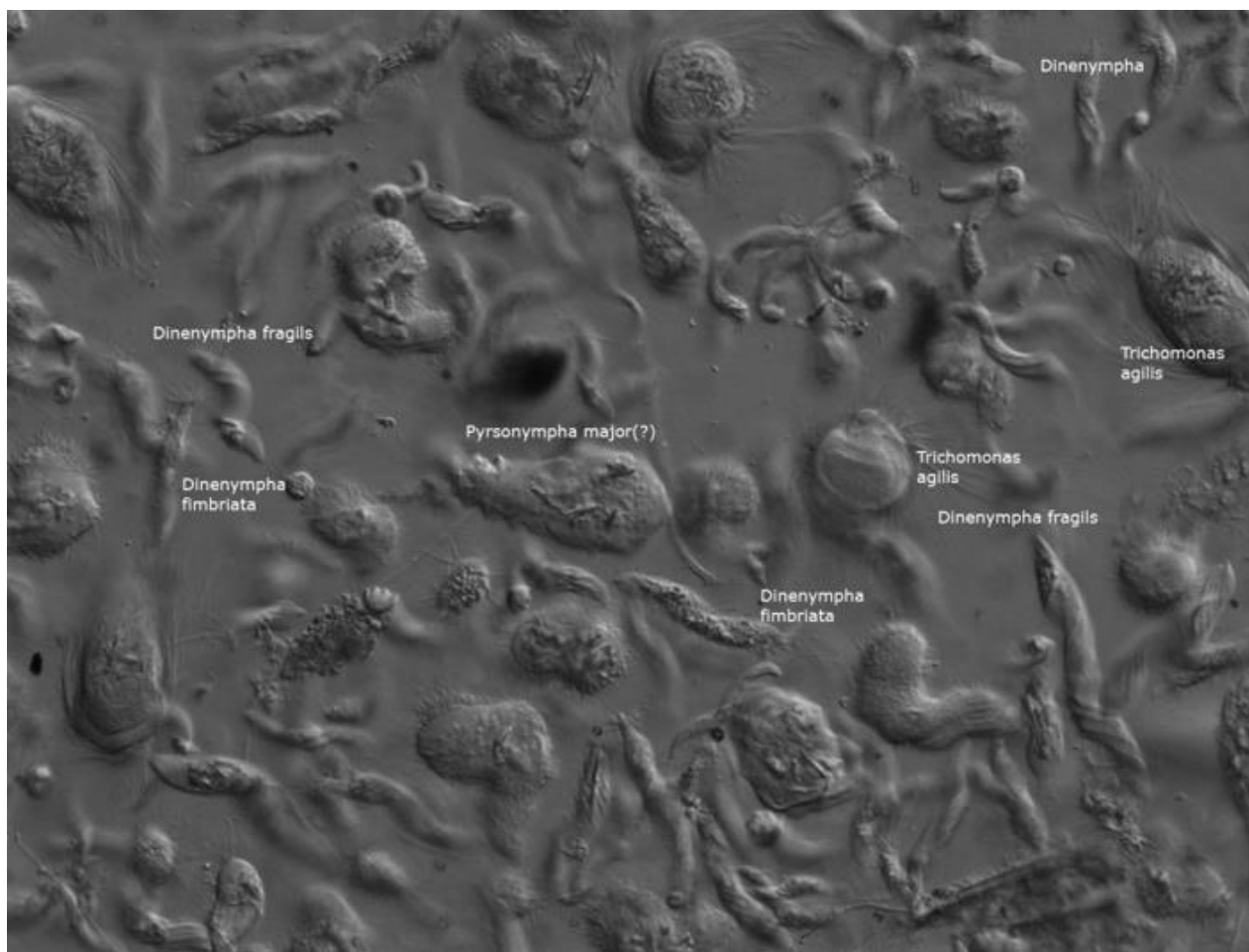


*Expression of Cellulosome Components and Type IV Pili within the Extracellular Proteome of Ruminococcus flavefaciens 007*

- Summary
  - Those are *Rumino-coccus* bacteria.
  - It's not just some chump. It has 3000 genes coding for 3000 proteins. That means 3000 working parts. It has a life. Each cell (a sphere shape) is an independent entity.
  - It's Figure 6 in this highly technical article.
- Source
  - PLOS ONE
  - 4 June 2013
  - <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0065333>
- Authors
  - The authors are from all over the place!
  - **Maša Vodovnik** - Chair for Microbiology and Microbial Biotechnology, Biotechnical Faculty, University of Ljubljana, Ljubljana, Slovenia, Rowett Institute of Nutrition and Health, University of Aberdeen, Aberdeen, United Kingdom
  - **Sylvia H. Duncan** - Rowett Institute of Nutrition and Health, University of Aberdeen, Aberdeen, United Kingdom
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## Termite



### Microbes and More

- Summary
  - That photo is a bunch of single-cell amoeba cousins. They are protozoans.
- Verbatim

No one microbe in the termite gut can do the job. A whole community of microorganisms is necessary. These microbes belong to three groups, bacteria, archaea and protozoans. Organisms that live with one another for long periods of time are said to live in symbiosis. The symbioses in the termite gut are often beneficial to both partners and so are called a mutualistic relationship. Sometimes neither partner can live without the other, so the relationship is called an obligate symbiosis. The protozoans and the bacteria and archaea that live inside them often depend upon one another and cannot live without each other, so they are an example of an obligate symbiosis. The bacteria and archaea that live inside their partner are also called endosymbionts, "endo-" meaning "within."

**In these photos** you can only see the largest microbes, the protozoans. Bacteria and archaea are about a ten times smaller and **appear as small specks in these photos**. None of these organisms have a color and are largely transparent. To photograph them without using dyes to stain them (which would kill them) we used a special kind of microscope that uses Nomarski optics to distinguish the microbes from the surrounding water. This gives three-dimensional images of the microbes.

The protozoans come in a variety of shapes and move around rapidly. For example, if you look closely at the *Trichonympha agilis* cells here, you can see around them some thread-like strands. These are their flagella that they use to move. (The *Trichonympha* cells in this image were inadvertently labeled "Trichomonas.")

- Source
  - Dr. Kenneth Noll, University of Connecticut
    - <https://kenneth-noll.uconn.edu/termite-gut-microbes/#>

**Cellulose**

**small carbohydrates = sugars**

$$\begin{array}{c}
 \text{O}=\text{C}-\text{H} \\
 | \\
 \text{H}-\text{C}-\text{OH} \\
 | \\
 \text{HO}-\text{C}-\text{H} \\
 | \\
 \text{H}-\text{C}-\text{OH} \\
 | \\
 \text{H}-\text{C}-\text{OH} \\
 | \\
 \text{CH}_2\text{OH}
 \end{array}$$

**glucose**

### Carbohydrates Part 1: Simple Sugars and Fischer Projections



Professor Dave Explains  
2.95M subscribers

Join

Subscribed

24K



Share



Thanks



Clip



Save



*Carbohydrates Part 1: Simple Sugars and Fischer Projections*

*Carbohydrates Part 2: Polysaccharides*

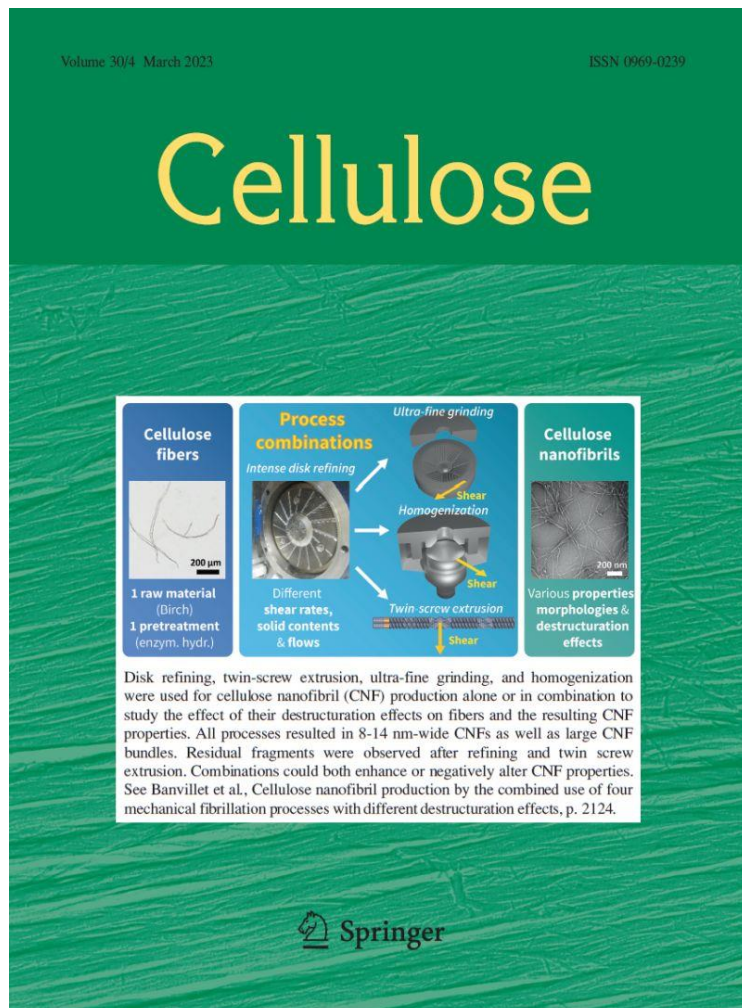
- Summary

- Professor Dave is an awesome explainer. I needed a big review of glycolysis and the Krebs cycle and he totally delivered.
- This video gives the big picture of sugar. Part 2 gets into cellulose, starch, glycogen, and the alpha and beta bonds in my diagram.

- Source

- Professor Dave Explains

- Part 1 (9 minutes) <https://www.youtube.com/watch?v=wFYsufJ9XMM>
- Part 2 (4 minutes) <https://www.youtube.com/watch?v=FILqt0nSiRo>

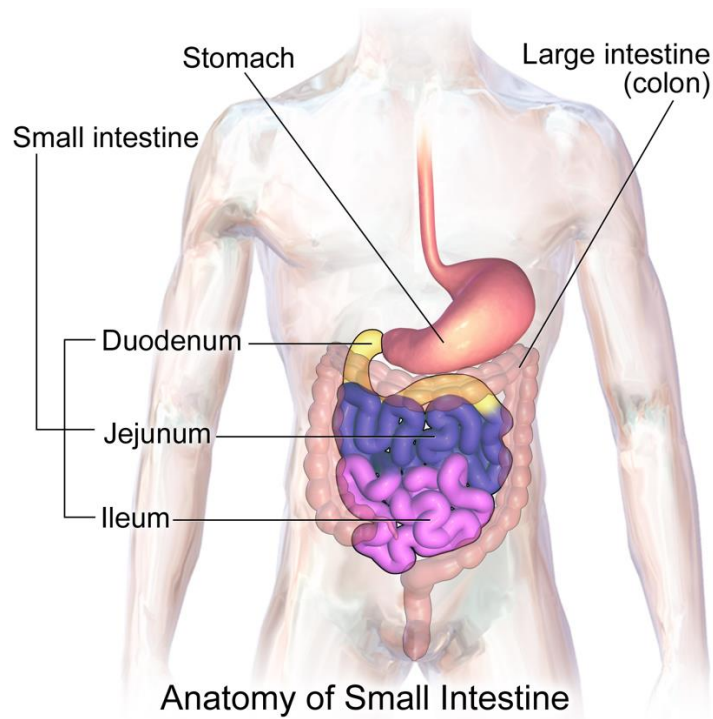


Would you believe there is an actual science journal called **Cellulose**?

- Springer is the publisher.
- <https://link.springer.com/journal/10570>

**Page 177 – Walkerton #2: E. coli**

**E coli**



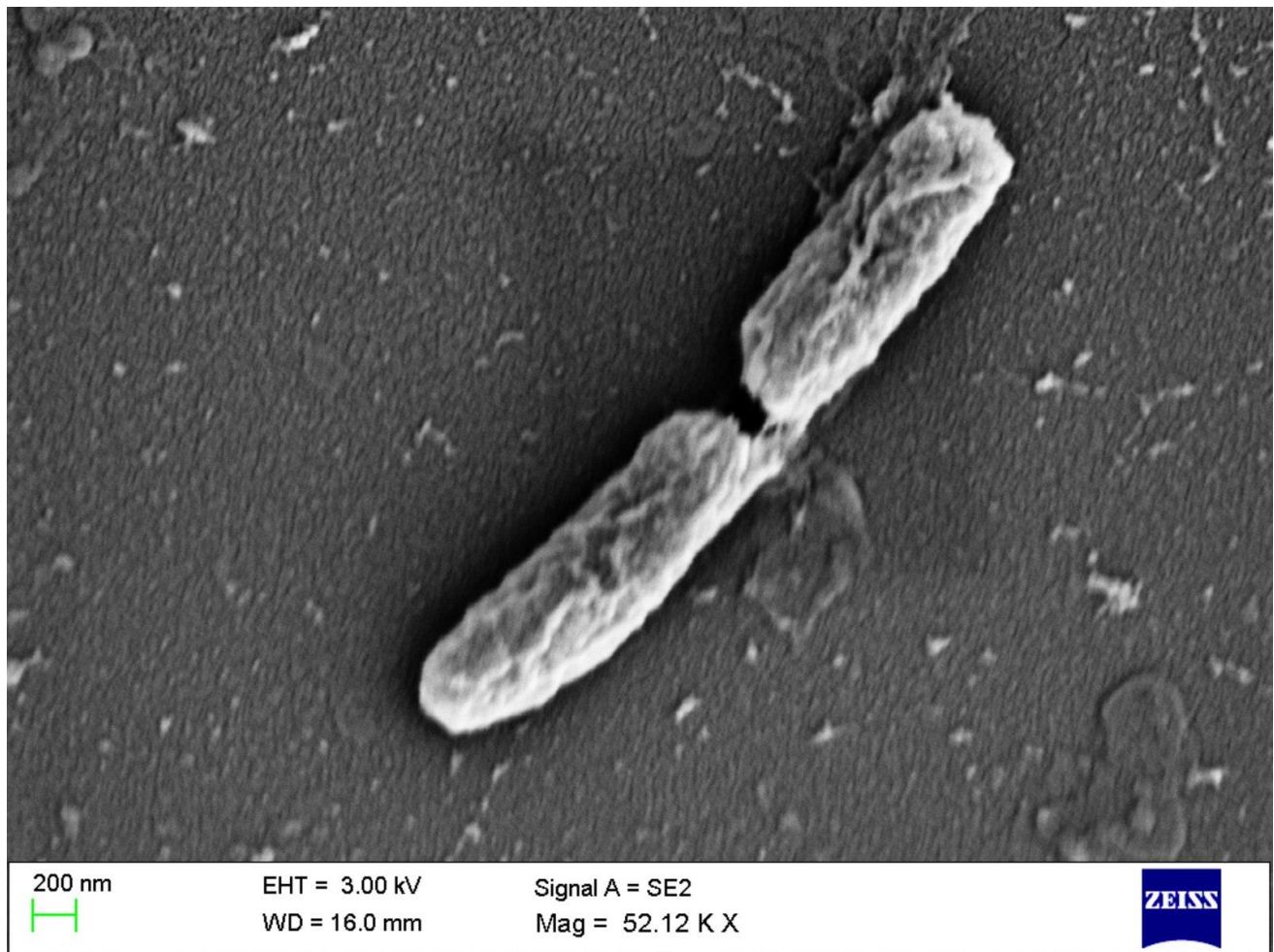
#### Gastrointestinal tract

- **E coli** lives in the large intestine.
- See how the **large intestine** (tan color) is kind of like a picture frame surrounding the **small intestine**? It needs a touch of imagination.
- [https://en.wikipedia.org/wiki/Gastrointestinal\\_tract#Lower\\_gastrointestinal\\_tract](https://en.wikipedia.org/wiki/Gastrointestinal_tract#Lower_gastrointestinal_tract)

#### Escherichia coli O157:H7

- Summary
  - **E coli O157:H7** lives in the cow's large intestine.
- Verbatim
  - A particular strain of E. coli known as E. coli O157:H7 causes a severe **intestinal infection in humans**. It is the most common strain to cause illness in people. It can be differentiated from other E. coli by the production of a potent toxin that damages the lining of the intestinal wall causing **bloody diarrhea**. It is also known as enterohemorrhagic E. coli infection.
- Source
  - **Johns Hopkins Medicine**
    - No date. No author.
    - <https://www.hopkinsmedicine.org/health/conditions-and-diseases/escherichia-coli-o157-h7>

**Shigella**



That's *Shigella* ("shig ella"). It is a **rod-shaped bacteria**. That one either broke in ½ of it's 2 of them - I don't know.

- [https://en.wikipedia.org/wiki/Shigella\\_flexneri](https://en.wikipedia.org/wiki/Shigella_flexneri)

#### Shigella – Shigellosis

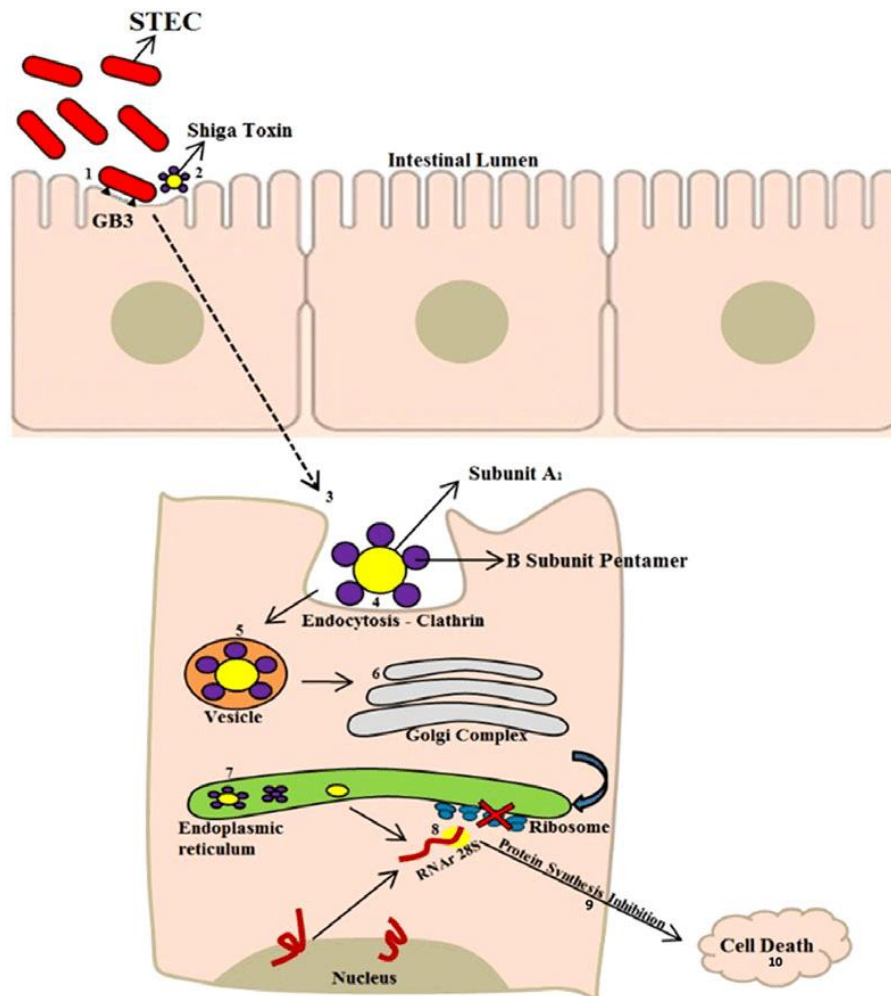
- Summary
  - This CDC page has oodles of information on the bacteria *Shigella* and **Shigellosis** ("shig ell oh sis") the (sometimes bloody) diarrhea caused by it.
- Source
  - **CDC**
    - February 2023
    - <https://www.cdc.gov/shigella/index.html>

#### *Shiga toxin*

- Summary
  - The terminology is confusing. **Shiga toxin** is the preferred term.
- Verbatim
  - Microbiologists use many terms to describe Shiga toxin and differentiate more than one unique form. Many of these terms are used interchangeably.
  - **Shiga toxin type 1** and **type 2** (Stx-1 and 2) are the Shiga toxins produced by some *E. coli* strains. Stx-1 is identical to Stx of *Shigella* spp. or

differs by only one amino acid. Stx-2 shares 56% sequence identity with Stx-1.

- **Cytotoxins** - an archaic denotation for Stx - is used in a broad sense.
- **Verocytotoxins/verotoxins** - a seldom-used term for Stx - is from the hypersensitivity of Vero cells to Stx.[7][8][9]
- The term **Shiga-like toxins** is another antiquated term which arose prior to the understanding that Shiga and Shiga-like toxins were identical.[10]
- [https://en.m.wikipedia.org/wiki/Shiga\\_toxin](https://en.m.wikipedia.org/wiki/Shiga_toxin)



### Shiga-toxin Producing Escherichia coli : Pathogenicity, Supershedding, Diagnostic Methods, Occurrence, and Foodborne Outbreaks: Shiga-toxin producing E. coli

- Summary
  - These Brazilian scientists research how **Shiga toxin** binds to the cells in our intestines. If you can understand this, you can then figure out how to prevent it.
  - This article shows the insane lengths scientists go to understand *how bacteria harm us*. The fancy term for that is **bacterial pathogenicity** ("path oh gen iss ity").
  - This is a technical article.
- Drawing
  - The Shiga toxin kills those 3 tan-colored cells that line our intestines.
  - **STEC**
    - = Shiga T toxin producing E. Coli (Of note, *coli* is actually lower case as a species but microbiologists make it upper case for the sake of the abbreviation. This comment is for those of us anal about word case, um, me.)
- **Shiga Toxin**

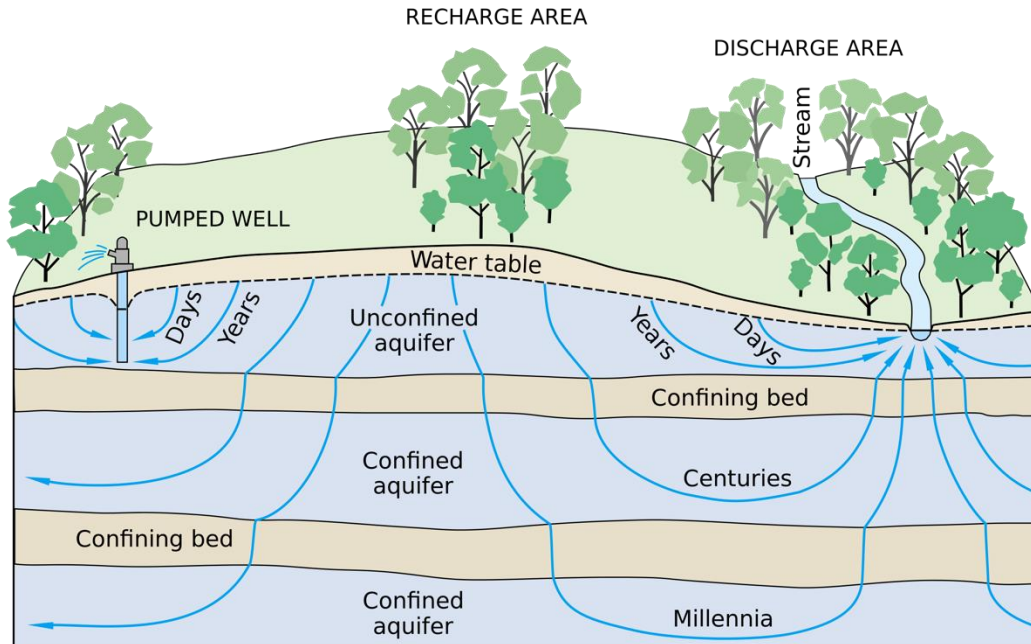


- = It's the yellow circle with 5 purple dots.
- **Intestinal lumen**
  - = fancy way of saying the hollow interior of the intestine tube.
- **Endocytosis**
  - This is how cells engulf food. But in this case, the cell is tricked into engulfing the toxin.
  - "En dough sigh toe sis"
- **Clathrin**
  - This is a very special protein involved with endocytosis.
  - "Clath rin"
- Verbatim
  - Mechanism of action of the shiga toxin. (1) Binding of the bacterium to the gb-3 layer of the cell. (2) Production of the shiga toxin. (3) Stx is transported to the Golgi complex. (4) Endocytosis of the toxin in the cell. (5) Clathrin-enveloped vesicle formation. (6) The toxin is transported to the Golgi complex. (7) Vesicle breaking and separation of pentamer B from the toxic A1 fraction. (8) Action of the A1 portion on the rRNA in the 28S portion, acting as N-glycosidase, replacing an Adenine moiety. (9) Inability to translate the RNA tape. (10) Cell death.
- Source
  - Comprehensive Reviews in Food Science and Food Safety
    - September 2017
    - You have to sign up with [ResearchDirect](#) to download this. It's free.
    - [https://www.researchgate.net/publication/319655863\\_Shiga-toxin\\_Producing\\_Escherichia\\_coli\\_Pathogenicity\\_Supershedding\\_Diagnostic\\_Methods\\_Occurrence\\_and\\_Fo](https://www.researchgate.net/publication/319655863_Shiga-toxin_Producing_Escherichia_coli_Pathogenicity_Supershedding_Diagnostic_Methods_Occurrence_and_Fo)  
[odborne\\_Outbreaks\\_Shiga-toxin\\_producing\\_E\\_coli](#)
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# Page 178 – Walkerton #3

## Aquifer

Aquifer



### Aquifer

- Summary
  - **Aquifer**
    - An aquifer is water-bearing permeable rock.
    - Vary greatly in characteristics.
    - Depth range is huge, from surface depth to 30,000 FT (yes, thirty thousand!, that's 6 miles ... that sounds too deep to be true? A hydrologist or geologist could verify that).
  - **Aquitard**
    - It's not water.
    - It's an impermeable layer like clay that confines the water in the aquifer.
- <https://en.wikipedia.org/wiki/Aquifer>

Manure



#### Disc harrow

- This farming implement incorporates cow manure fertilizer into the soil.
- [https://en.wikipedia.org/wiki/Disc\\_harrow](https://en.wikipedia.org/wiki/Disc_harrow)

## Chlorine - mechanism of action

#### Chemical Disinfectants - Guideline for Disinfection and Sterilization in Healthcare Facilities (2008)

- Summary
  - A range of disinfectants are described.
  - The chemistry is technical but you can get the gist of things.
- Chlorine
  - How chlorine kills bacteria is not exactly known but it's thought to be a combination of these things:
    - Oxidation of sulf-hydril enzymes and amino acids
    - Ring chlorination of amino acids
    - Loss of intra-cellular contents
    - Decreased uptake of nutrients
    - Decreased uptake of O<sub>2</sub>
    - Inhibition of protein synthesis
    - Decreased ATP production
    - Breaks in DNA
    - Decreased DNA synth
- Time to kill using chlorine
  - **Seconds** *Mycoplasma*
  - **Seconds** *Vegetative bacteria*
  - **5 min** *B. atrophaeus*
  - **10 min** *C. diff* spores (5000 ppm chlorine)
  - **1 hour** fungi

- Verbatim
  - Low concentrations of free available chlorine (e.g., HOCl, OCl<sup>-</sup>, and elemental chlorine-Cl<sub>2</sub>) have a biocidal effect on mycoplasma (25 ppm) and vegetative bacteria (<5 ppm) in seconds in the absence of an organic load <sup>329, 418</sup>. Higher concentrations (1,000 ppm) of chlorine are required to kill *M. tuberculosis* using the Association of Official Analytical Chemists (AOAC) tuberculocidal test <sup>73</sup>. A concentration of 100 ppm will kill ≥99.9% of *B. atrophaeus* spores within 5 minutes <sup>541, 542</sup> and destroy mycotic agents in <1 hour <sup>329</sup>. Acidified bleach and regular bleach (5,000 ppm chlorine) can inactivate 10<sup>6</sup> *Clostridium difficile* spores in ≤10 minutes <sup>262</sup>. One study reported that 25 different viruses were inactivated in 10 minutes with 200 ppm available chlorine <sup>72</sup>. Several studies have demonstrated the effectiveness of diluted sodium hypochlorite and other disinfectants to inactivate HIV <sup>61</sup>. Chlorine (500 ppm) showed inhibition of *Candida* after 30 seconds of exposure <sup>54</sup>. In experiments using the AOAC Use-Dilution Method, 100 ppm of free chlorine killed 10<sup>6</sup>-10<sup>7</sup> *S. aureus*, *Salmonella choleraesuis*, and *P. aeruginosa* in <10 minutes <sup>327</sup>. Because household bleach contains 5.25%-6.15% sodium hypochlorite, or 52,500-61,500 ppm available chlorine, a 1:1,000 dilution provides about 53-62 ppm available chlorine, and a 1:10 dilution of household bleach provides about 5250-6150 ppm.
- Translation
  - ppm = parts per million
- Source
  - CDC
    - 2008
    - <https://www.cdc.gov/infectioncontrol/guidelines/disinfection/disinfection-methods/chemical.html>

### Mechanism of disinfection: Effect of chlorine on cell membrane functions

- Verbatim
  - Treatment with chlorine induced the leakage of macromolecules from the cells indicating the permeability changes of the membrane. Proteins and RNA were detected in the supernatant when the cells were treated with chlorine dose of 1.5 mg l<sup>-1</sup> (100 µg Cl mg<sup>-1</sup> N).
- Source
  - Water Research
    - This is journal. The article appeared in Science Direct. Elsevier is the publisher – they publish a ton of academic papers.
    - 12 July 1976
    - <https://www.sciencedirect.com/science/article/abs/pii/0043135477901142>
- Authors
  - C. Venkobachar, Leela Iyengar, A.V.S. Prabhakara Rao - Environmental Engineering Laboratory, Department of Civil Engineering, Indian Institute of Technology, Kanpur 208016, India
    - The Indian Institute of Technology (IIT) is basically India's version of the Massachusetts Institute of Technology (MIT). Lots of brain power is vested in these places.

## Walkerton E coli outbreak - details

These are the notes I made.

### Walkerton E coli outbreak

- **Aquifer**

- = water-bearing permeable rock.
- Vary greatly in characteristics.
- Depth range is huge, from surface depth to 30,000 FT (yes, thirty thousand!).
- **Aquitard**
  - It's not water.
  - It's an impermeable layer like clay that confines the water in the aquifer.
  - <https://en.wikipedia.org/wiki/Aquifer>
- **Wells**
  - **Artesian well**
    - Water flows even if pump off. Hmm.
    - Karst limestone → contaminated surface water easily enters the aquifer.
  - 3 chlorinated wells
    - W of town
    - SW of town
  - **Well 5**
    - #1 culprit in Wik – Walkerton
    - South of town.
    - Closest to the town.
    - It is drilled to about 15 m.
    - Draws water from 18-19 FT and 23 – 24 FT through soft limestone.
    - Steel casing.
    - No contamination alarms.
    - No auto shut off.
    - April 22 - Manure laid down on lot 20 some 81 m / 266 FT from Well 5.
    - May 8-12 - heavy rainfall → bacteria in manure go deeper into soil near Well 5.
    - May 12 – Infected water enters Well 5.
    - Verbatim
      - To the immediate south and west of Well 5 lay farmland used as a cattle-breeding operation, occupying four lots (18-21, west to east). On April 22, 2000, following heavy rainfall on April 20-21, manure from the cattle was used to fertilize crops growing on lot 20 of the property, the nearest edge of which lay approximately 81 metres (266 ft) from Well 5. The manure was subsequently incorporated into the soil of lot 20 using a disc harrow. (Wik – Walkerton)
  - **Well 7**
    - It is drilled to about 75 m.
    - Cement casing followed by steel casing.
    - Steel corroding.
    - Faulty overflow valve on Well 7.
    - May 15 -19 – Well 7 supplying unchlorinated water to Walkerton.
- **Microbiology**
  - **Human**
    - E coli
    - Human intestines
  - **Cow**
    - E coli O:157:H7
    - Cow intestines
    - Serotype (a.k.a. serovar) is O:157:H7
      - = Bacteria (or virus) with similar surface Antigen. Basically.
    - Does not bind to Shiga Tx Rc! That's why it does not cause illness in cattle. Cool!!!
    - Verbatim
      - While it is relatively uncommon, the E. coli serotype O157:H7 can naturally be found in the intestinal contents of some cattle, goats, and even sheep.<sup>[10]</sup> The digestive tract of cattle lack the Shiga toxin receptor globotriaosylceramide, and thus, these can be asymptomatic carriers of the

bacterium.<sup>[11]</sup> The prevalence of *E. coli* O157:H7 in North American feedlot cattle herds ranges from 0 to 60%.<sup>[12]</sup> Some cattle may also be so-called “super-shedders” of the bacterium. Super-shedders may be defined as cattle exhibiting rectoanal junction colonization and excreting  $>10^3$  to  $4$  CFU  $g^{-1}$  feces. Super-shedders have been found to constitute a small proportion of the cattle in a feedlot (<10%) but they may account for >90% of all *E. coli* O157:H7 excreted.<sup>[13]</sup>

- [https://en.wikipedia.org/wiki/Escherichia\\_coli\\_O157:H7](https://en.wikipedia.org/wiki/Escherichia_coli_O157:H7)

- Timeline of 2000 A.D.

- April 20-21- heavy rainfall
- April 22 - Manure laid down on lot 20 some 81 m / 266 FT from Well 5.
  - Manure ‘later’ ‘incorporated into soil’ with disc harrow.
- May 8-12 - heavy rainfall → bacteria in manure go deeper into soil near Well 5 → *E coli* O157:H7 and *Campylobacter jejuni* in cow manure → into aquifer of shallow well that supplied the town → 2000 cases **Gastroenteritis**.
- May 12 – Infected water enters Well 5
- May 15 -19 – Well 7 supplying unchlorinated water to Walkerton.
  - Justice O’Connor noted that Stan Koebel did not disclose this.
- May 13-16 – Walkerton residents become infected with *E coli*.
  - That’s a best guess based on backdating of incubation time of *E coli* and *Campylobacter*.

- TSN Turning Points

- (I like to apply this Total Sports Network (TSN) concept to all kinds of things).
- Dope
  - This is in fact a geology issue!
  - Increased permeability (of karst limestone) → decreased filtration of bacteria in cow manure → bacteria into aquifer → lack of chlorination (0.27 mg/ml instead of 0.5 mg/ml) by the Koebel brothers of the Walkerton Public Utilities Commission (PUC) → microbiology samples from already-chlorinated tap water! → **Gastroenteritis** x 2000 cases, **Hemolytic Uremic Syndrome** x 6 deaths.
- Stratigraphy
  - Highest risk
    - Sand and gravel.
  - High risk
    - Fractured Limestone = highly permeable.
    - It’s Karst.
  - Low risk
    - Clay and silt cover bedrock.
- Well 5
  - I get the sense Well 5 is the culprit.
  - No contamination alarms. No auto shut off.
- Well 7
  - Faulty overflow valve.
  - So Well 7 is a culprit, too.
  - \$100. Simple plastic ‘flap gate.’ It was standard (read, state of the art) at time well was dug.
  - \$1000 for a better one with an alarm and a spring.
- Brothers
  - Basically untrained, complacent.
- Microbiology samples
  - Brothers were subpar
    - 9 samples/month rather than mandated 13 samples /month
    - They (or other ee) took samples from own home i.e. water already chlorinated.
  - Incubation
    - *E coli* O157:H7 incubation 3-4 days

- *Campylobacter jejuni* incubation 2-5 days.
    - This info used to date backwards to date well became infected.
  - Chlorine
    - It is a known fact that cow manure contains *E coli*.
    - The brothers were subpar.
      - Did not use enough Chlorine for chlorination.
        - Chlorine 0.5 mg/L is the standard.
        - The average was 0.27 mg/L because:
          - The brothers drank fresh water from the well and thought chlorine was not even needed, it seems.
          - Town resident complained the water tasted chlorinated.
      - Did not test chlorine levels daily.
    - Chlorine plant broke down (?) -> chlorine not being added to water.
  - Broken loop
    - 'Broken loop': abnormal *E coli* result sent from private lab to brothers who do not forward to Ministry of Environment (MOE) and Medical Officer of Health.
  - Lack of oversight
    - This is my gestalt.
    - It seems there was lack of oversight from the Ministry of Environment (MOE), lack of follow-up of previously subpar standards in Walkerton.
- **NOT at fault**
  - Manure supply farm.
- **Walkerton**
  - Population 5000
  - Considered a town / township.
- **Walkerton Public Utilities Commission (PUC)**
  - owns and operates the wells.
  - managed by Stan Koebel
  - run by foreman Frank Koeb
  - They are brothers. Worked there since teens. Father worked there.
  - No formal training in H2O management.
    - But they nevertheless are Class 3 water system distribution operators.
    - They were somehow grandfathered into that by the Ministry of Environment based on experience.
  - Knew very little about water safety. Oversaw their own continuing education which some of it was simply CPR training.
    - Faulty overflow valve on Well 7.
- **Walkerton Inquiry** (that is the official name)
  - Chief Justice Dennis O'Connor
  - Verbatim - He concluded:
    - The Walkerton Public Utilities Commission operators engaged in a host of improper operating practices, including
      - failing to use adequate doses of chlorine,
      - failing to monitor chlorine residuals daily,
      - making false entries about residuals in daily operating records, and
      - misstating the locations at which microbiological samples were taken.
    - The operators knew that these practices were unacceptable and contrary to Ministry of Environment guidelines and directives.
- **Punishment**
  - Frank Koebel – 9 months house arrest
  - Stan Koebel – 1 year (jail, I think)
  - I wasn't there but I'm guessing they felt very badly about the children who died. I think if the Ministry of the Environment made the consequences of E coli O157:H7 and Shiga toxin abundantly clear and had created standards for employees then they would have performed

the job differently. You're gonna be clueless unless someone higher up in the food chain ensures you are provided the education to not be clueless. Point is, it takes death and disasters to make improvements in 'state of the art.'

## Hemolytic Uremic Syndrome (HUS)

### Hemolytic Uremic Syndrome

- Summary
  - This is a difficult concept to understand. Here is the verbatim from several sources.
- Verbatim **Mayo Clinic**
  - Hemolytic uremic syndrome (HUS) is a condition that can occur when the small blood vessels in your kidneys become damaged and inflamed. This damage can cause clots to form in the vessels. The clots clog the filtering system in the kidneys and lead to kidney failure, which could be life-threatening.
  - <https://www.mayoclinic.org/diseases-conditions/hemolytic-uremic-syndrome/symptoms-causes/syc-20352399>
- Verbatim **Medscape**
  - Hemolytic-uremic syndrome (HUS) is a clinical syndrome characterized by progressive kidney failure that is associated with microangiopathic (nonimmune, Coombs-negative) hemolytic anemia [MAHA] and thrombocytopenia. HUS is the most common cause of acute kidney injury in children and is increasingly recognized in adults.
  - The Swiss pediatric hematologist **Conrad von Gasser** and colleagues first described hemolytic-uremic syndrome (HUS) in 1955. [5] In 1983, Karmali and colleagues reported finding a toxin produced by specific strains of *Escherichia coli* in the stools of children with HUS. This toxin was lethal to **Vero cells** (a line of kidney cells isolated from the African green monkey), and so was termed verotoxin. Also in 1983, O'Brien and colleagues purified a lethal toxin from the enteropathogenic *E coli* O157:H7 strain that structurally resembled that of *Shigella dysenteriae* type 1, and termed it Shiga-like toxin (both terms honor the **Japanese bacteriologist Kiyoshi Shiga**, who in 1898 discovered *S dysenteriae* and its toxin as the cause of dysentery).
  - Translation
    - **MAHA** means **Micro-Angiopathic Hemolytic Anemia** ("micro" "an gee oh path ik" "hee moh lit ik" "ah nee me ah") and is fancy way of saying the first sentence of the preceding **Mayo Clinic** article: 'small blood vessels' become 'damaged and inflamed.'
    - MAHA is super-duper complicated.
  - Medscape
    - <https://emedicine.medscape.com/article/201181-overview>
    - May 2023
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## Uremia

- Verbatim **Medscape**
  - Uremia usually develops only after the creatinine clearance falls to less than 10 mL/min, although some patients may be symptomatic at higher clearance levels, especially if renal failure develops acutely. The syndrome may be heralded by the clinical onset of the following symptoms:
    - Nausea.
    - Vomiting.
    - Fatigue.
    - Anorexia.
    - Weight loss.
    - Muscle cramps.
    - Pruritus.
    - Change in mental status.
- **Medscape**
  - March 2024
  - [https://emedicine.medscape.com/article/245296-overview?gad\\_source=1&gclid=Cj0KCQjwzZmwBhD8ARIsAH4v1gWCx9-ifDJxuE5yGfxDI3dyVUPHvweiTRmQgnxgBX7A4K64HaUVnSEaAphHuEALw\\_wcB](https://emedicine.medscape.com/article/245296-overview?gad_source=1&gclid=Cj0KCQjwzZmwBhD8ARIsAH4v1gWCx9-ifDJxuE5yGfxDI3dyVUPHvweiTRmQgnxgBX7A4K64HaUVnSEaAphHuEALw_wcB)
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**Page 179 - Mother Nature**

There are some really cool Mother Nature images in Google Images. I like this one:



Sculpture "Mother Earth: The Legend of Aataentsic" in the Jacques-Cartier Park, Gatineau, Québec. Interpretation of Mother Earth from the creation story of the Haudenosaunee people. Like the stars and the moon, she was created from parts of Sky Woman (Aataentsic), which the good spirit buried in the earth so that all living beings would always find food.

- 23 August 2018
- Flickr <https://www.flickr.com/photos/archer10/44107473564>
- Dennis Jarvis
- [https://en.m.wikipedia.org/wiki/File:Mother\\_Earth- The\\_Legend\\_of\\_Aataentsic.jpg](https://en.m.wikipedia.org/wiki/File:Mother_Earth- The_Legend_of_Aataentsic.jpg)

**Page 180 – Acronyms who help you**



### International Maritime Organization (IMO)

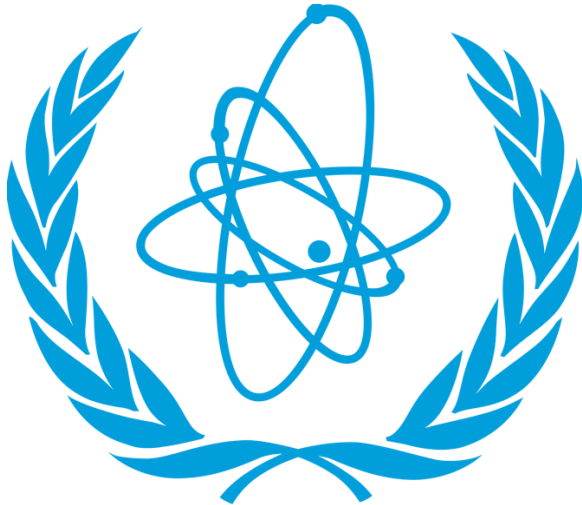
- It's an agency of the United Nations. HQ in London.
- They oversee a number of important maritime conventions.
  - *International Regulations for Preventing Collisions at Sea 1972 (COLREGs)*
  - *International Convention for Safe Containers*
  - *International Convention for the Prevention of Pollution from Ships, 1973 as modified by the Protocol of 1978 (MARPOL 73/78)*
  - *International Convention on Maritime Search and Rescue (SAR)*
  - *International Convention for the Safety of Life at Sea (SOLAS)*
  - *International Convention for the Regulation of Whaling*
- [https://en.wikipedia.org/wiki/International\\_Maritime\\_Organization](https://en.wikipedia.org/wiki/International_Maritime_Organization)
- <https://www.imo.org>



### International Civil Aviation Organization (ICAO) ("eye kay oh")

- Guess what?
  - Planes flying west use even altitudes, e.g. 38,000 feet.
  - Planes flying east use odd altitudes, e.g. 37,000 feet.

- That way, a minimum of 1000 feet of separation is maintained.
- You can thank ICAO for that.
- <https://www.icao.int/Pages/default.aspx>



# IAEA


International Atomic Energy Agency (IAEA)

- Please contact them prior to installing a nuclear reactor in your back yard.
- <https://www.iaea.org>



# World Health Organization

World Health Organization (WHO)

- See page 184 for WHO organization.
-  Scroll through this A to Z page to learn metric tonnes of information on major health topics.
- <https://www.who.int/health-topics/>
- Verbatim – About WHO

We are champions for healthier, safer lives

Our team of 8000+ professionals includes the world's leading public health experts, including doctors, epidemiologists, scientists and managers. Together, we coordinate the world's response to health emergencies, promote well-being, prevent disease and expand access to health care. By connecting nations, people and partners to scientific evidence they can rely on, we strive to give everyone an equal chance at a safe and healthy life.

- Safe to say, if you were alive in 50,000 BC, there was no WHO looking out for you. Enjoy your 30-year lifespan.



**CENTERS FOR DISEASE™  
CONTROL AND PREVENTION**

**CDC (Centers for Disease Control and Prevention)**

- It found it hard to draw that logo and get all the diagonal white lines lined up with the letters. CDC, could you please reduce it to 3 white lines? No? You don't feel like doing that? You're busy with Ebola?
- See page 50 for how the CDC is organized.



**U.S. FOOD & DRUG  
ADMINISTRATION**



#### Center for Veterinary Medicine

- I dig this logo. It's very Dr. Doolittle.
- [https://en.wikipedia.org/wiki/Center\\_for\\_Veterinary\\_Medicine](https://en.wikipedia.org/wiki/Center_for_Veterinary_Medicine)
- <https://www.fda.gov/about-fda/fda-organization/center-veterinary-medicine>

#### FDA

- These are notes I made from a bunch of Wikipedia articles, my goal being the big picture.
- Synonyms
  - Food and Drug Administration
  - FDA
  - U.S. Food and Drug Administration
  - USFDA
- HQ: [White Oak Campus, 10903 New Hampshire Ave, Silver Spring, MD](#)
  - 14,800 employees (ee)
  - \$3b budget
  - Current Director = [Dr. Andres von Eschenbach](#), confirmed by Senate 2006
- Parent agency
  - [Dept Health and Human Services \(HHS\)](#)
- **What does it regulate?**
  - **Food, dietary supplements, drugs, biological medical products, blood products, medical devices, radiation emitting devices, veterinary products, cosmetics.**
- Child agencies (n = 6 centers)
  - [Center for \*\*Biologics\*\* Evaluation and Research \(CBER\)](#)
    - General
      - CBER reviews New Drug Applications. 1300 ee. \$290m budget.
      - Safety Team of 72 ee to look out for more risks. Monitors Side Effects (SE) of 3000 prescriptions drugs on 200m Americans. \$15m budget.
      - Clinical trials have 4 phases. Ph3 is largest and req 1000-3000 pts.
    - Determines safety, purity, potency, effectiveness of:
      - **blood, blood products**
      - **cells for TP, tissues for TP**

- vaccines
  - Gene therapy
- What do they evaluate?
  - Blood products
  - Vaccines
    - Vaccine Adverse Event reporting goes to them.
  - Allergenic extracts
  - Probiotics a.k.a. live bio-therapeutics
  - HIV test kits
  - Xeno-transplants
  - Monoclonal AB
    - This was transferred to CDER.
- Center for **Devices** and Radiological Health (CDRH)
  - Building 66
    - Sounds ominous.
  - General
    - premarket approval of all medical devices.
    - This includes manufacture, performance, safety.
    - Also oversees non-medical devices that emit radiation (what would that be?)
  - What do they evaluate?
    - Class 1 devices
      - Toothbrush
      - Unlikely to cause harm.
    - Class 2 devices
      - Demineralized bone powder for reconstructive surgery.
      - 113 devices were recalled over 5y, and 35 of them were cardiac devices (like what?)
    - Class 3 devices
      - Pacemaker
      - Likely to cause harm / death if malfunctions.
- Center for **Drug** Evaluation and Research (CDER)
  - 1300 ee
  - Basically all new drugs.
    - That includes Monoclonal Antibodies.
  - And they monitor 3000 prescription drugs that are prescribed to 200 million Americans.
- Center for **Food** Safety and Applied Nutrition
  - What do they evaluate?
    - Food
      - Dietary supplements
      - Food allergens
    - Pathogens
      - Biological pathogens
      - Prion diseases ie spongiform encephalopathies.
        - Hmm.
    - Toxins
      - Pesticides
      - Natural toxins
      - Heavy metals
      - 'Decomposition and filth'
        - That sounds so British Navy.
      - Radionuclides
      - Product tampering
        - I'm thinking of the Tylenol bottles that were tampered with.

- Tamper-evident seals are use.
  - Center for **Tobacco** Products
    - Enforce standards.
  - Center for **Veterinary** Medicine (CVM)
    - General
      - Regulates manufacture and distribution of food additives / drugs given to animals.
      - This includes animals we eat (chicken, pigs, cows, turkey) and pets (cats, dogs, hoes).
    - Nice logo.
      - [https://en.wikipedia.org/wiki/Center\\_for\\_Veterinary\\_Medicine](https://en.wikipedia.org/wiki/Center_for_Veterinary_Medicine)
      - Their own website does not have it. Defunct?
    - Food / food additives / drugs / devices given to:
      - Companion animals
      - Farm animals
    - The director is a vet.
    - It does NOT regulate vaccines to animals. That is done by the USDA.
    - 2003 - CDC and FDA ban the sales of prairie dogs in USA.
      - I am assuming it was the CVM that made this decision.
  - National Center for **Toxicological** Research
    - Toxicology research, basically.
  - Office of **Criminal** Investigations (OCI)
    - 180 agents
    - Works with Interpol.
    - 1991 – Established due to generic drug scandal.
    - Investigate tampering whereas Ctr for Food Safety and Nutrition seems to ensure the tamper-proof lids are made properly. I am inferring.
  - Office of **Regulatory** Affairs (ORA) a.k.a. Global Regulatory Operations and Policy
    - Eyes and ears of FDA.
    - Enforces federal laws.
- General
  - Of every \$1 spent by American consumers, 25 cents is regulated by the FDA. Wow.
    - That goes to show how much effort goes into ensuring it's a safe society, which in turn massively increases productivity. It's really, really smart. It's an unstated reason why the US became a global superpower.
  - Generally Considered as Safe (GRAS)
    - That is an FDA grading applied to perfume.
      - [https://en.wikipedia.org/wiki/Perfume#Health\\_and\\_environmental\\_issues](https://en.wikipedia.org/wiki/Perfume#Health_and_environmental_issues)
      - [https://en.wikipedia.org/wiki/Generally\\_recognized\\_as\\_safe](https://en.wikipedia.org/wiki/Generally_recognized_as_safe)

#### History of legislation

- 1902 - *Biologics Control Act*
- 1906 - *Pure Food and Drug Act*
- 1938 - *Federal Food, Drug, and Cosmetic Act* - this says which drugs are prescription drugs.
- 1944 - *Public Health Service Act*
- 1953 - *Flammable Fabrics Act*
- 1960 - *Fed Hazardous Substances Labelling Act*
- 1965 - *Fed Cigarette Labelling and Advertising Act*
- 1966 - *Fair Packaging and Labeling Act*
- 1966 - *Child Protection Act*
- 1972 - *Consumer Products Safety Act*
- 1976 - *Medical Device Regulation Act*
- 1986 - *Comprehensive Smokeless Tobacco Health Education Act*
- 1988 - *Anti-Drug Abuse Act*
- 1990 - *Nutrition Labeling and Education Act*



1992 - *Prescription Drug User Fee Act*

1997 - *Food and Drug Modernization Act*

Source

- <https://www.fda.gov>
- [https://en.wikipedia.org/wiki/Food\\_and\\_Drug\\_Administration](https://en.wikipedia.org/wiki/Food_and_Drug_Administration)
- [https://en.wikipedia.org/wiki/Center\\_for\\_Biologics\\_Evaluation\\_and\\_Research](https://en.wikipedia.org/wiki/Center_for_Biologics_Evaluation_and_Research)
- [https://en.wikipedia.org/wiki/FDA\\_Center\\_for\\_Devices\\_and\\_Radiological\\_Health](https://en.wikipedia.org/wiki/FDA_Center_for_Devices_and_Radiological_Health)
- [https://en.wikipedia.org/wiki/Center\\_for\\_Drug\\_Evaluation\\_and\\_Research](https://en.wikipedia.org/wiki/Center_for_Drug_Evaluation_and_Research)
- [https://en.wikipedia.org/wiki/Center\\_for\\_Food\\_Safety\\_and\\_Applied\\_Nutrition](https://en.wikipedia.org/wiki/Center_for_Food_Safety_and_Applied_Nutrition)
- [https://en.wikipedia.org/wiki/Center\\_for\\_Food\\_Safety\\_and\\_Applied\\_Nutrition](https://en.wikipedia.org/wiki/Center_for_Food_Safety_and_Applied_Nutrition)
- [https://en.wikipedia.org/wiki/Center\\_for\\_Veterinary\\_Medicine](https://en.wikipedia.org/wiki/Center_for_Veterinary_Medicine)
- [https://en.wikipedia.org/wiki/National\\_Center\\_for\\_Toxicological\\_Research](https://en.wikipedia.org/wiki/National_Center_for_Toxicological_Research)
- [https://en.wikipedia.org/wiki/Office\\_of\\_Criminal\\_Investigations](https://en.wikipedia.org/wiki/Office_of_Criminal_Investigations)
- [https://en.wikipedia.org/wiki/Office\\_of\\_Global\\_Regulatory\\_Operations\\_and\\_Policy](https://en.wikipedia.org/wiki/Office_of_Global_Regulatory_Operations_and_Policy)



NIH HQ in [Bethesda, Maryland](#)

- Looks like the perfect location for a Hollywood slasher movie.

### NIH (National Institutes of Health)


- These are notes I made. I use the pink color for nouns and organisms.
- Dope
  - NIH is one of the 11 agencies of the Dept of Health and Human Services (HHS).
  - NIH is made up 27 Institutes.
- Structure (n = 27 arms)
  - Epidemiology
    - National Inst of Child Health and Human Development (NICHD)
    - National Inst on Aging (NIA)
    - National Inst on Minority Health and Health Disparities (NIMHD)
    - National Cancer Institute (NCI)
    - National Inst on Environmental Health Sciences (NIEHS)
    - National Inst on General Medical Sciences (NIGMS)
      - Basic research, e.g. burn treatment, Gene splicing
      - [https://en.wikipedia.org/wiki/National\\_Institute\\_of\\_General\\_Medical\\_Sciences](https://en.wikipedia.org/wiki/National_Institute_of_General_Medical_Sciences)
  - Psychiatry & Substances
    - National Inst on Mental Health (NIMH)
    - National Inst on Alcohol Abuse and Alcoholism (NIAAA)
    - National Inst on Drug Abuse (NIDA)
  - Head and Neck
    - National Inst on Neurological Disorders and Stroke (NINDS)
    - National Eye Institute (NEI)
    - National Inst on Deafness and Other Communications Disorders (NIDCD)
    - National Inst of Dental and Craniofacial Research (NIDCR)
  - Cardiovascular
    - National Heart, Lung, and Blood Institute (NHGRI)
  - Gastrointestinal & Endocrine
    - National Inst of Diabetes and Digestive and Kidney Diseases (NIDDK)
  - Hematology & Infectious Disease
    - National Inst of Allergy and Infectious Diseases (NIAID)



- **Anthony Fauci**
  - Dir NIAID, Chief Medical Advisor to POTUS
- **David M. Morens, M.D.**
  - CAPT, United States Public Health Service, Senior Advisor to the Director, Office of the Director, National Institute of Allergy and Infectious Diseases, National Institutes of Health
- **Jeffery K. Taubenberger, M.D., Ph.D.**
  - Chief, Viral Pathogenesis and Evolution Section, Deputy Chief, Laboratory of Infectious Diseases, National Institute of Allergy and Infectious Diseases, National Institutes of Health
- Musculoskeletal
  - National Inst of Arthritis and MSK and Skin Diseases (NIAMS)

- **National Inst of Biomedical Imaging and Bioengineering (NIBIB)**
- **Administration**
  - **National Inst of Nursing Research (NINR)**
  - **National Library of Medicine (NLM)**
    - **NCBI**
  - **Center for Information Technology (CIT)**
  - **Center for Scientific Review (CSR)**
  - **Fogarty International Center (FIC)**
    - **Trains international researchers.**
  - **National Center for Advancing Translational Sciences (NCATS)**
    - **Office of Rare Diseases research**
    - [https://en.wikipedia.org/wiki/National\\_Center\\_for\\_Advancing\\_Translational\\_Sciences](https://en.wikipedia.org/wiki/National_Center_for_Advancing_Translational_Sciences)
  - **National Center for Complementary and Integrative Health (NCCIH)**
  - **NIH Clinical Center (NIC CC)**

### Verbatim with links

-  You can explore each institute by clicking on a link.
- The NIH is composed of 27 separate institutes and centers (ICs) that conduct and coordinate research across different disciplines of biomedical science. These are:
  - [National Cancer Institute \(NCI\)](#)
  - [National Eye Institute \(NEI\)](#)
  - [National Heart, Lung, and Blood Institute \(NHLBI\)](#)
  - [National Human Genome Research Institute \(NHGRI\)](#)
  - [National Institute on Aging \(NIA\)](#)
  - [National Institute on Alcohol Abuse and Alcoholism \(NIAAA\)](#)
  - [National Institute of Allergy and Infectious Diseases \(NIAID\)](#)
  - [National Institute of Arthritis and Musculoskeletal and Skin Diseases \(NIAMS\)](#)
  - [National Institute of Biomedical Imaging and Bioengineering \(NIBIB\)](#)
  - [National Institute of Child Health and Human Development \(NICHD\[72\]\)](#)
  - [National Institute on Deafness and Other Communication Disorders \(NIDCD\)](#)
  - [National Institute of Dental and Craniofacial Research \(NIDCR\)](#)
  - [National Institute of Diabetes and Digestive and Kidney Diseases \(NIDDK\)](#)
  - [National Institute on Drug Abuse \(NIDA\)](#)
  - [National Institute of Environmental Health Sciences \(NIEHS\)](#)
  - [National Institute of General Medical Sciences \(NIGMS\)](#)
  - [National Institute of Mental Health \(NIMH\)](#)
  - [National Institute on Minority Health and Health Disparities \(NIMHD\)](#)
  - [National Institute of Neurological Disorders and Stroke \(NINDS\)](#)
  - [National Institute of Nursing Research \(NINR\)](#)
  - [National Library of Medicine \(NLM\)](#)
  - [Center for Information Technology \(CIT\)](#)
  - [Center for Scientific Review \(CSR\)](#)
  - [Fogarty International Center \(FIC\)](#)
  - [National Center for Advancing Translational Sciences \(NCATS\)](#)
  - [National Center for Complementary and Integrative Health \(NCCIH\)](#)
  - [NIH Clinical Center \(NIH CC\)](#)



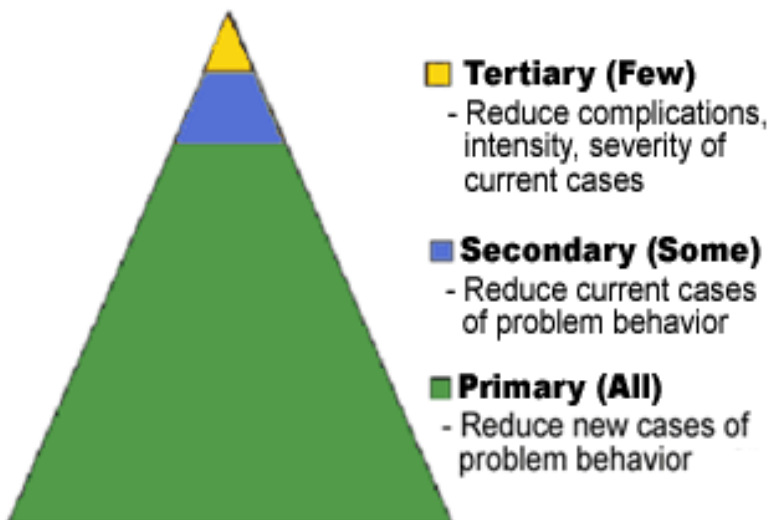
The National Institute on Drug Abuse (NIDA) is one of the 27 arms of the National Institutes of Health (NIH).

- Psychiatrist **Dr. Nora Volkow** is the director. She gave a great Ted Talk, *Why do our brains get addicted?*
  - <https://tedmed.com/talks/show?id=309096>
- [https://en.wikipedia.org/wiki/National\\_Institute\\_on\\_Drug\\_Abuse](https://en.wikipedia.org/wiki/National_Institute_on_Drug_Abuse)
- <https://nida.nih.gov>

# Page 181 – Unicorn of Prevention

Prevention

Primary 1<sup>o</sup> – Secondary 2<sup>o</sup> – Tertiary 3<sup>o</sup>



## Prevention Triangle

- I forget where I got this. I will hunt it down.

## Primary, secondary and tertiary prevention

- Verbatim

- **Primary prevention** aims to prevent disease or injury before it ever occurs.
- **Secondary prevention** aims to reduce the impact of a disease or injury that has already occurred.
- **Tertiary prevention** aims to soften the impact of an ongoing illness or injury that has lasting effects.
  - cardiac or stroke rehabilitation programs, chronic disease management programs (e.g. for diabetes, arthritis, depression, etc.)
  - support groups that allow members to share strategies for living well
  - vocational rehabilitation programs to retrain workers for new jobs when they have recovered as much as possible.
- Source
  - **Institute for Work & Health (IWH), Toronto**
    - They are not for profit independent agency.
    - <https://www.iwh.on.ca/what-researchers-mean-by/primary-secondary-and-tertiary-prevention>

### Hand Hygiene

- Verbatim **CDC**
  - Hand hygiene is a way of cleaning one's hands that substantially reduces potential pathogens (harmful microorganisms) on the hands. Hand hygiene is considered a primary measure for reducing the risk of transmitting infection among patients and health care personnel.
    - Do they mean **Primary Prevention**? It would seem so.
    - <https://www.cdc.gov/oralhealth/infectioncontrol/faqs/hand-hygiene.html>

### COVID-19 reinforces the importance of handwashing

- Verbatim
  - **Handwashing** has received considerable attention during the COVID-19 pandemic. It is a simple, primary preventive measure that most people can do independently. Handwashing with soap and water for at least 20 s or the use of alcohol-based hand sanitisers when soap and water are not available is the first line of defence in stopping the spread of infection (CDC 2020).
- Source
  - **Journal of Clinical Nursing**
    - August 2020
    - Their source is the CDC but that link seems to have been changed on the CDC website.
    - <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7267118/#jocn15313-bib-0004>
- Author
  - **Mamdooh Alzyood**, MSc, BSc (Hons), RN AFHEA
  - **Debra Jackson**, AO, PhD, FACN, SFHEA,<sup>2</sup>
  - **Helen Aveyard**, MA, PhD, RGN, SFHEA,<sup>1</sup>
  - **Joanne Brooke**, CPsychol, MSc, RN<sup>3</sup>
    - <sup>1</sup> Faculty of Health and Life Sciences, Oxford Institute of Nursing, Midwifery, and Allied Health Research (OxINMAHR), Oxford Brookes University, Oxford United Kingdom
    - <sup>2</sup> Faculty of Health, University of Technology, Sydney Australia
    - <sup>3</sup> Faculty of Health, Education and Life Sciences, Birmingham City University, Birmingham United Kingdom

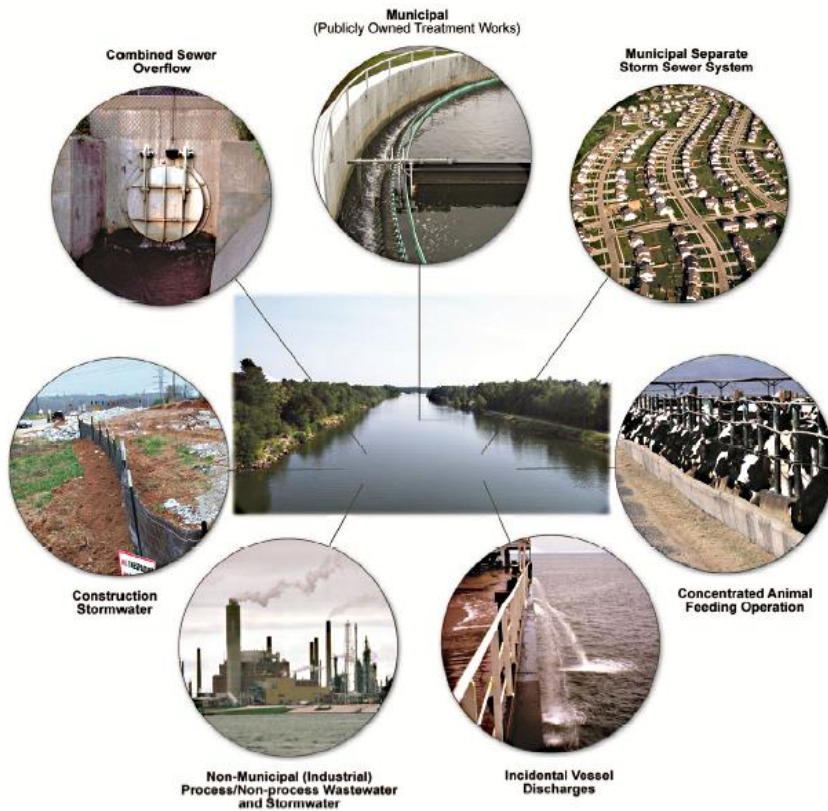
1ary: prevent disease or injury before it occurs (IWH defn, see below)	2ary: reduce impact of disease already present	3ary: reduce impacts of disease already present with lasting effects <ul style="list-style-type: none"> <li>Reduce complications</li> </ul>
<b>Trauma</b>		
Seat belts		Golden Hour
Bike helmet		Neurosurgery
<b>Cancer</b>		
Asbestos limit exposure	Chest X-Ray (CXR)	
Tobacco warning labels	Chest X-Ray (CXR)	Lobectomy, chemo, radiation
	Pap smear	
	Mammogram	Mastectomy, chemo, radiation
	Colonoscopy	
<b>Cardiovascular</b>		
Diet program	Blood Pressure testing	*Stroke rehab
	Carotid UltraSound (US)	*MI rehab
	Lipid levels	*Vocational rehab
	Baby aspirin (if MD says okay to take)	*Diabetes mgmt
	Diet program	
	Exercise program	
<b>Infectious Disease (Covid)</b>		
Vaccine	Serology (looking for antibodies)	ICU Ventilator
Masks	PCR (polymerase chain reaction)	
Social distancing		
Disinfectants		
<b>Sexually Transmitted Infection (STI)</b>		
Condom	Pap smear	doxycycline
Giardasil		
<b>Environment</b>		
Clean Air Act, 1970 (EPA)		
Clean Water Act, 1972 (EPA)		
National Environmental Public Health Tracking Network (CDC)		

I forget who I adapted this table from. Or if I just made it myself. I've been busy.

\* = As per the Institute for Work & Health (IWH). <https://www.iwh.on.ca/what-researchers-mean-by/primary-secondary-and-tertiary-prevention>

# Clean Water Act

Exhibit 1-2 Common point source discharges of pollutants to waters of the United States



## Clean Water Act of 1972

- Water pollution sources starting at 12 o'clock:
  - Municipal water treatment (I think)
  - Municipal storm sewer
  - Animal feed
  - Ships
  - Industrial wastewater
  - Construction stormwater
  - Sewer overflow

## SHORT TITLE

Pub. L. 92-500, § 1, Oct. 18, 1972, 86 Stat. 816, provided that: “That this Act [enacting this chapter, amending section 24 of Title 12, Banks and Banking, sections 633 and 636 of Title 15, Commerce and Trade, and section 711 of former Title 31, Money and Finance, and enacting provisions set out as notes under this section and sections 1281 and 1361 of this title] may be cited as the ‘Federal Water Pollution Control Act Amendments of 1972.’”

Act June 30, 1948, ch. 758, title V, § 520, formerly § 518, as added by Pub. L. 92-500, § 2, Oct. 18, 1972, 86 Stat. 896, amended Pub. L. 95-217, § 2, Dec. 27, 1977, 91 Stat. 1566, renumbered § 519, Pub. L. 100-4, title V, § 506, Feb. 4, 1987, 101 Stat. 76, renumbered § 520, Pub. L. 115-436, § 5(b)(1), Jan. 14, 2019, 132 Stat. 5561, provided that: “This Act [this chapter] may be cited as the ‘Federal Water Pollution Control Act’ (commonly referred to as the **Clean Water Act**).”

## SAVINGS PROVISION

Pub. L. 92-500, § 4, Oct. 18, 1972, 86 Stat. 896, provided that:

“(a) No suit, action, or other proceeding lawfully commenced by or against the Administrator or any other officer or employee of the United States in his official capacity or in relation to the discharge of his official duties under the Federal Water Pollution Control Act as in effect immediately prior to the date of enactment of this Act [Oct. 18, 1972] shall abate by reason of the taking effect of the amendment made by section 2 of this Act [which enacted this chapter]. The court may, on its own motion or that of any party made at any time within twelve months after such taking effect, allow the same to be maintained by or against the Administrator or such officer or employee.

“(b) All rules, regulations, orders, determinations, contracts, certifications, authorizations, delegations, or other actions duly issued, made, or taken by or pursuant to the Federal Water Pollution Control Act as in

trator of the Environmental Protection Agency, shall establish and administer a 5-year national shellfish research program (hereafter in this section referred to as the ‘Program’) for the purpose of improving existing classification systems for shellfish growing waters using the latest technological advancements in microbiology and epidemiological methods. Within 12 months after the date of enactment of this Act [Oct. 29, 1992], the Secretary of Commerce, in cooperation with the advisory committee established under subsection (b) and the Consortium, shall develop a comprehensive 5-year plan for the Program which shall at a minimum provide for—

“(1) an environmental assessment of commercial shellfish growing areas in the United States, including an evaluation of the relationships between indicators of fecal contamination and human enteric pathogens;

“(2) the evaluation of such relationships with respect to potential health hazards associated with human consumption of shellfish;

“(3) a comparison of the current microbiological methods used for evaluating indicator bacteria and human enteric pathogens in shellfish and shellfish growing waters with new technological methods designed for this purpose;

“(4) the evaluation of current and projected systems for human sewage treatment in eliminating viruses and other human enteric pathogens which accumulate in shellfish;

“(5) the design of epidemiological studies to relate microbiological data, sanitary survey data, and human shellfish consumption data to actual hazards to health associated with such consumption; and

“(6) recommendations for revising Federal shellfish standards and improving the capabilities of Federal and State agencies to effectively manage shellfish and ensure the safety of shellfish intended for human consumption.

“(b) ADVISORY COMMITTEE.—(1) For the purpose of providing oversight of the Program on a continuing

## Clean Water Act, 1972

- <https://www.govinfo.gov/content/pkg/USCODE-2018Q-title33/pdf/USCODE-2018-title33-chap26.pdf>

## Clean Water Act, 1972

- It’s actually about regulating discharge of pollutants into water i.e., Erin Brockovich stuff.
- <https://www.epa.gov/laws-regulations/summary-clean-water-act>
- <https://www.govinfo.gov/content/pkg/USCODE-2018-title33/pdf/USCODE-2018-title33-chap26.pdf>
- [https://en.wikipedia.org/wiki/Clean\\_Water\\_Act](https://en.wikipedia.org/wiki/Clean_Water_Act)
- [https://en.wikipedia.org/wiki/United\\_States\\_Environmental\\_Protection\\_Agency](https://en.wikipedia.org/wiki/United_States_Environmental_Protection_Agency)

## Clean Air Act, 1970

- <https://www.epa.gov/laws-regulations/summary-clean-air-act>

# Page 182 – Contagion

Secondary 2<sup>o</sup> prevention – see page 181.

Tertiary 3<sup>o</sup> prevention – see page 181.





### Contagion

- This movie was kinda spooky.
- Warner Brothers
  - <https://www.warnerbros.com/movies/contagion>

### What is Breast Cancer screening?

- Summary
  - This is well written and has lots of links.
- Verbatim
  - The USPSTF [United States Preventative Services Task Force] recommends that women who are 50 to 74 years old and are at average risk for breast cancer get a mammogram every two years.
- Source
  - CDC
    - July 2023
    - [https://www.cdc.gov/cancer/breast/basic\\_info/screening.htm](https://www.cdc.gov/cancer/breast/basic_info/screening.htm)

### Colorectal Cancer Screening Tests

- Summary
  - Easy to read.

- **Colo-rectal** refers to the colon, which is the large intestine. The rectum is the last part of the large intestine.
- Verbatim
  - The U.S. Preventive Services Task Force (Task Force) recommends that adults age 45 to 75 be screened for colorectal cancer.
- Source
  - **CDC**
    - July 2023
    - [https://www.cdc.gov/cancer/colorectal/basic\\_info/screening/tests.htm](https://www.cdc.gov/cancer/colorectal/basic_info/screening/tests.htm)

# Page 183 – QALY rhymes with Wally

## QALY

### Cost-Effectiveness, the QALY, and the evLYG

- Summary
  - There is a 2-minute video that offers a practical and understandable explanation of the **Quality Adjusted Life Year (QALY)**. It compares a drug to treat **toenail fungus** with a drug to treat **cancer**.
- Source
  - **Institute for Clinical and Economic Review (ICER)**
    - ICER is a non-profit organization.
    - <https://icer.org/our-approach/methods-process/cost-effectiveness-the-qaly-and-the-evlyg/>

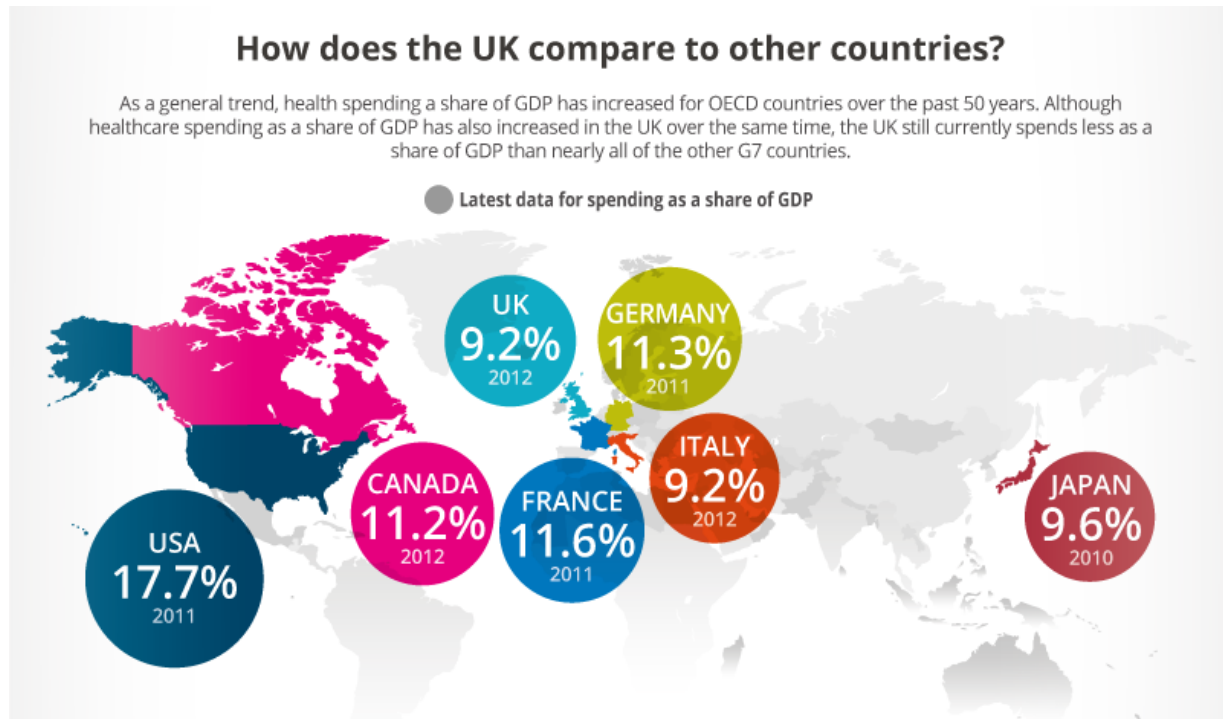
### QALYs – The basics

- Summary
  - This 5-page pdf is written in the dry technical language of economics, where you're like, *What exactly are they saying?* But once you watch the video (in the source above) then you can come back to this pdf and go, *Oh, okay that's where all this theory comes from.*
- Source
  - Value in Health
    - 2009
    - This is a medical journal.
    - It is reference no. 3 in Wikipedia – Quality-Adjusted Life Year.
    - [https://www.valueinhealthjournal.com/article/S1098-3015\(10\)60046-0/pdf?returnURL=https%3A%2F%2Flinkinghub.elsevier.com%2Fretrieve%2Fpii%2FS1098301510600460%3Fshowall%3Dtrue](https://www.valueinhealthjournal.com/article/S1098-3015(10)60046-0/pdf?returnURL=https%3A%2F%2Flinkinghub.elsevier.com%2Fretrieve%2Fpii%2FS1098301510600460%3Fshowall%3Dtrue)
- Authors
  - **Milton C. Weinstein, PhD.** Harvard School of Public Health.
  - **George Torrance, PhD.** McMaster University.
  - **Alistair McGuire, PhD.** London School of Economics.

### Quality-adjusted life year

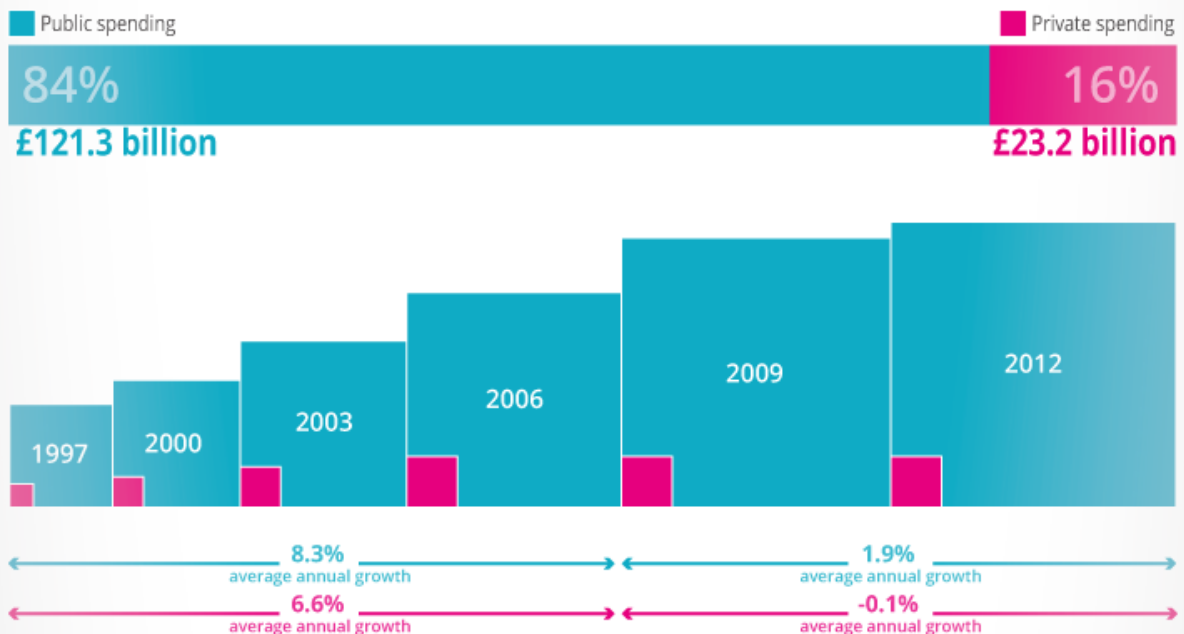
- Verbatim

- One QALY equates to one year in perfect health.
- **Source**
- [https://en.wikipedia.org/wiki/Quality-adjusted\\_life\\_year](https://en.wikipedia.org/wiki/Quality-adjusted_life_year)



## Who is paying for these services?

In 2012, public healthcare made up the largest proportion of UK healthcare spending. Public spending includes all government spending, while private healthcare spending includes household spending, private insurance, not for profit organisations service households and private sector capital.



### Health economics

#### ○ Summary

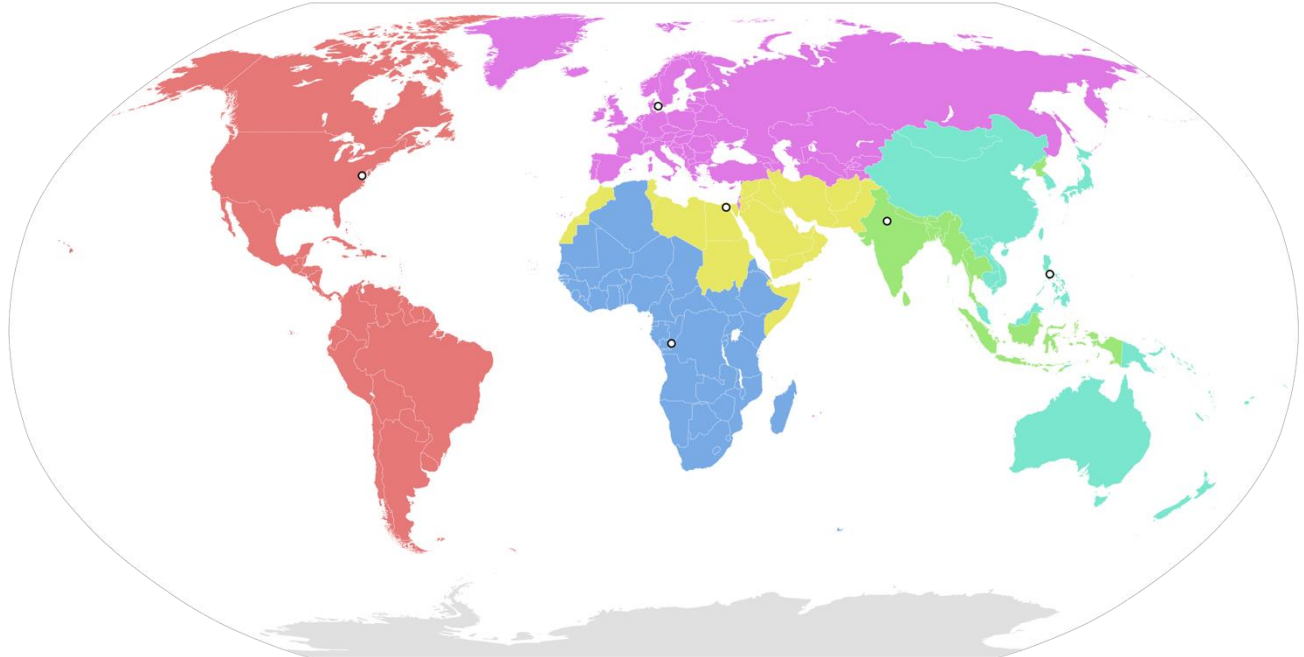
- **Health economics** is basically how much money people and government spend on health care, and how efficient this is.
- The **top image** is a comparison of healthcare spending – as a percent of Gross Domestic Product (GDP) – in the **UK** versus other countries.
- The **bottom image** compares public spending (which implies government) versus private spending in the **UK**.

#### ○ Source

- [https://en.wikipedia.org/wiki/Health\\_economics](https://en.wikipedia.org/wiki/Health_economics)
  - I cropped their single image and extracted and enlarged the two images above.

# Page 184 – Can a Pandemic be Prevented?

WHO regions



### List of WHO regions

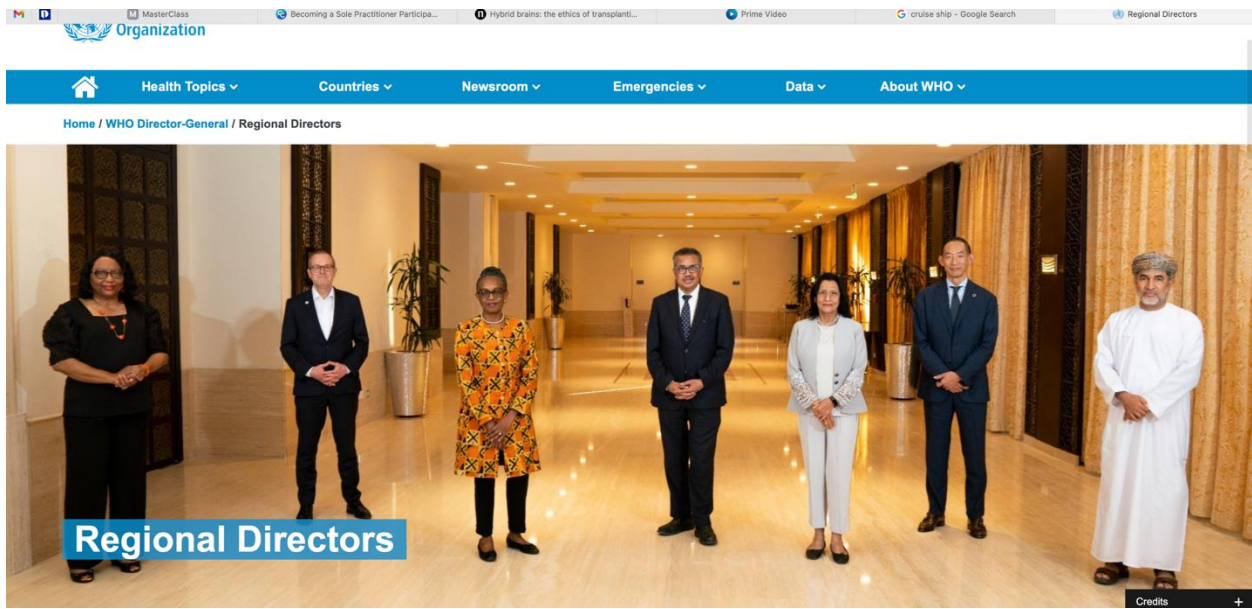
- Summary
  - The 6 dots are the HQ city for the 6 regions.

Region	HQ city
Americas	Washington, DC
Europe	Copenhagen, Denmark
Africa	Brazzaville, Congo
Eastern Mediterranean	Cairo, Egypt
South East Asia	New Delhi, India
Western Pacific	Manilla, Philippines
- Source
  - [https://en.wikipedia.org/wiki/List\\_of\\_WHO\\_regions](https://en.wikipedia.org/wiki/List_of_WHO_regions)

### WHO regional offices

- Summary
  - 🖱️ You can click on the links to the 6 regions to see what's going on there, as per the WHO.
- Source
  - WHO
    - <https://www.who.int/about/who-we-are/regional-offices>

## WHO Regional Directors



- <https://www.who.int/director-general/regional-directors>



**Dr Carissa F. Etienne, WHO Regional Director for the Americas**

- Dr. Carissa F. Etienne was elected Director of the Pan American Health Organization (PAHO) by the Member States of the Organization on 19 September 2012 and began her five-year term on 1 February 2013. From March 2008 until 1 November 2012, Dr. Etienne served as Assistant Director-General for Health Systems and Services at the World Health Organization in Geneva, Switzerland.

Prior to that, as Assistant Director of PAHO from July 2003 to February 2008, she led 5 technical areas: Health Systems and Services; Technology, Health Care and Research; Health Surveillance and Disease Management; Family and Community Health; and Sustainable Development and Environmental Health.

During her tenures at WHO and PAHO, Dr. Etienne led the efforts to renew primary health care and to strengthen health systems based on primary health care, promoting integration and improved functioning of health systems. She has also spearheaded policy directions for reducing health inequalities and advancing health for all through universal coverage, people-centered care, the integration of health into broader public policies, and inclusive and participatory health

leadership.

[Biography](#)

[Letter of Representation](#)

[Delegation of Authority](#)

- [Compact](#)
- [https://en.wikipedia.org/wiki/Carissa\\_Etienne](https://en.wikipedia.org/wiki/Carissa_Etienne)



**Dr Hans Kluge, WHO Regional Director for Europe**

- Dr Hans Kluge is the WHO Regional Director for Europe. His term began on 1 February 2020, following his nomination by the WHO Regional Committee for Europe and appointment by the WHO Executive Board.
- Throughout his career, beginning as a family doctor in Belgium, along a journey to Somalia, Liberia, the prisons in Siberia, former Soviet Union countries, Myanmar and the Democratic People's Republic of Korea, and most recently leading the Division of Health Systems and Public Health at WHO/Europe for a decade, Dr Kluge has always been committed to achieving better health for all with a focus on the vulnerable.
- As Regional Director, Dr Kluge's vision for the WHO European Region is "United action for better health", working in partnership to achieve universal health coverage, address health emergencies and promote healthier populations.
- Dr Kluge is from Belgium. He is married and has two daughters.

[Biography](#)

[Delegation of Authority](#)

[https://en.wikipedia.org/wiki/Hans\\_Kluge](https://en.wikipedia.org/wiki/Hans_Kluge)



**Dr Ahmed Al-Mandhari, WHO Regional Director for the Eastern Mediterranean**

- Dr Ahmed Al-Mandhari from Oman was appointed as WHO Regional Director for the Eastern Mediterranean by WHO's Executive Board at its 143rd session and assumed office on 1 June 2018.
- Dr Al-Mandhari has made a substantial, positive contribution to the development and modernization of Oman's health system, which has witnessed qualitative improvements in recent years, particularly in areas such as patient safety.
- A specialist in family and community medicine, Dr Al-Mandhari was Head of Quality Management and Development at Sultan Qaboos University Hospital from 2005 to 2006, followed by Deputy Director-General for Clinical Affairs until 2010. In 2013, he was appointed Director-General of Sultan Qaboos University Hospital, later becoming Director-General of the Quality Assurance Centre at the Ministry of Health. Dr Al-Mandhari has also worked as a senior consultant in family medicine and public health in Oman since 2009.
- In his acceptance speech to the Executive Board, Dr Al-Mandhari noted that the Region was facing major challenges caused by natural and manmade crises and sociopolitical and economic instability. He identified the main public health priorities as health emergencies including disease outbreaks, communicable and noncommunicable diseases, health system strengthening, and maternal and child health.

[Biography](#)

[Letter of representation](#)

[Delegation of authority](#)

- [https://en.wikipedia.org/wiki/Ahmed\\_Al-Mandhari](https://en.wikipedia.org/wiki/Ahmed_Al-Mandhari)





**Dr Matshidiso Rebecca Moeti, Regional Director for Africa**

- Dr Matshidiso Rebecca Moeti from Botswana was elected as WHO Regional Director for Africa on 1 February 2015. Dr Moeti is the first woman WHO Regional Director for Africa.

Dr Moeti aims to build a responsive, effective and result-driven regional secretariat that can advance efforts towards universal health coverage and accelerate progress toward global development goals, while tackling emerging threats. Strong partnerships will underpin every aspect of the Regional Office's work during her tenure.

Dr Moeti is a public health veteran, with more than 35 years of national and international experience. She joined WHO's Africa Regional Office in 1999 and has served as Deputy Regional Director, Assistant Regional Director, Director of Noncommunicable Diseases, WHO Representative for Malawi, and Coordinator of the Inter-Country Support Team for the South and East African countries.

[Biography](#)

[Letter of Representation](#)

[Delegation of Authority](#)

[https://en.wikipedia.org/wiki/Matshidiso\\_Moeti](https://en.wikipedia.org/wiki/Matshidiso_Moeti)



**Dr Poonam Khetrpal Singh, WHO Regional Director for South-East Asia**

- Dr Poonam Khetrpal Singh, an Indian national, became the first woman to assume the office of WHO Regional Director for South-East Asia on 1 February 2014. Dr Khetrpal Singh's priority areas of work in the Region are: addressing the persisting and emerging epidemiological and demographic challenges; promoting universal health coverage and robust health systems; strengthening emergency risk management for sustainable development; articulating a strong regional voice in the global health agenda.
- She served for over two decades as a **civil servant** in India as member of the **Indian Administrative Services**. She was the **Health Secretary** of the State of **Punjab**, with a population of 27 million and a health budget of US\$ 350 million.

In 1987 she moved to the Health, Population and Nutrition Department of The World Bank. In 1998 she joined WHO headquarters as Executive Director, Sustainable Development and Healthy Environments Cluster, and a member of the Director-General's Cabinet. Dr Khetrpal Singh served as WHO Deputy Regional Director for the South-East Asia Region from 2000 to 2013. In February 2013, she joined the Ministry of Health and Family Welfare of the Government of India as Advisor for International Health, where her principal task was to strengthen global health outcomes and provide guidance to the Ministry to take forward the international health agenda.

- Here's more bio: <https://www.who.int/southeastasia/about/governance/regional-director/biography>

•

[Biography](#)

[Letter of Representation](#)

[Delegation of Authority](#)

- [https://en.wikipedia.org/wiki/Poonam\\_Khetrapal\\_Singh](https://en.wikipedia.org/wiki/Poonam_Khetrapal_Singh)



**Dr Takeshi Kasai, WHO Regional Director for the Western Pacific**

- Dr Takeshi Kasai began his term as WHO Regional Director for the Western Pacific on 1 February 2019, following his nomination by the WHO Regional Committee for the Western Pacific and his appointment by the WHO Executive Board.
- The public health career of Dr Kasai began nearly 30 years ago when he was assigned to a remote post on the northeast coast of Japan, providing health-care services for the elderly. His early experiences there impressed upon him value of building strong health systems from the ground up. In the mid-1990s, Dr Kasai attended the London School of Hygiene & Tropical Medicine, where he studied in the Department of Global Health and Development and received a master's degree in public health.
- Dr Kasai has worked for WHO for more than 15 years, and at the time of his nomination was Director of Programme Management, the No. 2 position at the WHO Regional Office for the Western Pacific in Manila, Philippines. As a Technical Officer and later as the Director of the Division of Health Security at the Regional Office, he was instrumental in developing and implementing the *Asia Pacific Strategy for Emerging Diseases and Public Health Emergencies*, which guides Member States in preparing for and responding to public health emergencies.
- Dr Kasai also served as the WHO Representative in Viet Nam from 2012 to 2014, and in 2014 received the *For the People's Health Medal* from the Government, the top honor bestowed upon those who have made significant contributions to public health.
- Dr Kasai is from Japan. He is married and has three daughters.
- <https://www.who.int/westernpacific/about/governance/regional-director>

# WHO overview

These are my notes.

## WHO

- HQ Geneva
- There are **Regional Directors** (bios above) in these regions. Almost all are **MDs**.
  - Americas
  - Europe
  - E Mediterranean
  - Africa
  - SE Asia
  - W Pacific
- <https://www.who.int/director-general/regional-directors>
- **Cooperation problems (WHO)**
  - [\*The World Health Report 2006 – Working together for health\*](#)
    - 4.3m **doctors short** in the world. Eeek.
    - [\*Chapter 7: Working Together\*](#)
      - [5 problems in having countries cooperate for global health care](#)
        1. **lack of info and metrics, lack of shared standards.**
          - Whole bunch of **Venn diagrams** conveying confusion.
        2. **lack of technical expertise to make better metrics**
        3. **conflict / outbreak / catastrophe** can undermine best laid plans
        4. **global labour markets**
          - I'm not sure what this means. It might refer to the brain drain.
        5. **workforce crisis**
          - It is a crisis, lots of financing requirements.
      - **Healthcare Policy organization**
        1. **Policy and planning** - medical demographics, scenario dev
        2. **Institutional and mgmt dev** - sociology of professions
        3. **Legal frameworks and policies** - laws, constraints, self reg, govt regulation of bodies
        4. **healthcare workforce economics** - labour economics, labour market analysis
        5. **workforce mgmt systems** - data collection and analysis, IT, technology dev
        6. **education** - public health, HCP education (e.g. Pakistan's lady health workers)
        7. **professionally focussed workforce dev** - doc, nurse, dentist, MW, pharmacy
- **Challenges in cooperation a.k.a. barriers to Global Health Governance (source: [2016 National Academy of Sciences](#))**
  - **Summary**
    - Biggest barrier of all
      - **Conflict** (does not necessarily mean war) between **sovereign state right** vs **global solidarity**.
      - If a **[poor] country** has "**limited**" ability (I think this means \$ and **infrastructure**), then how to implement **WHO recommendations?**
      - **WHO** should coordinate but not replicate other institutions. Vague what that means. I guess you had to attend the talk.
    - Ebola challenges
      - **Absence of national detection and response capacities.**
      - **Limited surge capacity** from **int. community**. Hmmm.
      - **Conflict between sovereign action / collective action** against a **shared threat**.
      - **WHO 3-tiered decentralized structure (what are the 3 tiers?)** and **autonomous regional offices**.
    - Animal health
      - **World Organization for Animal Health (OIE)** has **member countries**.
      - Something about detecting **emerging diseases**.

- Workforce development
  - Study *real world cases*.
  - Get input from:
    - *Traditional leaders*
      - *What's that mean?*
    - *Cultural leaders*
    - *Political leaders*
  - Source
    - *Challenges in Design of Governance for Global Health. 2016*
    - <https://nap.nationalacademies.org/read/21854/chapter/6>
  - Here's the cumbersome credit
    - *National Academies of Sciences, Engineering, and Medicine. 2016. Global Health Risk Framework: Governance for Global Health: Workshop Summary.*
    - *Washington, DC: The National Academies Press.*
    - <https://doi.org/10.17226/21854>.
- Verbatim
  - Speakers and Participants
  - Top challenges for the World Health Organization (WHO) during the Ebola crisis included the absence of national detection and response capacities, limited surge capacity from the international community, and the conflict between sovereignty and collective action against a shared threat. (Chan)
  - The highest barrier to global health governance is the conflict between the rights of sovereign states and the need for global solidarity. If their ability to intervene is limited, this can add difficulty to the recommendation that WHO should promote and maintain global health security as a core function, but would also address their potential role in an outbreak. (Chan, Clift)
  - WHO's three-tiered, decentralized structure and autonomous regional offices obscure command and control and were an impediment to the organization's coordinated response to Ebola, but questions remain on whether a command-and-control organization is feasible and the best solution. (Clift, Fineberg, Gostin, McIff)
  - All of the World Organisation for Animal Health's (OIE's) member countries were involved in the Performance of Veterinary Services (PVS) Pathway development, the evaluation is voluntary, and the goal of the mission is to address the country's disease burden and not to detect emerging diseases—altogether resulting in successful benefit to both the prevention and detection of infectious disease. (Thiermann)
  - To ensure global public health security, WHO should not try to replicate other institutions with a greater capacity to respond, but should continue to be a coordinator and work to collaborate with the United Nations (UN) humanitarian system. (López-Acuña, McIff, Stocking, Takemi)
  - The theoretical discussion of the global health emergency workforce development should be balanced with examination and learning from real-world cases, input from traditional and cultural leaders, and political leadership. (Elias)

**Aspergillus infection of Penguins**

### *Mycotic Diseases of Pet Birds*

- Summary
  - Remember, *Aspergillus* is a fungus.
  - **Mycotic** (“my cot ick”) is a fancy synonym for **fungal infections**.
  - Potentially **GROSS** photo – depending on your sensitivities – of **penguin lungs** infected by the *Aspergillus* fungus.
- Source
  - **Merck Vet Manual**
    - Reviewed/Revised Sep 2021 | Modified Oct 2022
    - <https://www.merckvetmanual.com/exotic-and-laboratory-animals/pet-birds/mycotic-diseases-of-pet-birds>
- Author
  - **Sharman M. Hoppes, DVM**, DABVP (Avian), Texas Avian & Exotic Hospital
    - **DVM** = Doctor of **Veterinary Medicine**
  - Penguin lung photos courtesy of **Dr. Gerry Dorrestein**.

### *Aspergillosis in Animals*

- Summary
  - This is fairly dense vet language.
  - A number of different animals get *Aspergillus* infections in a variety of anatomic locations:
    - **Birds** and chickens – lungs.
    - **Penguins** are “overrepresented”, meaning more infections with *Aspergillus* than you’d expect.
    - **Cattle** have abortions, technically called a **mycotic abortion**. Mycotic just means fungal.
    - **Horses** get infection of the **guttural pouch** which is kinda sorta an expanded hearing tube that connects throat to ear (officially, the **eustachian tube**) (“you station”). And horses also get an *Aspergillus* infection of their **cornea** of the eye, officially **mycotic keratitis** (“my kot ick” “care ah tie tiss”).
    - **Dogs** get infections of the nasal cavities, the spine, and kidneys. There is a photo of a dog with **nasal aspergillosis** but it is not gross.
    - **Cats** get **sinus infections**.
  - So overall, *Aspergillus* is a nasty fungus.
  - I have to admit, *Aspergillus* is my favorite fungus.
- Verbatim
  - Aspergillosis is found worldwide and in almost all domestic animals and birds as well as in many wildlife species. It is primarily a **respiratory infection** that may become generalized; however, tissue predilection varies among species.
  - The most common forms of aspergillosis are pulmonary infections in poultry and other birds; mycotic abortion in cattle; guttural pouch mycosis and mycotic keratitis in horses; infections of the nasal and paranasal tissues, intervertebral sites, and kidneys of dogs; and sinonasal, sino-orbital, and pulmonary infection in domestic cats.
  - Among nonpoultry avian species, **penguins** appear to be overrepresented.
- Source
  - **Merck Vet Manual**
    - Reviewed/Revised Apr 2023 | Modified Jun 2023
    - <https://www.merckvetmanual.com/generalized-conditions/fungal-infections/aspergillosis-in-animals>
- Author
  - **Tamara Gull DVM, PhD**, DACVM, DACVIM (LA), DACVPM, University of Missouri, Veterinary Medical Diagnostic Laboratory

### Common Disorders and Procedures of Zoo Animals

- Summary
  - This article offers caution to vets when treating **penguins** with *Aspergillus* because the anti-fungal drug can be toxic. Specifically, the more drug is given, the greater the toxicity. This is called a **dose-dependent effect**.
  - There is also advice for treating **elephants** and other animals.
- Source
  - **Merck Vet Manual**
    - Reviewed/Revised Oct 2021 | Modified Oct 2022
    - <https://www.merckvetmanual.com/exotic-and-laboratory-animals/zoo-animals/common-disorders-and-procedures-of-zoo-animals?query=penguin%20species%20aspergillosis>
- Author
  - **Meredith Martin Clancy, DVM, MPH, DACZM, San Diego Zoo Safari Park**

## Page 185 – Continuum of Badness

Rought a.k.a. R<sub>0</sub> – see page 37.

## Page 186 – Geographic Information System

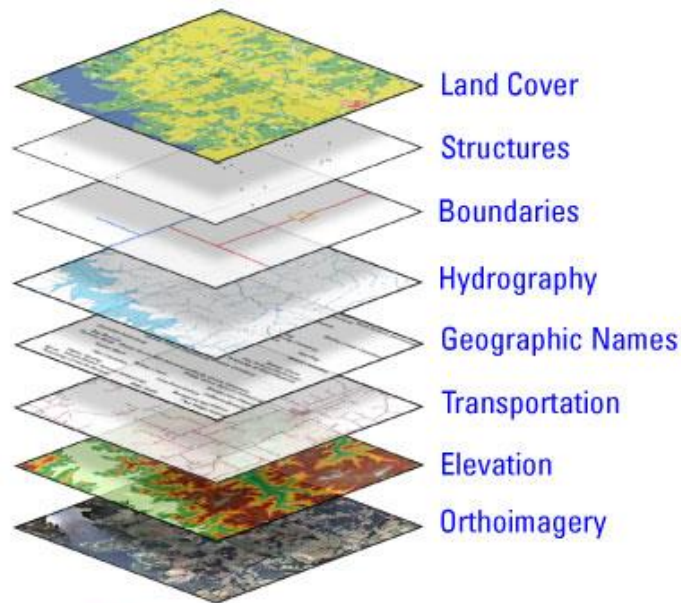
### Information System

#### Information System

- Summary
  - **An information system is a way to organize information.** A recipe book is an information system. A packing checklist before a vacation is an information system. It gets more technical as soon as we move beyond pen and paper so that a computer gets involved.
- The Information system for computers has 6 components:
  1. Hardware
  2. Software
  3. Data
    - **Data turns into information when people use it.** That seems like a bit of jargon to me.
  4. Procedures
    - These are the procedures that govern the computer system.
    - The employed analogy is: *'Procedures are to people what software is to hardware.'*
  5. People

- Users
- IT staff
- 6. Feedback
  - This is useful but not necessary for the system to run.
- Source
  - [https://en.wikipedia.org/wiki/Information\\_system](https://en.wikipedia.org/wiki/Information_system)

## Geographic Information System



### *The National Map*

- Summary
  - A **Geographic Information System (GIS)** is the marriage of maps, geography, geology, and a whole lot more, all coordinated by a computer. One such example is the **The National Map**, a multi-layered map of the USA made by the **US Geological Survey (USGS)**. Details in the next article.
- Source
  - [https://en.wikipedia.org/wiki/The\\_National\\_Map](https://en.wikipedia.org/wiki/The_National_Map)

### *What is a geographic information system (GIS)?*

- Verbatim
  - A Geographic Information System (GIS) is a computer system that analyzes and displays geographically referenced information. It uses data that is attached to a unique location.  
Most of the information we have about our world contains a location reference: Where are USGS streamgages located? Where was a rock sample collected? Exactly where are all of a city's fire hydrants?  
If, for example, a rare plant is observed in three different places, GIS analysis might show that the plants are all on north-facing slopes that are above an elevation of 1,000 feet and that get more than ten inches of rain per year. GIS maps can then display all locations in the area that have




similar conditions, so researchers know where to look for more of the rare plants.

By knowing the geographic location of farms using a specific fertilizer, GIS analysis of farm locations, stream locations, elevations, and rainfall will show which streams are likely to carry that fertilizer downstream.

These are just a few examples of the many uses of GIS in earth sciences, biology, resource management, and many other fields.

- Source
  - **US Geological Survey (USGS)**
    - <https://www.usgs.gov/faqs/what-geographic-information-system-gis>

### National Map viewer

- Summary
  - Try this to see how a Geographic Information System works.
  -  Click on the link below → You will see a map of the USA → In the search box at the top right enter 'Grand Canyon' → Chose the suggested option Grand Canyon National Park, AZ, USA → the map will zoom in → Go to the horizontal green menu and choose the icon 3<sup>rd</sup> from the left, which looks like four layers → now a 'Layer List' comes up at the right → Explore by clicking boxes, for example: 3DEP Elevation – Hillshade.
- Source
  - **US Geological Survey (USGS)**
    - <https://apps.nationalmap.gov/viewer/>

### How is this relevant to doctors and patients?

- In the grand scheme of things, the way doctors learn medicine is the same as The National Map – it is multi-layered. Instead of geologists looking at the body of the planet, it is doctors looking at the body of a human. How does the doctor view you? Through multiple layers.
- When you say you have pain in your chest, here's how you are analysed:
  - **Gross Anatomy** = The heart is a fist-sized organ in the chest cavity. With some forceps (tweezers) to tease the tissues apart, we can see some arteries on top of the surface of the heart – this is still 'gross' anatomy because these can be seen with the naked eye.
  - **Histology (microscopic anatomy)** = The heart is made of billions of individual cardiac muscle cells. They are different from skeletal muscle cells (like in your biceps muscle or leg muscles). And the electrical (conducting) system in the heart is made of modified muscle cells. The arteries on top of the heart are tubes also made of muscle but it's called smooth muscle and looks different.
  - **Physiology** = The heart has 4 chambers that contract and pump blood throughout the body.
  - **Pathology** = The arteries are narrowed. The blood supply to the heart (muscle) is compromised. This causes chest pain. If it is severe and heart muscle dies, that's a **Heart Attack**.
  - **Epidemiology:** The major Risk Factors (RF) for a Heart Attack are diabetes, high blood pressure, high cholesterol (the bad cholesterol), and smoking. Being sedentary is a minor risk factor.
  - **Cardiology:** A cardiologist will put a 'stent' into the narrowed/blocked arteries. Perhaps clot-busting drugs are employed.
  - **Cardiac Surgery:** There was so much narrowing that stents won't do. You need a coronary bypass operation by a cardiac (heart) surgeon.
  - **Bedside manner** = This is optional, haha.
- Rest assured, a patient with **viral pneumonia** due to **coronavirus** gets dumped into this same multi-layered approach, except the layers are shifted to focus on lungs and virus. And if it's a pandemic, then the layer of epidemiology is much more involved and subject to change as fresh knowledge is added.

# Page 187 – The European Journal of Incomprehensible Medicine

## *The European Journal of Incomprehensible Medicine*

- Okay, that's not a real journal. I made that up.
- Nevertheless those are real terms to describe what goes happens to the lungs in **Acute Respiratory Distress Syndrome (ARDS)**. See page 147 – ARDS.

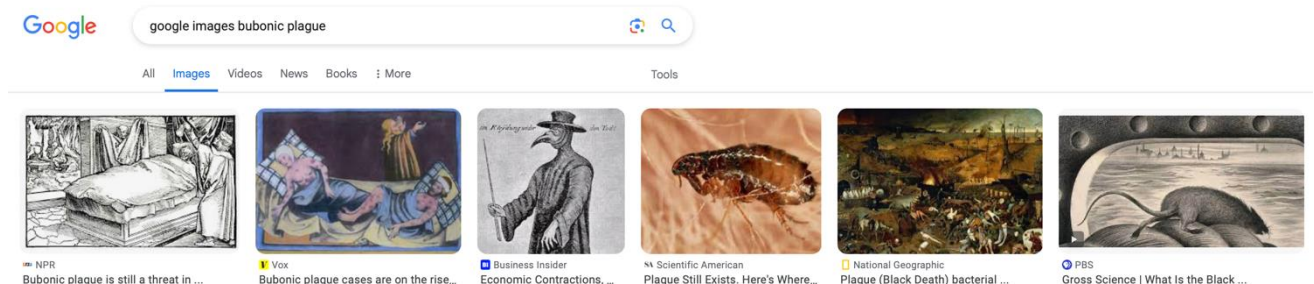
# Page 188 – Where to Find It

## Example search – Bubonic Plague

### Bubonic Plague

- The power of multiple *reliable* sources is that you recognize what is common to each. Your brain will automatically recognize patterns. Take a few minutes to read all the *verbatim* comments below, to get the gist of Bubonic Plague.

#### 1. 'Google Images bubonic plague'



[https://www.google.com/search?sca\\_esv=919db838b2730857&q=google+images+bubonic+plague&tbm=isch&source=lnms&prmd=ivsnmbtz&sa=X&ved=2ahUKEwjP49ys8p6FAxWmOTQIHQ4XDNsQ0pQJegQICxAB&biw=2170&bih=1385&dpr=2](https://www.google.com/search?sca_esv=919db838b2730857&q=google+images+bubonic+plague&tbm=isch&source=lnms&prmd=ivsnmbtz&sa=X&ved=2ahUKEwjP49ys8p6FAxWmOTQIHQ4XDNsQ0pQJegQICxAB&biw=2170&bih=1385&dpr=2)

#### 2. 'Wikipedia bubonic plague'

**Bubonic plague** is one of three types of plague caused by the bacterium *Yersinia pestis*.<sup>[1]</sup> One to seven days after exposure to the

bacteria, [flu-like symptoms](#) develop.<sup>[1]</sup> These symptoms include [fever](#), [headaches](#), and [vomiting](#),<sup>[1]</sup> as well as [swollen and painful lymph nodes](#) occurring in the area closest to where the bacteria entered the skin.<sup>[2]</sup> [Acral necrosis](#), the dark discoloration of skin, is another symptom. Occasionally, swollen lymph nodes, known as "[buboes](#)", may break open.<sup>[1]</sup>  
[https://en.wikipedia.org/wiki/Bubonic\\_plague](https://en.wikipedia.org/wiki/Bubonic_plague)

### 3. 'Mayo Clinic bubonic plague'

Plague is a serious illness caused by a germ called *Yersinia pestis*. The germs mostly live in small rodents and their fleas. The most common way for humans to get plague is a flea bite.

<https://www.mayoclinic.org/diseases-conditions/plague/symptoms-causes/syc-20351291>

### 4. 'CDC bubonic plague'

Plague is a disease that affects humans and other mammals. It is caused by the bacterium, *Yersinia pestis*. Humans usually get plague after being bitten by a rodent flea that is carrying the plague bacterium or by handling an animal infected with plague. Plague is infamous for killing millions of people in Europe during the Middle Ages. Today, modern antibiotics are effective in treating plague. Without prompt treatment, the disease can cause serious illness or death. Presently, human plague infections continue to occur in rural areas in the western United States, but significantly more cases occur in parts of Africa and Asia.

<https://www.cdc.gov/plague/index.html>

### 5. 'Medscape bubonic plague'

Plague is an acute, contagious, febrile illness usually transmitted to humans by the bite of an infected flea. Plague occurs as 3 major clinical events: bubonic plague, septicemic plague, and pneumonic plague. Human-to-human transmission is uncommon except during epidemics of pneumonic plague.

<https://emedicine.medscape.com/article/235627-overview>

### 6. 'UpToDate bubonic plague'

In the genus *Yersinia*, three species are important human pathogens: *Yersinia pestis*, *Yersinia enterocolitica*, and *Yersinia pseudotuberculosis*. The yersinioses are zoonotic infections of domestic and wild animals; humans are considered incidental hosts that do not contribute to the natural disease cycle.

<https://www.uptodate.com/contents/clinical-manifestations-diagnosis-and-treatment-of-plague-yersinia-pestis-infection>

UpToDate is published by **Wolters Kluwer** – I like their logo.



7. 'WHO [World Health Organization] bubonic plague'

Plague is caused by the bacteria *Yersinia pestis*, a zoonotic bacteria usually found in small mammals and their fleas. People infected with *Y. pestis* often develop symptoms after an incubation period of one to seven days.

<https://www.who.int/news-room/fact-sheets/detail/plague#:~:text=Bubonic%20plague%20is%20the%20most%20common%20form%20of%20plague%20and,node%20where%20it%20replicates%20itself.>

8. 'Medline bubonic plague'

Plague is an infection caused by the bacterium *Yersinia pestis*. The bacteria are found mainly in rats and in the fleas that feed on them. People and other animals can get plague from rat or flea bites. In the past, plague destroyed entire civilizations. Today plague is uncommon, due to better living conditions and antibiotics.

<https://medlineplus.gov/plague.html>

Also good are:

9. 'Britannica bubonic plague'

**Black Death**, [pandemic](#) that ravaged [Europe](#) between 1347 and 1351, taking a proportionately greater toll of life than any other known [epidemic](#) or war up to that time.

<https://www.britannica.com/event/Black-Death>

10. 'Cleveland Clinic bubonic plague'

Bubonic plague is an infection spread mostly to humans by infected fleas that travel on rodents. Called the Black Death, it killed millions of Europeans during the Middle Ages. Prevention doesn't include a vaccine, but does involve reducing your exposure to mice, rats, squirrels and other animals that may be infected.

<https://my.clevelandclinic.org/health/diseases/21590-bubonic-plague>

11. 'Review article bubonic plague'

This is not a website, rather a search term that will find a review article. These tend to be nice summaries that read more like a book.

For example: *History of the Plague: An Ancient Pandemic for the Age of COVID-19*

During the fourteenth century, the bubonic plague or Black Death killed more than one third of Europe or 25 million people. Those afflicted died quickly and horribly from an unseen menace, spiking high fevers with suppurative buboes (swellings).

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7513766/>

Do you see repeating terms? More nuance? Hopefully that is the result.

## What about information sources that do not agree with the 'mainstream'?

### Contrary information

When I do find a source that contains contrary information, I ask myself, *Was this written by a lone genius?*

This is when I dig deeper to find the academic qualifications of this lone genius. I do recognize that there are lone geniuses in science. For example, Alfred Wegener who proposed **continental drift** when he noticed that the west coast of Africa fits snugly into the east coast of South America. But the year was 1915 and he could not come up with a mechanism; gravity from the Moon is not strong enough to drag continents on Earth. The answer had to wait until nearly half a century later when two scientists towed a magnet behind their ship over the Mid-Atlantic Ridge (where fresh molten rock pours out). They discovered alternating magnetic fields encoded in older, solid rock due to the Earth's magnetic poles switching every 750,000 years (due to Earth's molten iron core that is rotating). This was the tip-off to the mechanism of continental drift, which is **plate tectonics**. The Earth remains hot inside because the crust acts as a giant insulating blanket; plus radioactive elements produce heat. This heat is what moves the plates. I think we can forgive Alfred Wegener for not knowing all this. Read the Wikipedia article on **paleomagnetism** to learn all about it.

Point being, academia can sometimes ridicule the lone genius. *But ...* and it's an important *but ...* such ridicule is kind of rare. Most scientists are extremely open-minded about new ideas which is precisely why they do experiments. They know that scientific knowledge grows in tiny, inexorable increments. I know this from having worked in hardcore neuroscience labs.

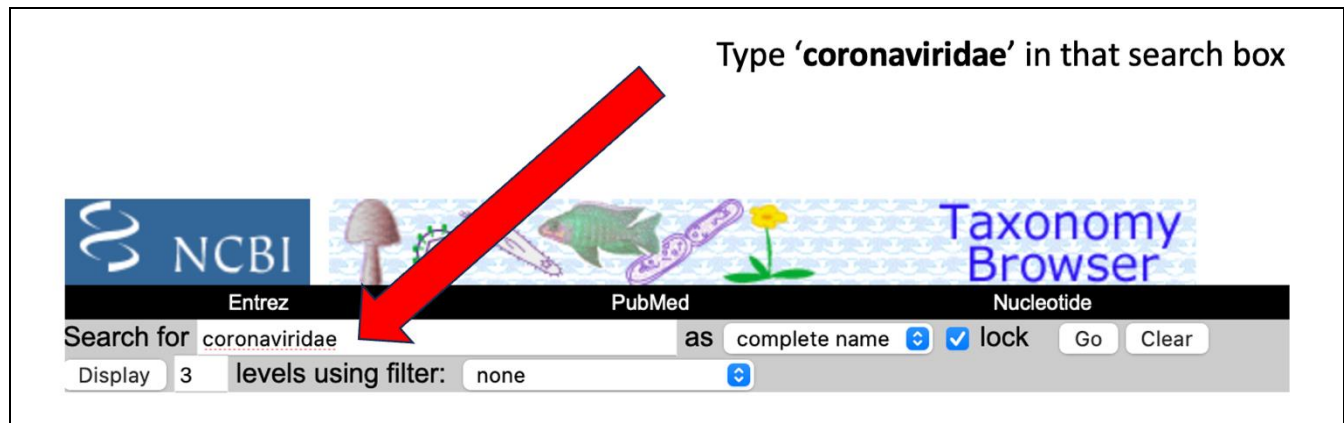
And let's be frank ... sometimes there is a fringe scientist who is rejected by the scientific community. Not because they dislike him. Not because he has bad breath. But because he is not a lone genius. He is simply wrong.

Obviously, the question being asked can dictate how broad (or even navigable) the answers are. *What is beauty?* is something practically every human has an opinion on. Whereas understanding plate tectonics requires knowledge of a decent amount of geology. Likewise particle physics where the vast majority of it is massively dumbed down for those of who don't even remotely understand the thousands of hours of math required. If you don't know anything about math then there will be plenty of 'lone geniuses' who can tell you whatever they want; except they are not geniuses. You know 1 hour of math. They know 10 hours ... so appear 10 x smarter to you. But the expert on particle physics has 10,000 hours. Your math knowledge is so paltry you cannot tell the difference between someone with 10 hours or 10,000 hours ... and that is precisely why you can be led astray.

Likewise a pandemic. If someone said, "The Bubonic Plague was created by the CDC," I'd reply, "The CDC did not exist in 1348 A.D., nor did Atlanta." You need to understand the basics of infectious disease in order to understand how viruses and bacteria spread. You need to recognize patterns. Hence this book. Now at least you're the one with 10 hours of knowledge. That's a good start.

Okay, my little soapbox is over.

**NCBI taxonomy browser**



If you click the link below you'll end up at this search box. However it is way easier if you go to page 112 of the bibliography where I've divided the coronavirus into its 4 groups – alpha, beta, gamma, delta – so now you can dive into all the animals easily.

- <https://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi>
- NCBI is the National Center for Biotechnology Information. It is also described on page 112.

# Page 189 – Mucociliary Escalator

## Muco-ciliary escalator

### The Mucociliary Escalator

- Summary
  - The **muco-ciliary escalator** moves upwards at 2 cm ( $\frac{3}{4}$ " ) per minute. That's quite a lot slower than a **mechanical escalator** (that we stand on) which moves at 36 meters (120 feet) per minute.
  - See page 146.

## Memorizing stuff

### SQ3R

- Summary
  - **SQ3R** is a way to way to memorize a textbook. It was created in 1946 by Francis Robinson.
  - **S = Survey** the book. When you first get the book you flip through it, see what it's all about, check out the drawings.
  - **Q = Question** = You create questions. They don't have to be that good. Maybe it's a physics textbook and in the chapter on Optics your question is, *omg what is optics?*
  - **R = Read**. Now you read it and answer your questions. You can refine your questions now. *How do lenses bend light if I am nearsighted or farsighted?*

- **R = Recite.** You basically explain your questions and answers to your clueless friend so he or she can understand it, too. This is key. It means you get it.
- **R = Review.** Yeah, you review the notes you took.
- Does it work?
  - An article by **The Learning Scientists** says SQ3R is not actually tested. It's just a method. But if it works for you, fine. And maybe drop the SQ and only use the 3R. Whatever you like.
- Source
  - *SQ3R or Read, Recite, Review*
    - **The Learning Scientists**
    - <https://www.learningscientists.org/blog/2021/3/4-1>
- Author
  - **Cindy Nebel**

### My advice on memorizing stuff

There is tons of advice on memorizing and exam preparation on the internet. In medicine we have to mass memorize which is quite different from someone in math who needs to understand formulas.

In my very first year of university I visited the '**Learning Specialist**' who told me, with a sad face, that no one ever came to visit him. I went to see him 3 times and what a difference it made. The first thing he said is most people can remember 7 things. That's why phone numbers are 7 numbers like 555-1212. We tend to just 'know' the area code. The next thing he said is that the key to long-term memory is *semantics*, which means you understand. For example, a bird and a plane both have wings but the one that flaps is a bird. You understand *wing*.

That being said, if you're a zoology student you need to memorize the names of body parts, and only then can you understand their relationships. So I have huge faith in mnemonics ("nee mon icks") a.k.a. memory devices a.k.a. **memory anchors**. I especially like taking the first letter of each word in a list and turning that letter into a sentence or new word. This is called **chunking** – you reduce a long list into one image. The quirkier the better as you are more likely to remember it. Rhymes help, too. And so do colors, for example, **people**, **places**, **numbers**, **nouns**, **quotes** ... now when I scan my Microsoft Word notes I can find a specific item by its color.

How to remember the correct order of the planets?

**Mercury Venus Earth Mars Jupiter Saturn Uranus Neptune Pluto**

**My Very Educated Mother Just Served Us Nine Pizzas**

I have used this for 20 years. It is a rock-solid memory anchor. You can add smell to the memory ... imagine the smell of the pizza. And colors .... imagine your mother wearing an apron. And her framed university degrees are hanging on the wall in the kitchen.

Pluto, you will always be a planet to me. Ignore those evil planetary scientists at NASA.

**ABC** means **A**irway, **B**reathing, **C**irculation ... and when I was doing my trauma rotation in Baltimore I would silently say it in my head. It would keep me calm and focused because A, B, C is literally the order in which things are addressed.

**Twelve Zulus Bit My Cucumber**

**Temporal Zygomatic Buccal Mandibular C**-something ... I am forgetting the C. I will maybe remember later today. I'm okay with 4 out of 5, for the moment. Anyways, those are the 5 branches of the facial nerve. And if you plaster your palm against your cheek, that helps to remember the 5 branches fanning out to their destinations.

If you *really* have a hard time remembering something – and it does happen – you may have to take five minutes to create a mnemonic. Make it good because it's gotta last for 20 years. Maybe you're a total loser at understanding wings so you come up with **p.s. BF** – plane still, **Bird Flap**. What you imagine is writing a letter to your boyfriend. At the end of the letter, after your signature, you write, *p.s. BF* (for boyfriend). Most people would

you look at you funny if you had to resort to that to remember that birds flap their wings whereas the wings of a plane don't move. Whatever, it works for you.

The good news is that when you get really familiar with a topic, the memory trick will just 'drop out' and you'll know the terms without thinking. The second good news is that if you leave that topic and lose the familiarity, the mnemonic is always there and even 5 years later it seems to magically 'drop in.' *Oh yeah, the TORCH infections of pregnancy are Toxoplasma, Other, Rubella, Cytomegalovirus, Herpes simplex virus / HIV virus / Hepatitis C virus.*

So ... if you have created a bunch of mnemonic words and sentences ... ABC, TORCH, Twelve Zulus Bit My Cucumber, and SLUDGE BAM (page 152 of bibliography) ... and you write these down on a single sheet of paper (repeatedly, if necessary) ... you are memorizing your memory anchors! ... and you review that stuff 5 minutes before your final exam ... and then the very second the final exam begins you write them down on the scrap paper provided ... you have massively increased your chances of remembering during the exam ... you are going to score higher on the exam. Is that cheating? No. Is it a little bit like using water wings? Probably. But so what! Five years from now you are gonna go back to those exact same words in a pinch. They are gold. They are the Long-Term Memory.

The irony of the word *mnemonic* is that it's hard to spell, pronounce or even know what it means. Let that kick-in-the-balls be a lesson to you that academia will always throw a curveball at you, so expect the unexpected.

Oh, the learning specialist also taught me that stuff about summarizing a lecture in 1 or 2 sentences as soon as the class ends. Then reviewing it 24 hours later. Then 7 days later. If you later on add your mnemonics to that stuff, now you're really set. You can look at these notes 5 years from now and get rapidly up to speed.

Not once did the learning specialist mention the word hippocampus. It was not necessary.

# Page 207 – About the Author

## Heart sounds

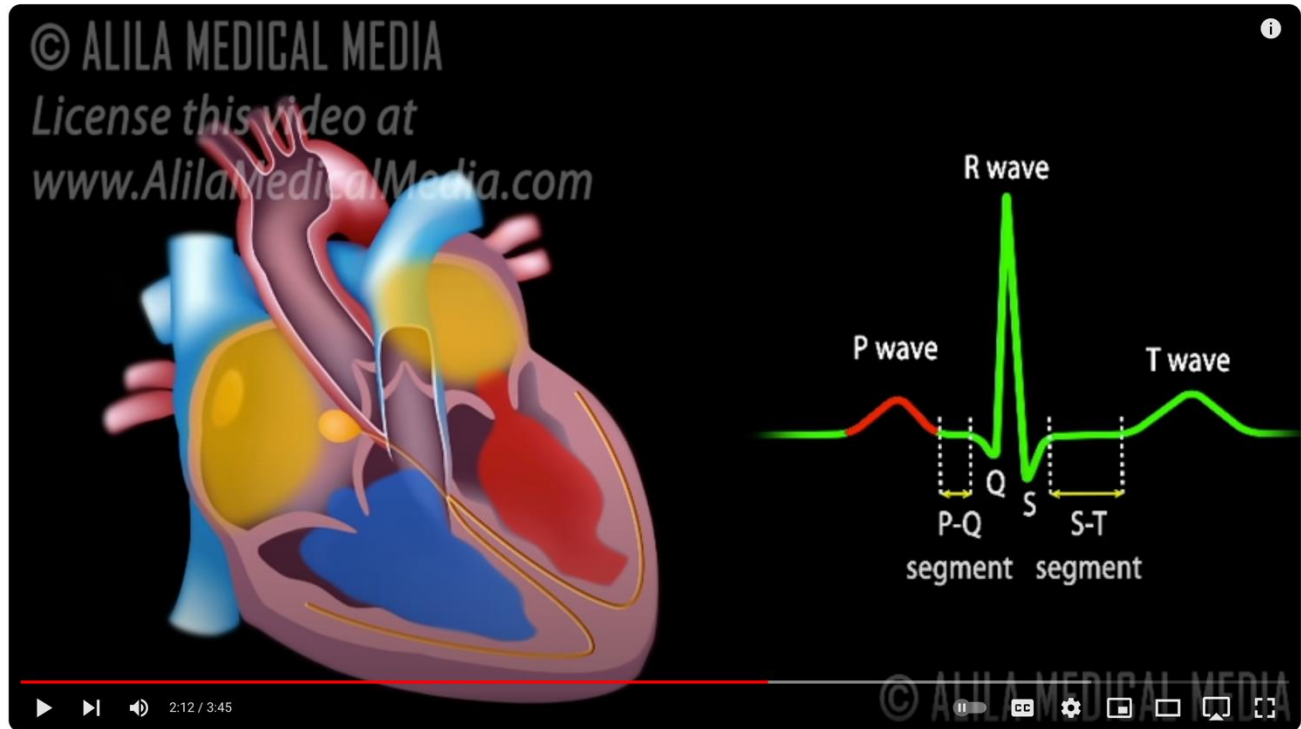
### These are synonyms

Electro-Cardio-Gram    ECG  
 Electro-Kardio-Gram    EKG    *Kardia* is the German word for heart. I think it's a cooler spelling.

### These are also synonyms

- Electro-Cardio-Gram
- Electro-Cardio-Graph
- Does anyone care which you say? No.





#### Cardiac Conduction System and Understanding ECG, Animation.



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Thanks

Clip

Save



6.5M views 9 years ago Cardiovascular Physiology  
The cardiac conduction system explained clearly and simply.

#### Cardiac Conduction System and Understanding ECG, Animation.

- Summary
  - This is a fairly technical but nevertheless well-explained 4-minute video on electrical events in the heart. If you skip to the 2:12 mark you can see the ECG tracing as is relates to events in the heart.
- Source
  - **Allia Medical Media**
    - YouTube April 2014
    - <https://www.youtube.com/watch?v=RYZ4daFwMa8>



This image should be beating! If not,  click this: <https://en.wikipedia.org/wiki/Heart>

### How do electrical events (the **ECG**) relate to things that can be heard (the **stethoscope**)?

- If you watched the video above, this will make more sense.
- Okay, the key to all this is that the heart has 2 floors – an upstairs and a downstairs. That image is almost entirely dominated by the downstairs (which has been cut open).
- The upstairs has 2 rooms a.k.a. 2 atria (Right Atrium, Left Atrium). The downstairs has 2 rooms a.k.a. 2 ventricles (Right Ventricle, Left Ventricle). Each room is filled with blood; the wall is made of muscle. When the muscle contracts the room shrinks. Their job in life is to **contract** then **relax**. Forever. That's it. Simple job description.
- This is the flow of blood through your heart: **RA** → **RV** → lungs → **LA** → **LV** → aorta (to the body).
- The upstairs contracts first, then the downstairs a split-second later. Look at that flowchart ... the **RA** and **LA** contract at the same time ... then the **RV** and **LV** at the same time. You can clearly see in the beating image that the downstairs (RV and LV) are contracting at the same time.
- When muscle contracts that is called **de-polarization**. When it relaxes, **re-polarization**. These are electrical events.
- What is heard in a stethoscope is “Lub-Dub, Lub-Dub, Lub-Dub” – that would be 3 heartbeats. The Lub is the **S1** sound. The Dub is the **S2** sound.
- The **S1** sound heard with a stethoscope is the valves closing between upstairs and downstairs. The valves are those weird things in the image that look like little parachutes. They are one-way valves. The blood is only allowed to go from upstairs to downstairs. It's not allowed to go backwards. The long slips of tissue are called **chorda tendinae** (“cord ah” “tend in a”) – they ensure the valves stay in place.
- The **S2** sound heard with a stethoscope is the valves closing downstairs. Specifically, the valve permitting blood flow from **RV** to the lungs, and the valve permitting blood flow from **LV** to the aorta (the big artery carrying blood out of the heart). They are also one-way valves.
- The **pulse** in your wrist can only be felt as a single pulse. It is a ‘pressure wave’ due to the contraction of the heart. From down in the wrist, you absolutely cannot feel the valves opening and closing way up in the chest. But ... if the doctor (me) feels your pulse while listening with the stethoscope, I can get a sense of when S1 will occur, which is when I feel the pulse. This is particularly helpful in a loud room or with ‘faint’ heart sounds.
- I'm skipping lots. It takes months to understand this, much of it at the bedside.

<u>ECG</u>	<u>Heart muscle event</u>	<u>Sound name</u>
P wave	upstairs atria ( <b>RA</b> , <b>LA</b> ) contract = atrial systole = atrial depolarization	S1
QRS complex	downstairs ventricles ( <b>RV</b> , <b>LV</b> ) contract = ventricular systole = ventricular depolarization*	S2
T wave	downstairs ventricles relax = ventricular diastole = ventricular repolarization	No sound

\* This is such a strong electrical event that it 'buries' (overshadows) atrial repolarization that is also occurring during the QRS.

# All Things Blood

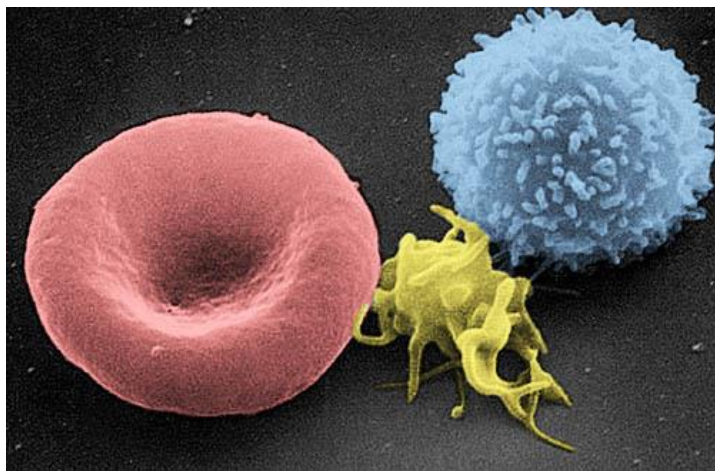
I thought it would be easier if all the blood stuff was in one place. Most of it is focused on red blood cells. It will probably make more sense if you read everything in the order you see here but feel free to jump around.

## Mini-Index

1. Blood basics
2. Jaundice (page 15)
3. Carbon monoxide poisoning (page 44)
4. Anemia (page 80)
5. Sickle Cell Anemia (page 70)
6. Fetal hemoglobin (page 84)

## 1. Blood basics

### Recipe



### Blood

- Summary
  - What is your blood made of? 50% of it is water. And carried along in this moving stream of water are cells. From left to right in this photograph from an electron microscope are:
    - **red blood cell (rbc)**
      - It carries oxygen. Our blood is red because of this cell.
      - The technical term for a red blood cell is **erythro-cyte** which literally means *red cell*. That's pronounced "air ith row sight."
    - **platelet**
      - "Plate let"
      - Its job is to clot the blood. Specifically, it plugs the hole in a torn blood vessel.
      - That's a color-enhance imaged. It's not actually yellow.
    - **white blood cell (wbc)**
      - There are 5 types of wbc and they fight infections. And not just infections in your blood, but infections anywhere because they are able to exit the blood vessels.

- They squeeze their way through the blood vessel wall in a rather complex fashion. Their ability to move is rather similar to amoebas.
- Most of them are twice as large as the red blood cells.
  - That's a color-enhance imaged. It's not actually blue.
- Those 3 cells are called '**formed elements**' but it's not a term used that often.
  - What else is in the blood?
    - **Hormones**, for example insulin, thyroid hormone, testosterone and estrogen that are being transported in the blood to distant targets.
    - **Clotting proteins** that work alongside the platelets.
    - **Transport proteins** like albumin that carry things that cannot dissolve in the blood.
    - And lots of other stuff.
  - Source
    - <https://en.wikipedia.org/wiki/Blood>

### White blood cells (wbc)

#### White blood cells (wbc)

- There are 5 types of white blood cell and they can be remembered by the sentence, *Never Let Monkeys Eat Bananas*. Do not feel obligated to memorize this ... but in the following photos you're gonna learn all about how they look and be able to identify them on a slide. It's not quite as daunting as you'd think.

#### Memory trick Type

Never

Let

Monkeys

Eat

Bananas

Neutrophil

Lymphocyte

Monocyte

Eosinophil

Basophil

#### Job

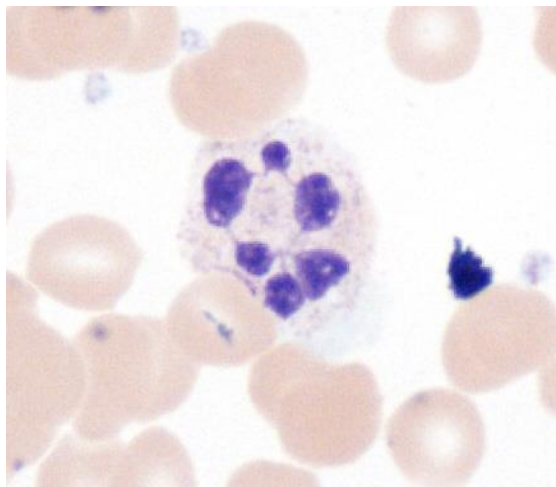
Kill bacteria

Make antibodies. Kill viruses. Kill tumors. Remember enemies.

Exit the blood stream and kill bacteria and viruses.

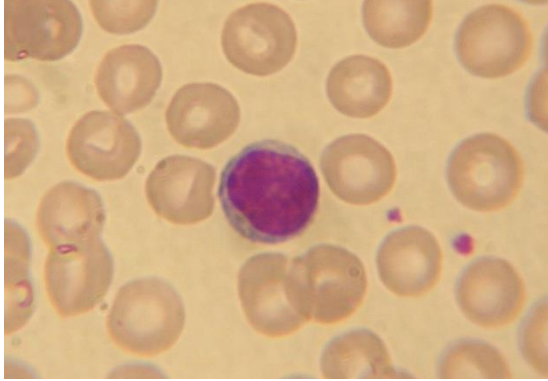
Kill parasitic worms.

Releases histamine. Associated with allergies.



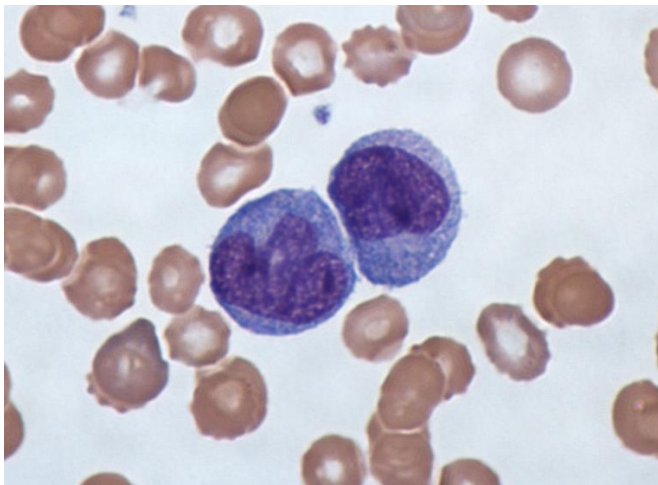
#### Neutrophil

- "New trow" – trow rhymes with row – "fill"
- It's surrounded by red blood cells in this photo.
- It has **multiple lobes** (of the nucleus) – they are the purple blobs you see, connected by a fine tendril – that's the tip-off under a microscope.
- Its job in life is to kill **bacteria**.
- <https://en.wikipedia.org/wiki/Neutrophil>



### Lymphocyte

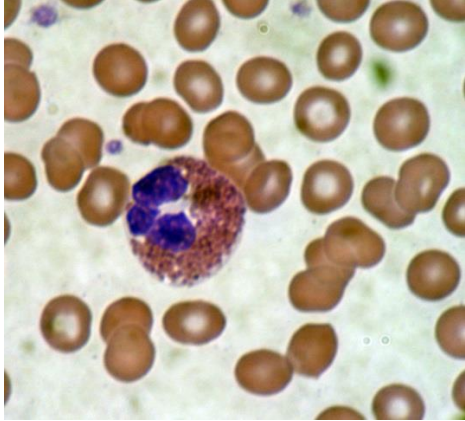
- “Limf oh sight”
- The nucleus practically fills the whole cell – that’s the tip-off under a microscope. There is one lymphocyte in this photograph. It is surrounded by red blood cells.
- There are 2 kinds – B and T – and they look the same under a standard microscope.
- **B-lymphocyte**
  - Its job is to make anti-bodies which are Y-shaped molecules that glom onto invaders and mark them for death by other white blood cells.
- **T-lymphocyte**
  - There are a many kinds but here are 3 important ones:
  - **Memory T-Cell**
    - Remember enemies.
  - **CD4+ T-Helper Cell**
    - It activates B-lymphocytes (that make antibodies).
    - The *HIV/AIDS virus* kills the CD4-T-helper cell. Now it can’t help fight infections. Eventually, all those helpers cells die. That’s bad. Now you can die of **AIDS**.
  - **CD8+ Cytotoxic T-Cell**
    - It kills virus-infected cells.
    - It kills tumor cells.
- That’s the tip of the iceberg. More like the tip of the tip. Lymphocytes are incredibly complicated. Academic careers are devoted to them.
- <https://en.wikipedia.org/wiki/Lymphocyte>



### Monocyte

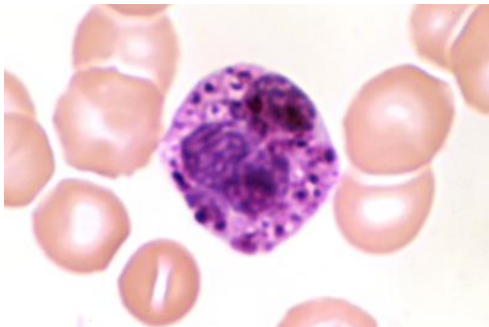
- “Mon oh sight”
- The tip-off is that the nucleus appears dented, like you poked your finger in it ... at least for the one on the right.

- Again, surrounded by red blood cells in the photo.
- They have an interesting life. They are made in the bone marrow, circulate in the blood for 1 to 3 days, then exit into the tissues and eat up bacteria and viruses.
- <https://en.wikipedia.org/wiki/Monocyte>



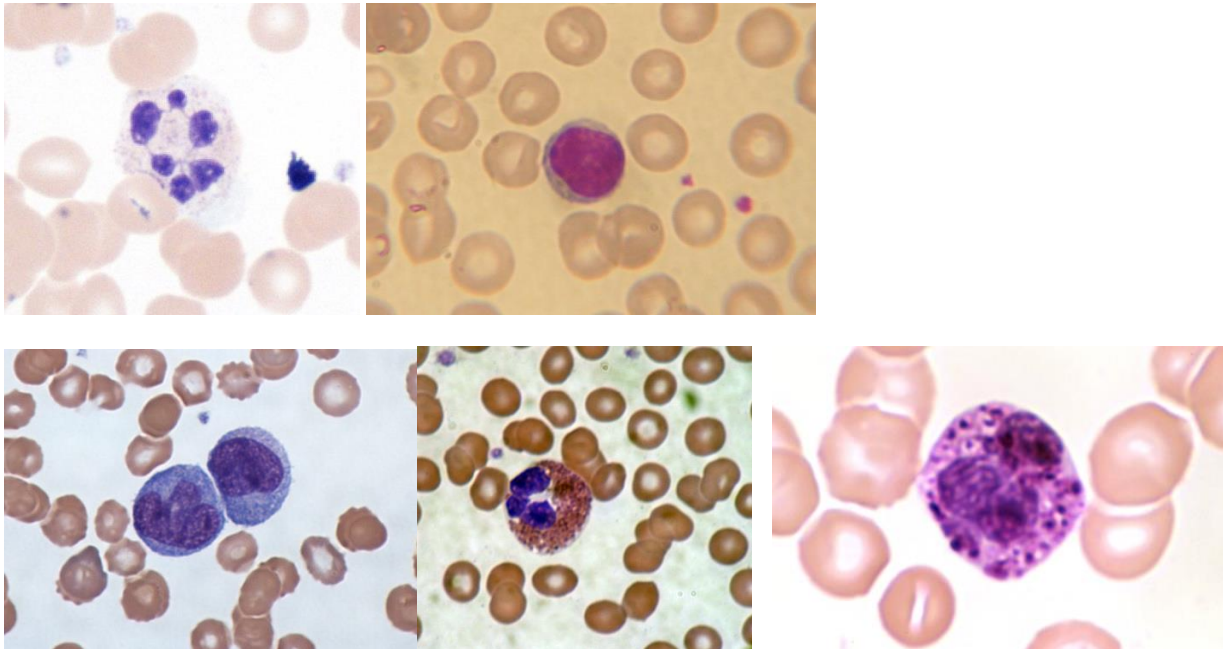
### Eosinophil

- “ee oss in oh fill”
- It has lots of granules – that’s the tip-off under a microscope. Guess what? **Eos** is the Greek goddess of the dawn ... which is the color of the cell when stained with laboratory dyes.
- It kills **parasitic worms** that get inside you.
- <https://en.wikipedia.org/wiki/Eosinophil>



### Basophil

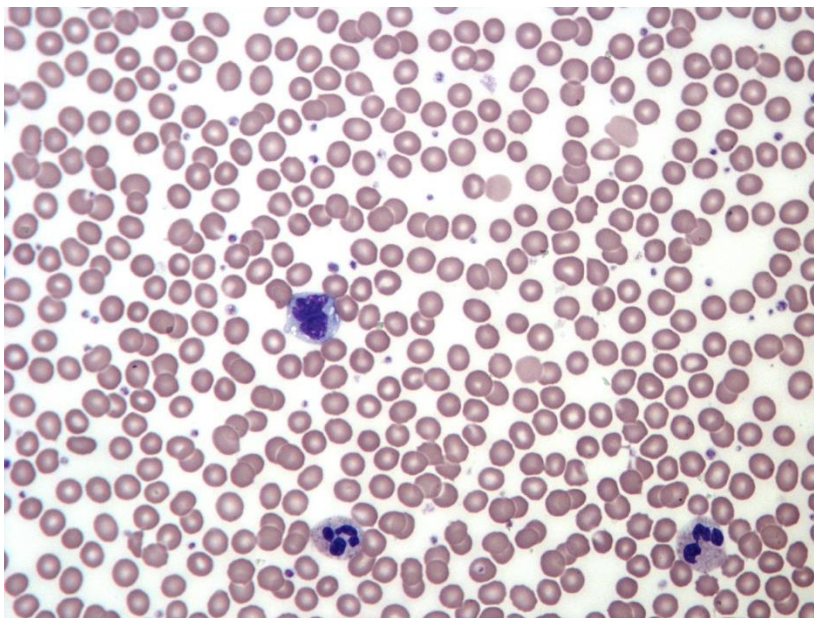
- “Bay zo fill”
- Honestly, I find it kind of hard to tell them apart from eosinophils. See those small purple dots? Those are granules containing histamine plus other chemicals harmful to invaders. The basophil will “degranulate” (pronounced “dee gran you late”) and release the contents of the granule.
- <https://en.wikipedia.org/wiki/Basophil>



Here they are, all together. Let's review.

- These 2 guys in the **top row** are distinctive:
  - **Neutrophil (top L)** – multiple lobes. Kills bacteria.
  - **Lymphocyte (top R)** – nucleus practically fills the cell. Makes anti-bodies. Remembers enemies.
- So that narrows the remaining 3 to these guys, so you've got a 1 in 3 chance of getting it right. Yay.
  - **Monocyte (bottom L)** – nucleus has a dent in it (on a good day). Exits the blood to kill enemies.
  - **Eosinophil (bottom middle)** – lots of granules the color of **Eos** the goddess of the dawn. Kills worms.
  - **Basophil (bottom R)** – lots of granules also. Releases histamine, and if too much then that's your allergy.

### Red blood cells (rbc)



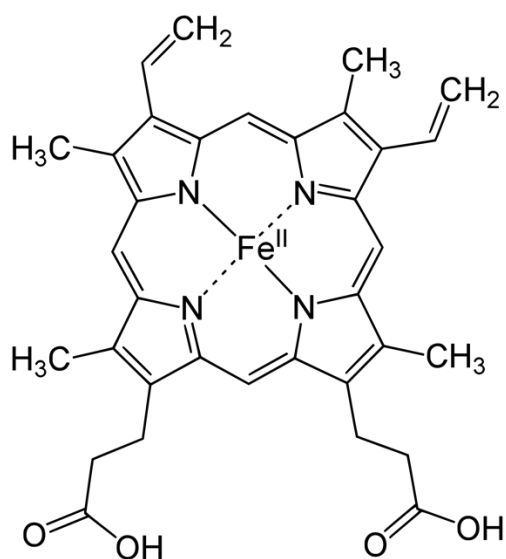


See all those roundish pinkish things? Those are **red blood cells** that were 'smeared' on a glass slide. There are a few hundred of them. You contain, on average, **30 trillion** (yes, trillion with a 't') red blood cells. They are produced in your **bone marrow** (the hollow core of your bones) at the phenomenal rate of **2 million per second**. It would take 951,000 years to count them all, at one per second. **They carry oxygen**. They have a short lifespan ... details later.

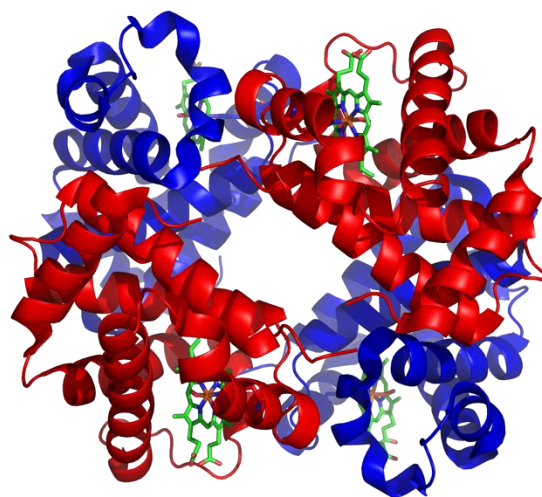
- **The 3 big things with purple blobs inside are white blood cells** (they appear to be neutrophils). The red blood cells vastly outnumber them. Please ignore the white blood cells.
- [https://en.wikipedia.org/wiki/Blood\\_smear](https://en.wikipedia.org/wiki/Blood_smear)

Time to visit what's inside the red blood cells ...

## Hemo-globin



Heme



Hemo-globin

Okay, just focus on the *shapes*.

- See the chemical structure on the left? That's **heme** ("heem"). 🖐️ It's fun to draw ... give it a shot ... the mere act of doing so will make you remember it.
- See the **blue** and **red** ribbons on the right? That's a gigantic protein called **globin** ("globe in").
- Find the **4 green things** embedded in the blue and red ribbons. Those are 4 hemes.
- And now you know what **hemo-globin** looks like. It is 4 hemes embedded in globin. So that's "heem oh globe in."
- There are 250,000 hemoglobins inside every single red blood cell. That's why some doctors refer to the red blood cell as a 'bag of hemoglobin.' Yeah! Look back at that photo of the red blood cells on the glass slide. Every single red blood cell in that photo is carrying a quarter million hemoglobins.
- Is it okay to call it a **hemoglobin molecule**? Yes. Or just hemoglobin? Yes. Same same.
- Okay, now look again at the heme on the left. See the '**Fe**' in the middle? That's the chemical symbol for **iron**. Guess what binds to that iron? Oxygen.
- We can interchangeably say that oxygen is carried by iron, carried by heme, carried by hemoglobin, carried by red blood cells, or carried by blood. It all basically means the same thing. And it's fair to interchangeably use the words *bind*, *carry*, and *transport*, generally speaking.
- <https://en.wikipedia.org/wiki/Hemoglobin>

Now let's bring this back to Jaundice ...

## 2. Jaundice

### Understanding the words



#### Jaundice

- That's **Jaundice**. The man is yellow. (But not from Yellow Fever – I'll explain later. Doesn't matter though because that's also what you'd look like if you had jaundice due to Yellow Fever).
- <https://en.wikipedia.org/wiki/Jaundice>

#### Some background

- When you have **Yellow Fever**, you turn *yellow*. And you have a *fever*. Sounds logical.
- Jaundice ("John diss") is French for yellow.
- When you have Jaundice, your skin turns yellow. And the white of your eye turns yellow.
- Is something yellow leaking into those areas? Yes.
- The *yellow* color of Jaundice is due to *red* blood cells. That is a strange fact, typical of our human body.

#### Jaundice mechanism

- **Red blood cells live for 120 days and then they get recycled.**
  - When they die they break apart.
  - NOW PAY ATTENTION!!
  - The iron gets recycled.
  - The globin gets recycled.
  - **The heme is converted to **bili-rubin** ("billy roo bin") which is a red-orange pigment. We're not at yellow yet.**
- Grammar detour
  - *Jack AND Jill went up the hill.*
  - What is 'AND' called in grammar? A **conjugation** ("con joo gay shun"). That means to join together, (which is also why there are 'conjugal' visits for prison inmates and their spouses).
  - In biochemistry, to **conjugate** ("con joo gate") is to join together 2 things.
- Pay attention!
  - Bili-rubin does not dissolve in water (and blood is mostly water).
  - So the liver conjugates (joins) bili-rubin to sugar. Now it can dissolve in water.
- Get it?
  - There are 2 kinds of bili-rubin.
    - **Conjugated bili-rubin** = bili-rubin + sugar = CB
    - **Unconjugated bili-rubin** = bili-rubin all by itself = UCB
- What if the liver cells are damaged by the *Yellow Fever virus*?

- They cannot do their conjugation job, meaning no sugar gets attached. So bili-rubin accumulates in the blood. But it cannot dissolve in water. So it leaks into the skin and eyes. **The yellow color is because the bili-rubin undergoes further chemical changes to a yellow pigment.**
- That was very much the short version of events. And the technical spelling is bilirubin. No hyphen.

## Jaundice

- Summary
  - **This is, by far, the best explanation I've ever seen for Jaundice. It's an 11-minute video.** The narrator is a chill dude. This is very much what is studied in medical school, namely Medical Biochemistry.
  - Jaundice is a really complicated topic. If you have to watch this 5 times, that's normal. If you still don't get it, that's normal. God didn't make us easy to understand.
  - The **Merck Manual** articles are incredibly well written. I always know when I read their articles it's solid information. It's rather technical, mind you.
- Source
  - **Merck Manual**
    - September 2022
    - <https://www.merckmanuals.com/en-ca/professional/hepatic-and-biliary-disorders/approach-to-the-patient-with-liver-disease/jaundice>
- Author
  - Danielle Tholey, MD. Sidney Kimmel Medical College at Thomas Jefferson University, Philadelphia, Pennsylvania

Okay ... now that you know everything above ...

The unfortunate man in the photo at the start of this Jaundice section has **Cancer of the Pancreas** a.k.a. **Pancreatic Cancer**

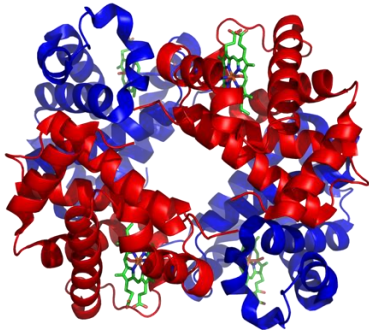
- This man's liver was working okay. But the cancer in the pancreas can block the ducts that the liver uses to empty **bile** into the small intestine. Bile contains, you guessed it, bili-rubin. The bili-rubin can't get out of the liver so it backs up into the blood. As with Yellow Fever, this excess bili-rubin makes you turn yellow. Have I skipped details? Yes.
- Because the ducts from the liver were blocked (obstructed), this is called **Obstructive Jaundice**.

## Spelling

hemo-globin or hemoglobin?

- Technically, the spelling is hemoglobin. No hyphen. But really, isn't hemo-globin better? It says, this is made of 2 different things. All in favor, say *Aye. Aye.*

**Beware the term 'helix'**



#### Actually ...

- The gigantic protein **globin** (the **red** and **blue** ribbons) is actually made of 4 separate chains (**2 alpha chains** and **2 beta chains**) that meld into a single shape. Insane amounts of medical research is devoted to these chains.
- Portions of each ribbon are actually spiral shapes that in biochemistry are known as a **helix**. That can get instantly confusing because:
  - **Globin** is a protein ... the amino acids that make it are arranged in a spiral ... a helix.
  - **DNA** is not a protein ... the 'letters' (C, G, A, T) that make it are arranged in a spiral ... a helix.
  - **So be careful when you read 'helix' – it refers to either proteins or DNA. It's up to you to figure out which.**

## 3. Carbon monoxide (CO) poisoning

### What happens to you?

#### Carbon monoxide poisoning

- Summary
  - **Oxygen gas (O<sub>2</sub>)** is what we breathe in. The good news is that Earth's atmosphere is 21% oxygen ... there's plenty to go around.
  - **Carbon monoxide gas (CO)** kills you. Does carbon monoxide gas smell like roses? No. Like pizza? No. Like Giorgio Armani cologne? No. It's odorless. And what color is it? Green? Orange? Fuchsia? No, no, and no. It's colorless. That means you breathe it in, blissfully unaware, until you die. So don't breathe it in.
    - "mon ox ide" – the ide rhymes with tide
  - This Mayo Clinic article is an easy-to-read summary of carbon monoxide poisoning.
- Source
  - **Mayo Clinic**
    - <https://www.mayoclinic.org/diseases-conditions/carbon-monoxide/symptoms-causes/syc-20370642>

#### Carbon Monoxide Toxicity Clinical Presentation

- **Carbon monoxide toxicity** and **Carbon monoxide poisoning** mean exactly the same thing.
- This is a very technical article.
- Verbatim
  - For nonfatal nonintentional non-fire-related exposures, the most common symptom was headache (37%) followed by dizziness (18%) and nausea (17%).
    - I love how succinctly that is written.
- Source
  - **Medscape**

- 26 January 2023
- <https://emedicine.medscape.com/article/819987-clinical>
- Author
  - **Guy N Shochat, MD** Associate Clinical Professor of Emergency Medicine, University of California, San Francisco, School of Medicine
- Coauthor
  - **Michael Lucchesi, MD** Chair, Associate Professor, Department of Emergency Medicine, State University of New York Downstate Medical Center
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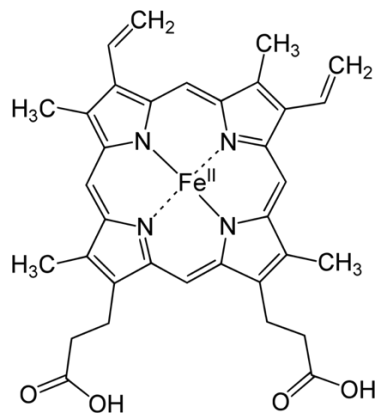
## Gas

### Gas

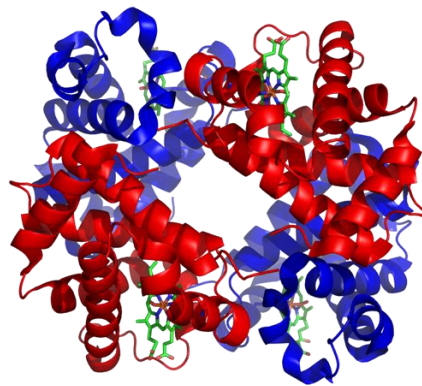
- Oxygen gas
  - 2 Oxygen atoms
  - $O + O$
  - $O_2$  ← That's the chemical formula you'll see most often. The subscript 2 is your clue.
- Carbon monoxide gas
  - 1 Carbon atom + 1 Oxygen atom
  - $C + O$
  - $CO$  ← That's the chemical formula you'll see most often.
  - $C_1O_1$  ← It's actually 1 of each but the 1 is implied so this is never written.

## Chemystery

**Carbon monoxide poisoning** ... to know the chemistry is to understand it ... but it's not quite as daunting at it looks.



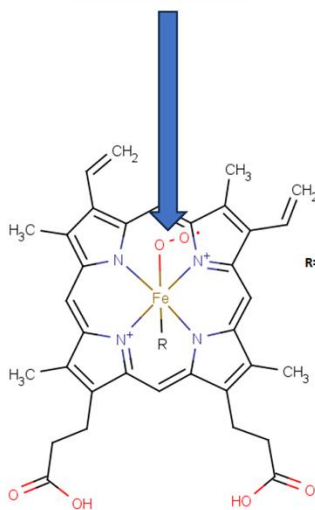
Heme



Hemo-globin

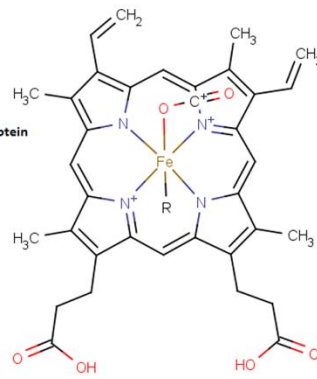
Remember, there are the 4 hemes embedded in globin (blue and red ribbons). The whole thing is hemo-globin.

That's O<sub>2</sub> (oxygen).  
That's good.



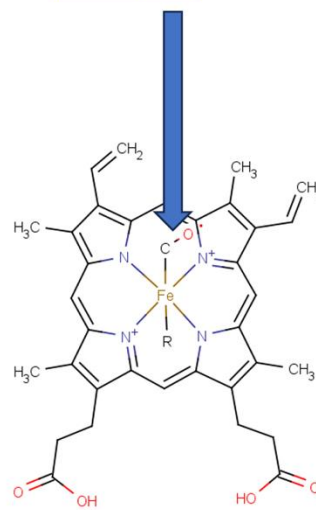
Oxyhemoglobin

R = globin protein



Carbaminohemoglobin

That's CO (Carbon monoxide)  
That's bad.



Carboxyhemoglobin

### Carboxyhemoglobin

- Summary

- That's **heme** on the left. There are **2 red Oxygens (O – O)** bound to the iron (Fe) in the middle. This is why you are alive. Like, exactly why you are alive.
  - When oxygen is bound to hemoglobin it's called **oxy-hemoglobin**, if you wanna get technical.
- **On the far right, carbon monoxide (C – O) has displaced (kicked off) the oxygen.** Why? Because carbon monoxide binds to hemoglobin with **250 times more affinity** than oxygen. 'Affinity' means attraction. It's chemically very complicated and involves the 3D structure (and electric charge) of the huge globin protein. The moral of the story is that your blood is no longer carrying oxygen. If you breathe in enough carbon monoxide gas – I remind you it's odorless and colorless – then eventually all your red blood cells will be carrying carbon monoxide instead of oxygen. You die.
  - When carbon monoxide is bound to hemoglobin it's called **carboxy-hemoglobin**.

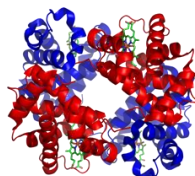
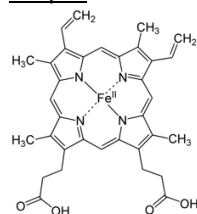
- What's the treatment for **carbon monoxide poisoning**?
  - Get away from the source of the carbon monoxide.
  - **100% oxygen**. Since our atmosphere is only **21% oxygen**, that means a paramedic or fireman gives you pure oxygen (100%), then it continues at the hospital.
- Source 1
  - WikiLectures
    - This is the chemical shapes. I added the yellow highlighted comments in PowerPoint.
    - <https://www.wikilectures.eu/w/Carboxyhemoglobin>
- Source 2
  - Medscape
    - This is information about the **250 x more affinity**. In fact, the range is **230 to 270**.
    - This is the same Medscape article above, *Carbon Monoxide Toxicity Clinical Presentation*, but a different page.
    - <https://emedicine.medscape.com/article/819987-overview#a5>

## Big Numbers

### How many oxygen atoms are carried in your blood?

- The short answer is **60 quintillion (60 billion billion)**.
- This is based on a 70 kilogram (154 pounds) male who contains 5 liters (1.3 gallons) of blood.
- Let's do the math to figure it out.

#### Step 1



- There are 4 hemes per hemoglobin.
- Each heme contains 1 Fe (iron) atom. So that's 4 Fe atoms in total.
- Each Fe (iron) atom carries O<sub>2</sub> (oxygen).
- So 4 Fe atoms x each one carries O<sub>2</sub> = 4 O<sub>2</sub> carried per hemoglobin.
- Restated, each hemoglobin transports 8 oxygen atoms (but it's actually 4 O<sub>2</sub>).

#### Step 2 (restate the question)

- Question
  - If you have **30 trillion red blood cells** and each red blood cell contains **250,000 hemoglobins** and each hemoglobin carries **8 oxygen atoms**, how many oxygen atoms are in your blood?
- Answer
  - $30,000,000,000,000 \times 250,000 \times 8 = \boxed{60 \text{ quintillion}} = 60 \text{ billion billion oxygen atoms}$ .
  - You can do this without a calculator if you use exponents and do the math in chunks.

#### Math

$$\begin{aligned}
 &30 \times 10^{12} \times (250,000 \times 8) \\
 &30 \times 10^{12} \times (2 \text{ million}) \\
 &30 \times 10^{12} \times (2 \times 10^6) \\
 &= 60 \times 10^{18} \\
 &= 60 \text{ quintillion} \\
 &= 60 \text{ billion billion}
 \end{aligned}$$

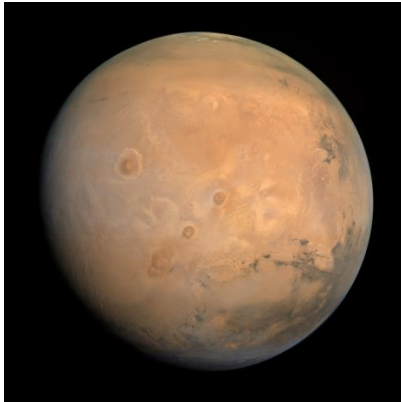
#### Tip

I already know  $250,000 \times 4 = 1 \text{ million}$ .  
 So  $250,000 \times 8 = 2 \text{ million}$ .  
 When you multiply exponents you *add* them.  
 So  $10^{12} \times 10^6 = 10^{18}$   
 Quintillion means 18 zeroes.  
 Billion means 9 zeroes.  $60 \times 10^9 \times 10^9 = 60 \times 10^{18}$

## Why is it red?

Why is it red?

- **Mars is red** because it contains **iron oxide**.  $\text{Fe}_2\text{O}_3$
- **Rust on your car is red** because it contains **iron oxide**.  $\text{Fe}_2\text{O}_3$
- **Blood is red** because **Fe** combines with  $\text{O}_2$ , which is:  $\text{FeO}_2$



Mars

<https://en.wikipedia.org/wiki/Mars>



Rust

<https://en.wikipedia.org/wiki/Rust>



Blood

- The top 2 syringes are dark red because it's from veins a.k.a. **venous blood**. **Less** oxygen.
- The bottom 3 syringes are bright red because it's from arteries a.k.a. **arterial blood**. **More** oxygen.
- <https://en.wikipedia.org/wiki/Blood>

**How Mars got its rust**

- Summary
  - This is a fascinating article comparing iron on Mars versus Earth.
  - Early Earth had a **magma ocean** (imagine the entire Earth covered by an ocean of liquid rock) of **3200 °C (5792 °F)**. Whereas the magma ocean of early Mars was **2200 °C (3992 °C)**. That's the starting point for the comparison.
- Source
  - nature
    - 6 May 2004



- Mark Peplow
  - He nicely summarizes the more formal scientific paper.
- <https://www.nature.com/news/2004/040503/full/news040503-6.html>

### **Nature of the FeO<sub>2</sub> bonding in myoglobin and hemoglobin: A new molecular paradigm.**

- Summary
  - This is an insanely detailed paper on the FeO<sub>2</sub> in our blood.
  - Hemo-globin, as you already know, carries oxygen. So does **myo-globin**, but it's found in our muscle.
- Verbatim
  - The iron(II)-dioxygen bond in myoglobin and hemoglobin is a subject of wide interest.
- Source
  - Progress in Molecular Physics and Biology
    - May-June 2006
    - <https://www.sciencedirect.com/science/article/pii/S0079610705000131?via%3Dihub>
- Author
  - Keiji Shikama
    - Biological Institute, Graduate School of Life Sciences, Tohoku University, Sendai, Japan

### **Why did I mention Mars and rust and blood?**

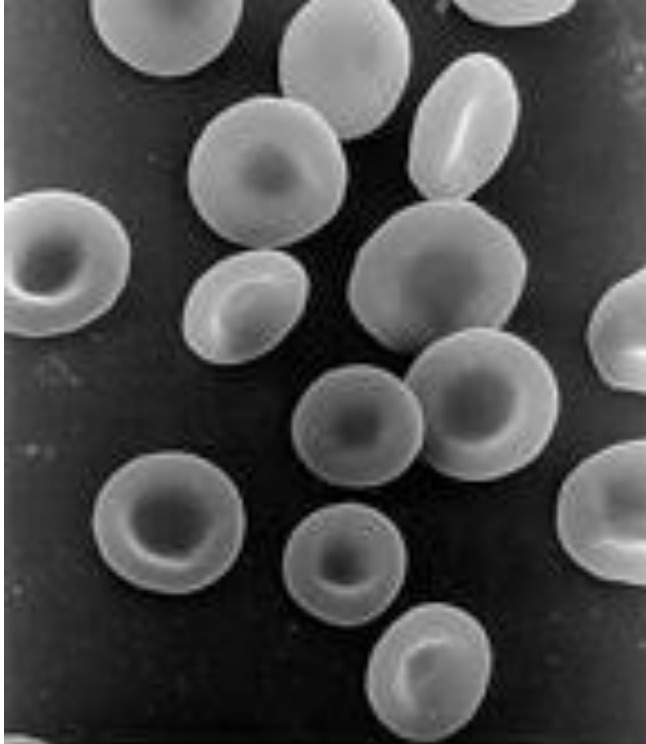
Because everything is connected and this is a source of wonder I bathe in daily.

### **Why do we need iron in the first place?**

We need iron because oxygen gas cannot simply dissolve in the water portion of the blood. Correction – the gas *can* dissolve, but not nearly in sufficient amounts for us to live on. That's why we need iron as a carrier of oxygen. And that's why we have 30 trillion red blood cells.

## **4. Anemia**

**As a refresher ...**



That's a photograph of 15 red blood cells. They are incredibly small – a volume of blood the size of a sugar cube contains 5 – 8 million red blood cells. That's how come there are 30 trillion in your blood.

- [https://en.wikipedia.org/wiki/Red\\_blood\\_cell](https://en.wikipedia.org/wiki/Red_blood_cell)

## The official sources

### Anemia

- Summary
  - This is a nice, readable overview of anemia. Great place to start.
  - Red blood cells carry oxygen. Guess what? if you don't have enough red blood cells you cannot carry as much oxygen so you feel fatigue.
- Source
  - Mayo Clinic
    - <https://www.mayoclinic.org/diseases-conditions/anemia/symptoms-causes/syc-20351360>

### Overview of Anemia

- Summary
  - This is fantastic. Loads and loads of readable information.
  - The 3 causes of Anemia (summarized below) are based on what's going on with your red blood cells.
  - 🖐️ Click on Table 1. All the causes are there. I will give the skinny on a few of them.
  - 🖐️ There is a menu on the left side with links to all kinds of anemia. The explanations are very good, very readable.
  - Cause #1) Blood loss.
    - When the blood exits your body it's red blood cells, really.
    - It could be sudden.

- Like, you got stabbed. There's absolutely nothing wrong with your red blood cells ... it's just that they are exiting you via the knife wound in your body. The treatment here, surprisingly, is not a **blood transfusion** (it comes second). The most important thing is **fluid** to restore your blood pressure, therefore you are administered slightly salty water (from those clear, hanging IV bags that are always in Hollywood movies). That salty water goes directly into your veins, restoring blood volume, thus restoring blood pressure. *Drinking* that salty water would be close to useless because it would take waaaay too long to get absorbed by your intestines; plus, you might be unconscious from your blood loss so you couldn't drink it anyways. And of course, the other part of treatment is to stop the bleeding, either by direct pressure on the wound or a blood clotting agent (found in battlefield trauma kits) or surgery.
- It could be **slow**.
  - For example, women with **heavy periods** a.k.a. **Menorrhagia** a.k.a. **Hypermenorrhea** in medicalese. In fact, this is the #1 way that women get anemia.
  - Or maybe you have **Colon Cancer**. Cancer cells secrete growth factors that cause the growth of new blood vessels just for them. But these new blood vessels are fragile (which is abnormal) and bleed easily. That's the source of the slow bleeding. It can be so slow that you can't see the blood in your poop. This is called **occult bleeding** – like the *occult*, you can't see it. That's why we do **occult blood testing** – your poop is smeared on a piece of paper impregnated with chemicals that change color in the presence of blood. Or you simply get a **colonoscopy** so the doctor can look for weirdness in your colon.
  - As a generality, this slow loss of iron is called **Iron Deficiency Anemia**.
- **Cause #2) Decreased production of red blood cells.**
  - Think of the **bone marrow** (the hollow core of bone) as a factory for making red blood cells. The factory output is **2 million** red blood cells *per second*. It is a phenomenal output. The most productive bones are the upper arm bone (humerus), upper leg bone (femur) and breastbone (sternum).
  - In some people with chronic (ongoing) illness, their bone marrow is sluggish in meeting its factory quotas. This is called **Anemia of Chronic Disease**.
  - Vitamin B12 is required to make red blood cells. If a **tapeworm** in your intestine is stealing your dietary B12, the result is a **Vitamin B12 Deficiency** and the resulting anemia is called **Pernicious Anemia**. It doesn't just have to be a tapeworm. A severe alcoholic might have a terrible diet and also suffer from a B12 deficiency; he or she would also have Pernicious Anemia.
  - **Radiation poisoning** also decreases factory output. That's no fun. Not only do you feel tired, you cannot get any cell phone reception in the rubble of your glowing city. The resulting anemia is called **Aplastic Anemia** ("a" – it's a long 'a' like in 'ray' – "plastic") ... one of my favorite medical terms. I think it's the alliteration. In this type of anemia, there is decreased production of everything:
    - ↓ red blood cells
      - This is **anemia**.
      - This causes fatigue, generally speaking.
    - ↓ white blood cells
      - This is **leuko-penia** ("lou kow" – kow rhymes with row – "peen ee ah"). *Leuko* means white, and *penia* means lack of.
      - You get infections more easily. That's no good.
    - ↓ platelets
      - "plate lets"
      - This is **thrombo-cyto-penia** ("throm bow" – bow rhymes with row – "sight oh peen ee ah").
      - Their job in life is blood clotting, so if you're short on them, you bleed more easily. That's no good.
- **Cause #3) Increased destruction of red blood cells.**

- Remember, red blood cells are supposed to live for **120 days**. Something is killing them before their little lives have been lived.
- **Sickle Cell Anemia**
  - This is described in the next section.
- **Auto-Immune Hemo-lytic Anemia**
  - This is a very unfair type of anemia. Your own immune system attacks you! Specifically, it attacks your red blood cells. They basically disintegrate.
  - The word 'auto' means self. So your immune system is attacking self.
  - Hemo-lytic means *blood split*, literally. But it refers to the red blood cells that are splitting.
  - The treatment is a blood transfusion, meaning you get a bunch of red blood cells from a donor (who generously donated at the Red Cross). The donor red blood cells – once inside your body – can still get attacked mind you, so you might need more blood transfusions.
- **MAHA**
  - Okay, the reason I like this is because it's pronounced, "Ma ha." That's just cool.
  - MAHA is the acronym for **M**icro-**A**ngiopathic **H**emo-lytic **A**nemia.
  - In this strange disorder, the red blood cells are disintegrating inside the very smallest of blood vessels – the capillaries. That's the **MA** part. The 'micro' refers to the capillaries. And *Angio-pathic* means blood sadness, literally.
  - The fact that the red blood cells are fragmenting (think, being spilt apart) is the **HA** part.
  - So the reason pronouncing it "ma ha" is useful is that each syllable is telling you what's going on. The "ma" means it's in the capillaries. The "ha" means the red blood cells are fragmenting. Oh, the joy of words.
- Source
  - **Merck Manual – Consumer Version**
    - As mentioned before, these Merck Manuals, whether professional (for MDs), consumer (for the 'layman') or for veterinarians are just so concise and well-written.
    - September 2022
    - <https://www.merckmanuals.com/en-ca/home/blood-disorders/anemia/anemia-due-to-excessive-bleeding>
- Author
  - **Evan M. Braunstein, MD, PhD**. Johns Hopkins University School of Medicine, Baltimore, Maryland, USA

## Low Hemoglobin

- Summary
  - This is a basic introduction to low hemoglobin. Think, low iron levels.
  - The **Cleveland Clinic** in Cleveland, Ohio, is also a fantastic medical resource. Very good, understandable explanations.
- Source
  - Cleveland Clinic
    - <https://my.clevelandclinic.org/health/symptoms/17705-low-hemoglobin>

## Blood tests that help to figure out the type of anemia

**Anemia** is all about iron ...



### How much iron is in your blood?

- If we poured all 5 liters (1.3 gallons) of your blood into a bucket it would contain somewhere between 675 - 875 grams (1.5 – 1.9 pounds) of **iron**. Let's just say 2 pounds. So it's two of those 1-pound weights (though I think in the photo it is brass. Please pretend it is iron). It's all this iron that's distributed in your 30 trillion red blood cells. Each red blood cell gets a tiny fraction of those 2 pounds.
- If the bucket of your blood contained only one of those 1-pound weights (pretend it's iron), that would be severe **Anemia**.
- <https://en.wikipedia.org/wiki/Bucket>
- [https://en.wikipedia.org/wiki/Pound\\_\(mass\)](https://en.wikipedia.org/wiki/Pound_(mass))



<https://en.wikipedia.org/wiki/Litre>

How do you suppose the laboratory reports this information to the doctor?

- Total amount of iron in a bucket of blood? No.
- The amount of iron in 1 liter of blood? Yes. That's the quantity of blood in that **beer mug** (1 liter = 34 ounces). Just replace the beer with blood. Specifically, the result is **grams of iron per liter of blood**.
- There are '**reference ranges**' based on age and gender.

Who?	Reference range	Shorthand
Male	135 – 175 grams of iron per liter of blood (think, 34 oz beer mug)	135 –175 g / L
Female	120 – 155 grams of iron per liter of blood	120 –155 g / L
Newborn	140 – 240 grams of iron per liter of blood	140 – 240 g / L

Hemoglobin	149	135 - 175	g/L
------------	-----	-----------	-----

**That's an actual blood test result for a male.**

- This patient has **149** grams of iron per liter of blood. It's reported as 149.
- The reference range is **135 – 175 g / L**.
- The reference range varies slightly from lab-to-lab but it's not a big deal. They are approximations.
- Does that lab report say **Hemoglobin** on the far left? Yes. But what's *actually* being measured is **grams of iron per liter of blood**.
- To make life confusing, sometimes the result seems to be 1/10<sup>th</sup> of what you'd expect. For the result above, instead of **149** it would be **14.9**. That's precisely because the reference range (for *that* hospital) was based on 1/10<sup>th</sup> of a liter. In other words, 1/10<sup>th</sup> of the beer mug. It's exactly the same result, just a different volume. And in metric what is 1/10<sup>th</sup> of a liter? It's called a **deci-liter**. So the reference range would be **13.5 – 17.5 g / dL**. Same same.

Test	Flag	Result	Reference Range - Units
<b>matology</b>			
WBC		6.1	4.0 - 11.0 x E9/L
RBC		4.51	4.50 - 6.00 x E12/L
Hemoglobin		149	135 - 175 g/L
Hematocrit		0.420	0.400 - 0.500 L/L
MCV ←		93	→ 80 - 100 fL
MCH		33.0	27.5 - 33.0 pg
MCHC		355	305 - 360 g/L
RDW ←		12.3	→ 11.5 - 14.5 %
Platelet Count		238	150 - 400 x E9/L

**That's the same patient but with more blood tests.**

- Notice, first of all, that nothing is in the **Flag** column. 'Flag' means an abnormal result. The flag column is empty because each **Result** falls within the **Reference Range – Units**. That's good. This male patient (it's me, in fact) was in good health.
- Now let's look at some important stuff, as it concerns **Anemia**.
- **MCV**
  - This is in the **Test** column.
  - **MCV means Mean Cell Volume** and it's the volume of an individual red blood cell. Yes, this can actually be calculated. It's an insanely small volume, measured in femto-liters (that's 10 to the minus 18, i.e. 10<sup>-18</sup> fL). That's a **billionth** of a **billionth** of the beer mug. A very small sip. Femto is pronounced "fem toe."
  - Guess what? Red blood cells can be normal volume, low volume, or high volume (and those 3 choices actually look different under the microscope – which helps tremendously making the diagnosis). Point is, **measuring the volume of the red blood cell is another way to classify anemia but perish the thought we'd use simple terminology**. So here goes.

- **Normo-cytic Anemia**
  - "Norm oh sit ick"
  - Ok, you'll have to imagine some new **male** patients now. Forget about me. But use the **Reference Range – Units** to help you.
  - This patient has anemia. We know this because their Hemoglobin is less than **135 g/L** (the Reference Range is 135 – 175). And don't forget what's being measured here is grams of iron.
  - The patient's Mean Cell Volume (MCV) is normal. It's between **80 – 100 fL** (femtoLiters).
  - Get it? **Low** iron. **Normal** red blood cell volume.
  - The word *normal* got turned into *normo*. And *cytic* means cell. Hence, normo-cytic anemia.
  - What type of anemia fits in this group?
    - **Anemia of Chronic Disease**. Yes, their iron is low but their red cell volume is normal.
- **Micro-cytic Anemia**
  - This patient has anemia. Their Hemoglobin (but think iron) is less than **135** grams per liter.
  - The red blood cell volume is less than **80 fL** (the reference range is 80 – 100 fL).
  - Get it? **Low** iron. **Low** red blood cell volume.
  - What type of anemia fits in this group?
    - **Iron Deficiency Anemia** falls in here. Think, heavy periods in a female, or unnoticed colon cancer.
- **Macro-cytic Anemia**
  - The patient has anemia. And the red blood cell volume is larger than normal.
  - Get it? **Low** iron. **High** red blood cell volume (greater than **100 fL**) (reference range 80 – 100 fL).
  - What type of anemia fits in this group?
    - This is the hungry tapeworm causing **Vitamin B12 deficiency** causing **Pernicious Anemia**.
- **RDW**
  - This is in the **Test** column.
  - This means **Red** (blood cell) **Distribution Width**. This is a measure of the ratio of **young red blood cells** (they just got released from the bone marrow) to **old red blood cells** (nearing the end of their 120 day life).
  - If this number is high, in the setting of anemia, it means that the bone marrow is keeping up, churning out young red blood cells, and in fact has increased factory output. But it has not caught up because the cause of the anemia is still present. That's the basic picture.
- And lots of other stuff that doctors way smarter than me totally get.

#### Extras

- Can you see the word that got cut off at the top of the report? It says **matology**. The full word is **Hematology** ("heem ah tall ah jee") which is the study of the blood.
- The reference range on the report is matched to gender (since the lab knows the gender of the patient). Or sometimes both male and female ranges are given. And for many things the male and female ranges are identical.

## Reference range sources

### Reference range sources for hemoglobin

- **Red Cross**
  - <https://www.redcrossblood.org/donate-blood/dlp/hematocrit.html>
- **Mount Sinai Hospital**
  - <https://www.mountsinai.org/health-library/tests/hemoglobin#>

### Here's the math for the bucket

5 liters of blood x 135 grams of iron / liter  
5 liters of blood x 175 grams of iron / liter

### Just the numbers

5 x 135 = **675 grams** iron  
5 x 175 = **875 grams** iron

## Physiology, Blood Volume


- Verbatim
  - Blood volume refers to the total amount of fluid circulating within the arteries, capillaries, veins, venules, and chambers of the heart at any time. The components that add volume to blood include red blood cells (erythrocytes), white blood cells (leukocytes), platelets, and plasma. Plasma accounts for about 60% of total blood volume, while erythrocytes make up roughly 40%, along with leukocytes and platelets. The amount of blood circulating within an individual depends on their size and weight,

- but the average human adult has nearly 5 liters of circulating blood. Women tend to have a lower blood volume than men. However, a woman's blood volume increases by roughly 50% during pregnancy.
- Source
    - StatPearls
      - This was in PubMed which is part of the NIH National Library of Medicine
      - <https://pubmed.ncbi.nlm.nih.gov/30252333/>
  - Author
    - Ragav Sharma - Midwestern University
    - Sandeep Sharma - Mery Fitzgerald Hospital

### Estimated Blood Volume

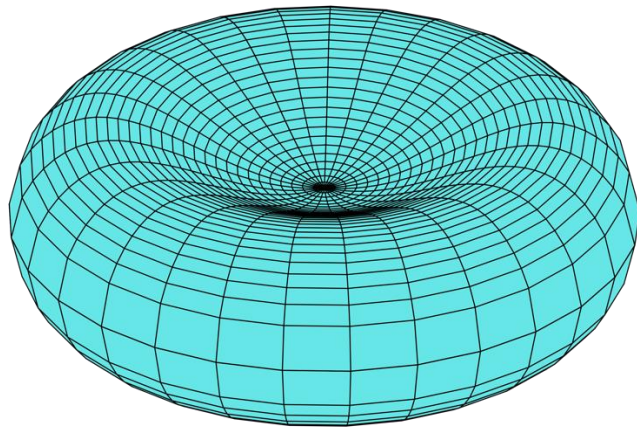
- Summary
  - The volume of your blood is based on the **Nadler equation** created in 1962 by a guy named **Samuel Nadler**. The volume is measured in milli-liters. A **sugar cube**, if it was liquid, is about 1 ml (milli-liter).
- Formula
  - $\text{Blood volume (ml)} = \text{weight (kg)} \times (\text{constant ml / kg})$ 
    - Adult male = 75
    - Adult female = 65
    - Infants = 80
    - Neonates = 85
    - Premature neonates = 95
- Example
  - Let's do the math for a male and female who each weigh 70 kg (154 lb).
    - 70 kg male x 75 ml / kg = 5250 ml = 5.25 liters (1.4 gallons) = Let's just say 5 litres, for ease.
    - 70 kg female x 65 ml / kg = 4550 ml = 4.55 liters (1.2 gallons) = Let's just say 5 liters, for ease.
- Source
  - Medscape
    - <https://reference.medscape.com/calculator/648/estimated-blood-volume>

### Blood Volume Calculation

- Summary
  - This is an online calculator that does the math for you. It uses the **Nadler equation** but has a few bells and whistles.
- Source
  - **MD Calc**
    - This site has an absolute ton of calculators used in medicine.
    -  At the top left of the web page click on the 3 horizontal bars → now click 'Calculators' in the drop down menu → then click 'All' → now you will see a gazillion formulas. Most of these formulas are highly technical but they are kind of cool to peruse to see the onion layers of medicine.
    - <https://www.mdcalc.com/calc/4065/blood-volume-calculation>

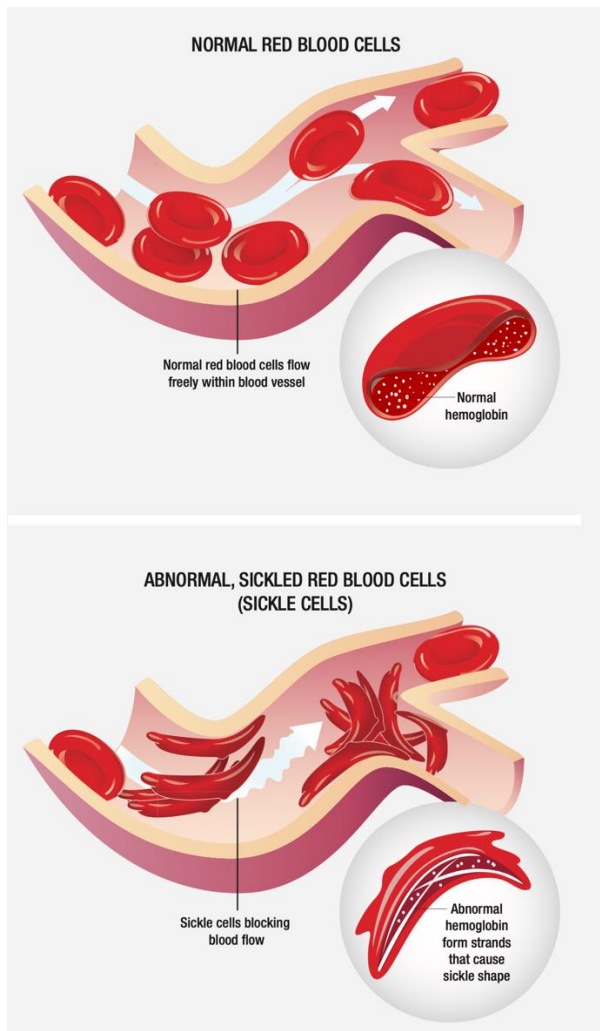
## 5. Sickle Cell Anemia (SCA)





That's a **jelly donut**. If you use your thumb and index finger to gently squeeze it on the top and bottom surface, you'll create a **bi-concave disk**. That's exactly the shape of a **red blood cell**.

- The word *concave* simply means there is a depression. And bi means 2, so there are 2 depressions – one on the top surface, one on the bottom surface.
- [https://en.wikipedia.org/wiki/Jelly\\_doughnut](https://en.wikipedia.org/wiki/Jelly_doughnut)
- [https://en.wikipedia.org/wiki/Biconcave\\_disc](https://en.wikipedia.org/wiki/Biconcave_disc)



## Sickle Cell Disease

- Summary
  - In **Sickle Cell Anemia**, the red blood cell has a sickle shape. That's abnormal. They get into traffic jams in the smallest blood vessels called capillaries.
  - The technical term for the traffic jam is **sickle cell crisis** or **vaso-occlusive crisis** (“vay zoh awk clue siv”). The term *vaso* refers to blood vessels. And the word *occlude* means to block. *Occlusive* is another way of saying occlude.
  - The cause of all this is abnormal **hemo-globin**.
  - The red blood cells get destroyed. Remember, the 3 causes of anemia are: increased rbc destruction, decreased rbc production, and excessive blood loss.
  - Genetics
    - And now ... getting technical ... remember how the gigantic **globin** protein is made of 4 chains? 2 **alpha chains** and 2 **beta chains**. A mutation in the beta chain creates a new chain (which is only a teensy weensy bit different). There are still 2 alpha chains and 2 beta chains, it's just that the beta chain is ever so slightly different. This results in a different hemoglobin called **Hemoglobin-S**. This is what is responsible for Sickle Cell Anemia.
- Source
  - Wikipedia
    - [https://en.wikipedia.org/wiki/Sickle\\_cell\\_disease](https://en.wikipedia.org/wiki/Sickle_cell_disease)
      - Their image is from the **National Heart, Lung and Blood Institute**, which is 1 of the 26 arms of the **National Institutes of Health (NIH)** (see page 180 of *Hidden Zoo*).
      - <http://www.nhlbi.nih.gov/health/health-topics/topics/sca/>

### Sickle Cell Disease

- Summary
  - This is a nice summary of [Sickle Cell Anemia](#). It's 95% readable, 5% technical.
- Verbatim
  - People always have **anemia** and sometimes **jaundice**.
  - Worsening anemia, fever, and shortness of breath with pain in the long bones, abdomen, and chest can indicate **sickle cell crisis**.
  - A special blood test called **electrophoresis** can be used to determine whether people have sickle cell disease.
  - Avoiding activities that may cause crises and treating infections and other disorders quickly can help prevent crises.
- Source
  - Merck Manual – Consumer Version
    - <https://www.merckmanuals.com/en-ca/home/blood-disorders/anemia/sickle-cell-disease>
- Author
  - Evan M. Braunstein, MD, PhD. Johns Hopkins University School of Medicine, Baltimore, Maryland, USA

### Sickle Cell Disease (SCD)

- Summary
  - There is loads of information here for people who suffer from [Sickle Cell Anemia](#).
- Source
  - CDC
    - [https://www.cdc.gov/ncbddd/sicklecell/index.html#:~:text=Sickle%20cell%20disease%20\(SCD\)%20is,activities%20that%20other%20people%20do.](https://www.cdc.gov/ncbddd/sicklecell/index.html#:~:text=Sickle%20cell%20disease%20(SCD)%20is,activities%20that%20other%20people%20do.)

### Natural Selection: Uncovering Mechanisms of Evolutionary Adaptation to Infectious Disease - The evolutionary link between sickle-cell trait and malaria resistance showed that humans can and do adapt. But are the “bugs” that make us sick evolving as well?

- Summary
  - J. B. S. Haldane is a famous scientist. In 1954 he noticed that disorders of red blood cells – including **sickle cell anemia** – occurred in tropical regions. This was **natural selection** – it protected humans from **malaria**.
- Verbatim
  - In the 1940s, **J. B. S. Haldane** observed that many red blood cell disorders, such as sickle-cell anemia and various thalassemias, were prominent in tropical regions where malaria was **endemic** (Haldane, 1949; Figure 1). Haldane hypothesized that these disorders had become common in these regions because **natural selection** had acted to increase the prevalence of traits that protect individuals from malaria. Just a few years later, Haldane's so-called "malaria hypothesis" was confirmed by researcher A. C. Allison, who demonstrated that the geographical distribution of the sickle-cell **mutation** in the beta hemoglobin **gene** (*HBB*) was limited to Africa and correlated with malaria endemicity. Allison further noted that individuals who carried the sickle-cell **trait** were resistant to malaria (Allison, 1954).
  - Research indicates that the malaria-causing parasite **Plasmodium falciparum** has occurred in human populations for approximately 100,000 years, with a large population expansion in the last 10,000 years as human populations began to move into settlements (Hartl, 2004)
  - <https://www.nature.com/scitable/topicpage/natural-selection-uncovering-mechanisms-of-evolutionary-adaptation-34539/>
- Source
  - nature education

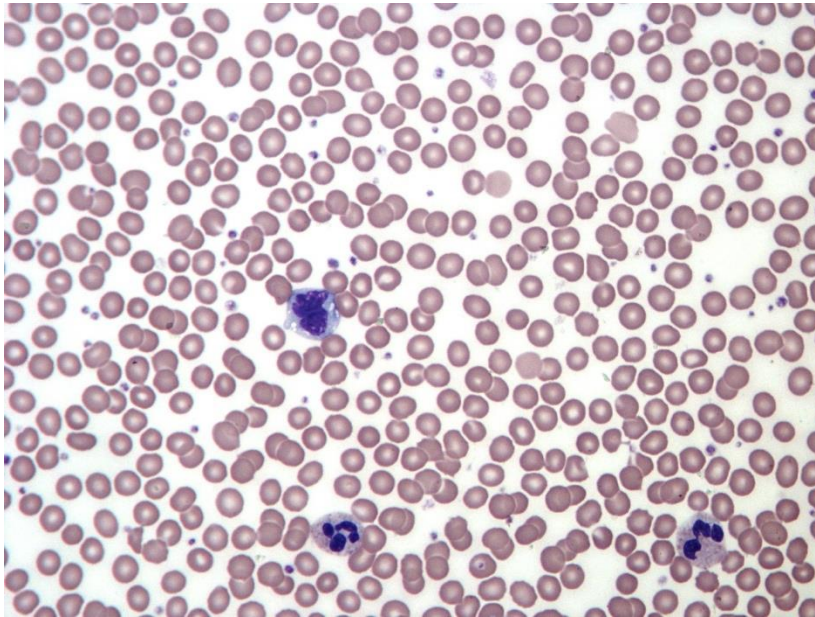
- 2008
- <https://www.nature.com/scitable/topicpage/natural-selection-uncovering-mechanisms-of-evolutionary-adaptation-34539/>
- Author
  - **Pardis C. Sabeti M.D., D.Phil.** (*Harvard University, Cambridge, MA*)
    - His references are:
      - **Allison, A. C.** *Protection afforded by sickle-cell trait against subtertian malarial infection*. *British Medical Journal* **4857**, 290–294 (1954)
      - **Diamond, J. M.** *Guns, Germs, and Steel: The Fates of Human Societies* (New York, Norton, 2005)
      - **Haldane, J. B. S.** *Disease and evolution*. *Ricerca Science Supplement* **19**, 3–10 (1949)
      - And others.

### ***Resistance to Plasmodium falciparum in sickle cell trait erythrocytes is driven by oxygen-dependent growth inhibition***

- Summary
  - The good news is that an abnormal hemoglobin called **Hemoglobin-S** causes a growth arrest of the **Plasmodium** organism.
  - That bad news is that this abnormal hemoglobin causes **Sickle Cell Anemia**.
  - This is technical article.
- Source
  - **Proceedings of the National Academy of Sciences (PNAS)**
    - This source tends to have very solid science.
    - 26 June 2018
    - [https://www.pnas.org/doi/full/10.1073/pnas.1804388115#:~:text=Sickle%20cell%20trait%20\(A%20confers,red%20blood%20cells%20\(RBCs\).](https://www.pnas.org/doi/full/10.1073/pnas.1804388115#:~:text=Sickle%20cell%20trait%20(A%20confers,red%20blood%20cells%20(RBCs).)
- Authors
  - **Natasha M. Archer**
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## **6. Fetal Hemoglobin**

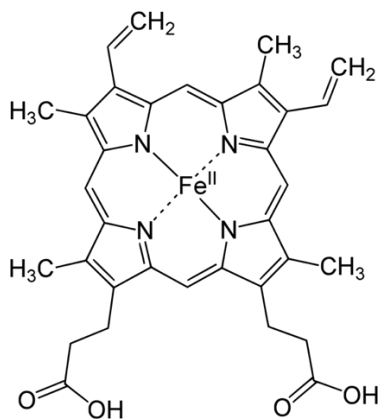
**Red blood cells**

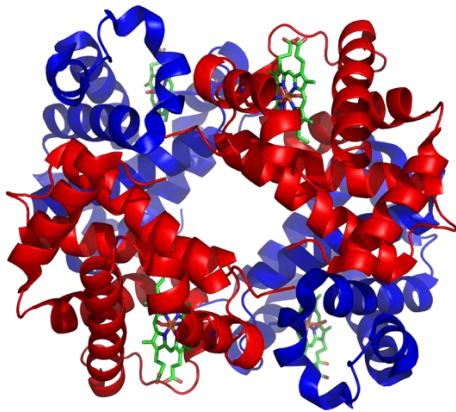
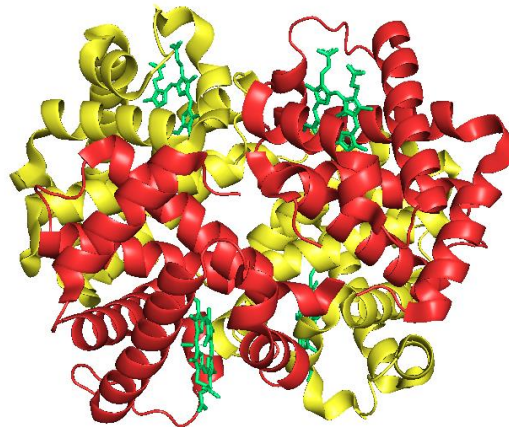


See all those roundish pinkish things? Those are **red blood cells** that were 'smear'd' on a glass slide. Remember these 2 facts please:

- A **pregnant woman's** red blood cells remain in her blood.
- The **fetus's** red blood cells remain in its blood.
- **They do not mix.** (There are exceptions, like say a high-velocity car accident where the placenta is injured, but let's ignore that).
- The fancy way of saying this is that there is a separation of **maternal circulation** from **fetal circulation**.
- The 3 big things with purple blobs inside are **white blood cells**. Like the rbc, the wbc stay in their respective person and do not mix.
- [https://en.wikipedia.org/wiki/Blood\\_smear](https://en.wikipedia.org/wiki/Blood_smear)

## Hemoglobin



Maternal (**mother**) hemoglobinFetal (**fetus**) hemoglobin

### Fetal hemoglobin

- Summary

- This will make sense after you read the Shapes explanation just below.

<u>Who?</u>	<u>Type of hemoglobin</u>	<u>Chains</u>	<u>Shorthand</u>
Pregnant woman	Adult hemoglobin	2 alpha + 2 beta	$\alpha_2\beta_2$
Fetus (living in the womb)	Fetal hemoglobin	2 alpha + 2 gamma	$\alpha_2\gamma_2$

- Shapes

- Okay, pay attention to the *shapes*.
- See the chemical structure at the top? That's **heme** ("heem").
  - See the '**Fe**' in the middle? That's the chemical symbol for **iron**. Guess what binds to that iron? Oxygen.
- **Maternal hemoglobin**
  - This is the hemoglobin in the blood of the pregnant woman. The hemoglobin of an adult man is exactly the same. This is basically adult hemoglobin. But in this setting, we refer to 'maternal hemoglobin' in order to distinguish it from 'fetal hemoglobin.'
  - See the **blue** and **red** ribbons? That's a gigantic protein called **globin** ("globe in").
  - Find the **4 green things** embedded in the blue and red ribbons. Those are 4 hemes.
  - And now you know what **hemo-globin** looks like. It is 4 hemes embedded in globin. So that's "heem oh globe in."
  - But if you look more closely ...
    - There are **2 red ribbons**. These are called the **alpha chains** (or **alpha sub-units**).
    - There are **2 blue ribbons**. These are called the **beta chains** (or **beta sub-units**).
- **Fetal hemoglobin**
  - This is made in the fetus. Then it stops getting made after birth and things switch over to adult mode.
  - Does it have **4 hemes** just like in the mom? Yes.
  - But if you look more closely ...
    - There are **2 red ribbons**. These are called the **alpha chains** (or **alpha sub-units**).
    - There are **2 yellow ribbons**. These are called the **gamma chains** (or **gamma sub-units**).
  - Fetal hemoglobin has a higher affinity for oxygen than maternal hemoglobin. That way the fetus can extract oxygen from the pregnant woman. Specifically, this occurs in the placenta where the fetal circulation and maternal circulation are very close but not actually touching.

- Source

- <https://en.wikipedia.org/wiki/Hemoglobin>
- [https://en.wikipedia.org/wiki/Fetal\\_hemoglobin#](https://en.wikipedia.org/wiki/Fetal_hemoglobin#)