

Beneficial Bacteria

The vast majority of bacteria are **harmless** or **beneficial**.

- **Lactobacillus**: makes cheese, yogurt, helps initial digestion in your mouth and produces vitamins in your intestine.



- **Leuconostoc**: makes pickles and sauerkraut as well as sour cream.



- **Pediococcus**: makes pepperoni, salami, summer sausage.
- **Actinomyces**: produce antibiotics such as streptomycin and nocardicin and are very useful in breaking down compost (the "earthy" smell of soil).



Pathogenic Bacteria

Pathogenic bacteria that can **cause infectious diseases** are much better studied than many of the free-living species.



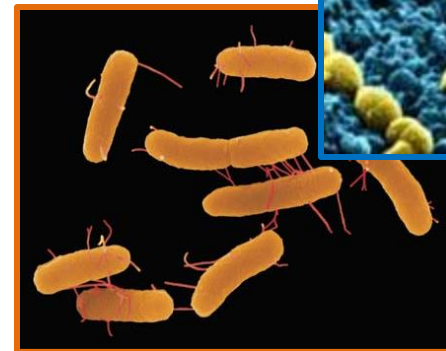
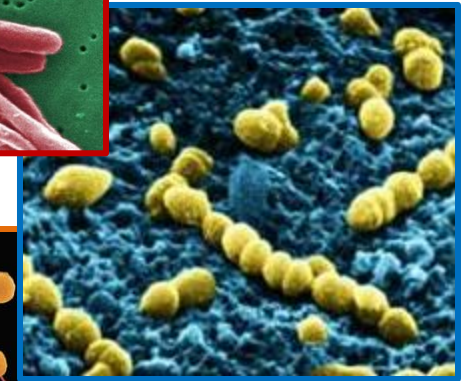
Illustration: Don Smith



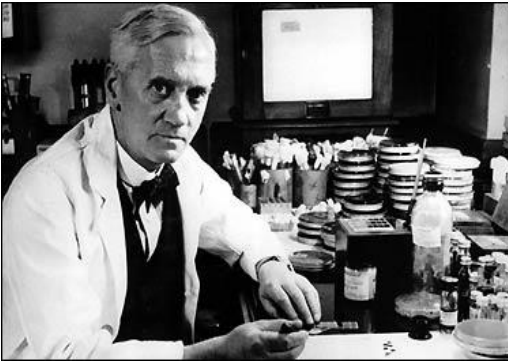
- How do they make us sick:
 - **Iron** competition.
 - **Direct damage** to host cells.
 - Production of **toxins** - poisonous substances that work by destroying particular parts of the host cell or by inhibiting certain metabolic functions (*release of toxins* after death of bacterial cells often cause *symptom worsening* immediately after beginning the course of antibiotics...).
- Conditionally pathogenic bacteria are **only pathogenic under certain conditions**, such as a wound that allows for entry into the blood stream, or a decrease in immune function.

Globally Important Diseases caused by bacterial infections

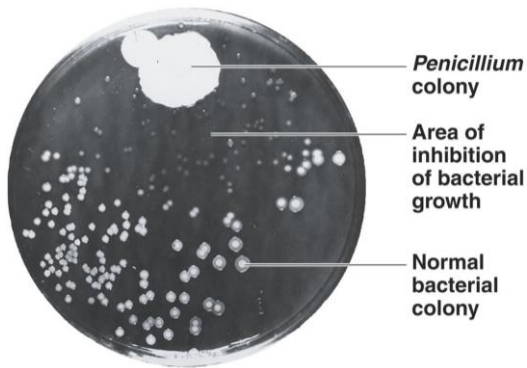
- Tuberculosis (*Mycobacterium tuberculosis*) still kills about 2 million people a year!
- Pneumonia can be caused by *Streptococcus* and *Pseudomonas*.
- Foodborne illnesses can be caused by *Shigella*, *Campylobacter*, and *Salmonella*.
- Other: tetanus, typhoid fever, diphtheria, borelliosis etc.
- **Common pathogenic bacteria:** pathogenic *E. coli*, *Salmonella*, *Helicobacter*, *Clostridium*, *Enterococcus*, *Listeria*, *Pseudomonas*, *Staphylococcus*, *Streptococcus*.



A discovery by accident...



Alexander Fleming



H. Florey and E. Chain

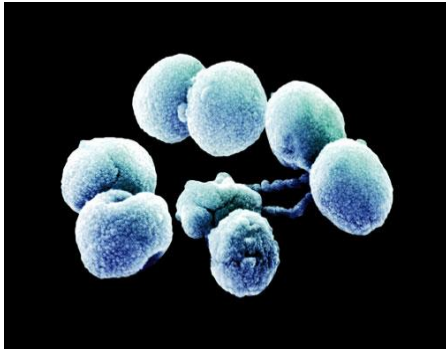
- A **fungus spore** that the wind might have blown into his lab while Fleming was on vacation in 1928, **forever changed the course of medicine...**
- **Fleming** observed that a number of disease-causing bacteria were killed by a fungus of the genus *Penicillium*.
- He **named the active agent Penicillin** (after the mould *Penicillium notatum*) – but was unable to isolate the substance.
- **Howard Florey and Ernst Chain purified the first penicillin**, penicillin G, in 1942.
- Successful trials on mice showed that penicillin displayed **potent antibacterial activity** against a **wide range of bacteria** and had **low toxicity** in humans.
- **Nobel prize in 1945**

What are antibiotics for?

An antibiotic is given for the treatment of an infection caused by **bacteria**. However, **they are not effective against viruses**.

BACTERIAL

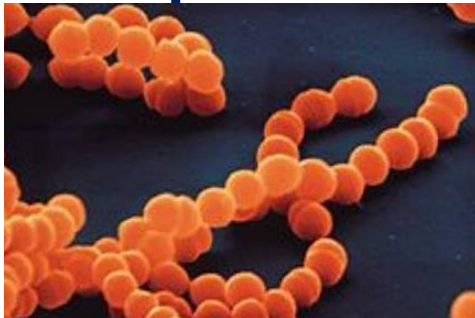
Pneumonia



Lyme Disease



Strep Throat



Ear Infection (Otitis)

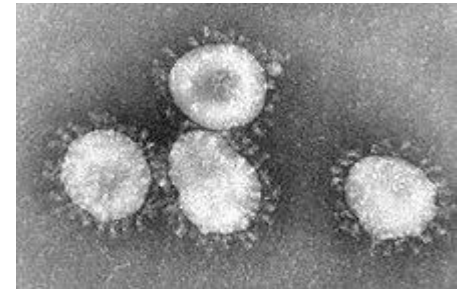


VIRAL

Flu (Influenza)



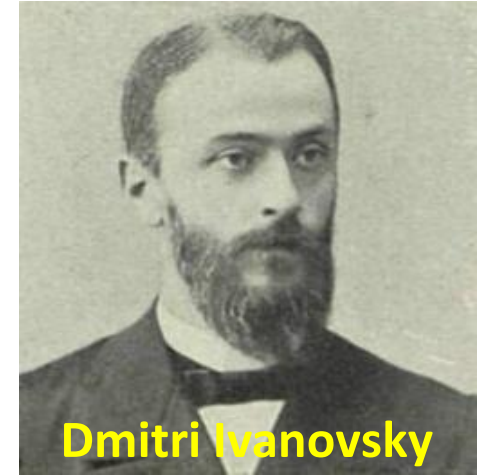
Common Cold



Discovery of Viruses

(1884: invention of the *Chamberland filter* with pores smaller than bacteria)

- **1892:** Russian biologist Dmitri Ivanovsky publishes a paper in which shows that extracts from diseased tobacco plants remain infectious after filtration through Chamberland filter. **MEANING?**
- **1898:** Dutch microbiologist Martinus Beijerinck postulates a new form of “filterable” infectious agent – term **virus** introduced.

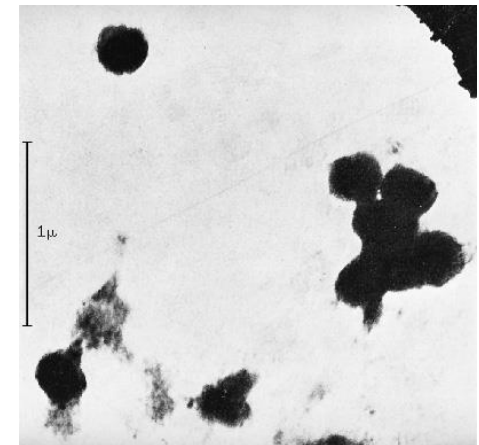


By the end of the 19th century, viruses were defined in terms of their infectivity, their ability to be filtered, and their requirement for living hosts, but...

... **they still could not be directly observed!**

(1930: invention of the *electron microscope*)

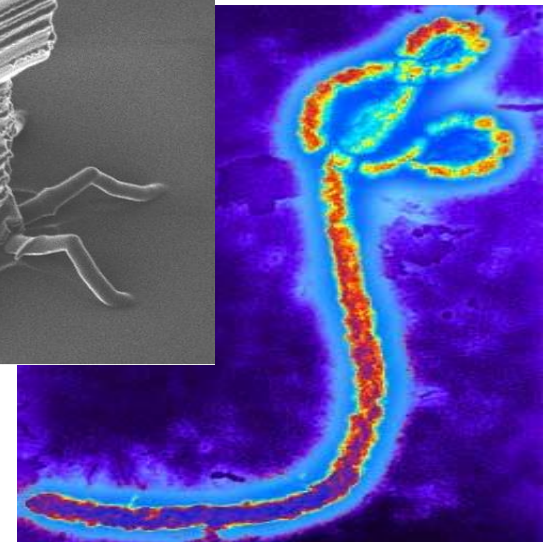
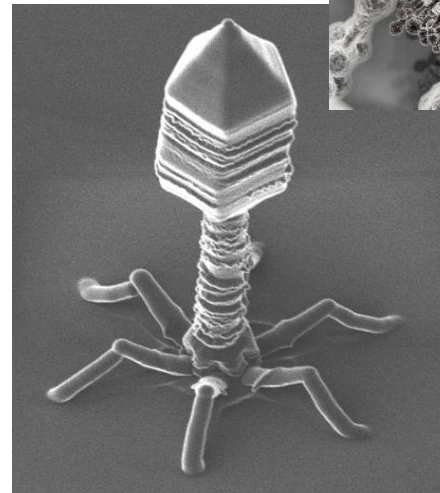
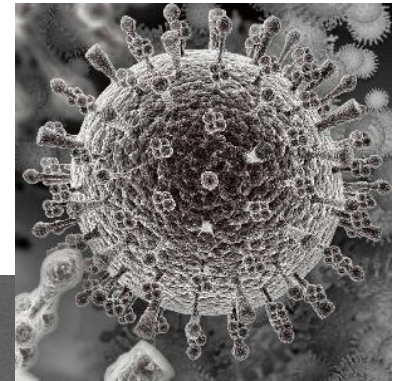
- **1931:** first images of viruses obtained using electron microscopy by German engineers Ernst Ruska and Max Knoll.



What are Viruses?

A virus is a **non-cellular biological particle** made of genetic material (DNA or RNA) and protein coat.

- From the Latin *vīrus* referring to poison.
- **Infect living cells** to **reproduce**.
- Capable of causing diseases.
- Co-exist with life everywhere.
- About 5,000 viruses have been studied and described in detail, although there are **millions of different types**.
- The **origin of viruses remains unclear** because they do not form fossils...



Virus Structure

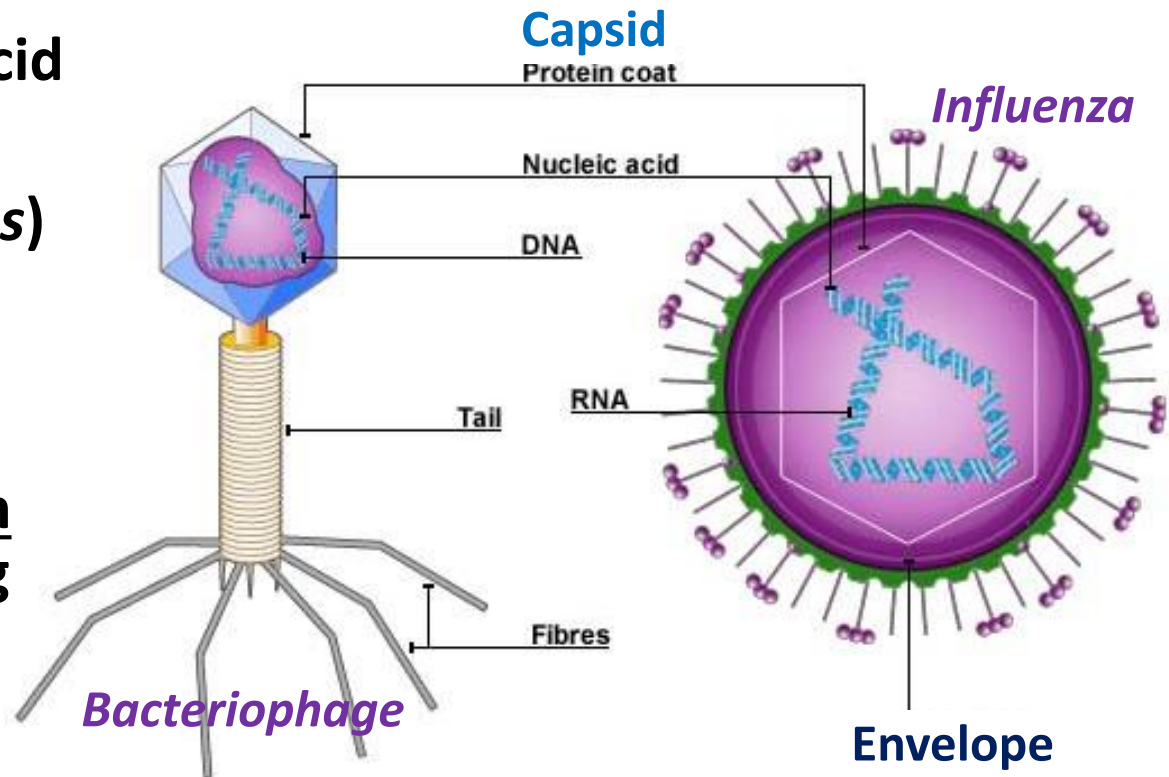
A virus particle, called a *virion*, consists of:

- **Genes** – nucleic acid

- DNA or
- RNA (*retroviruses*)
- But not both!

- **Capsid**

- a specific protein coat surrounding the nucleic acid



- (Optional) **Envelope**

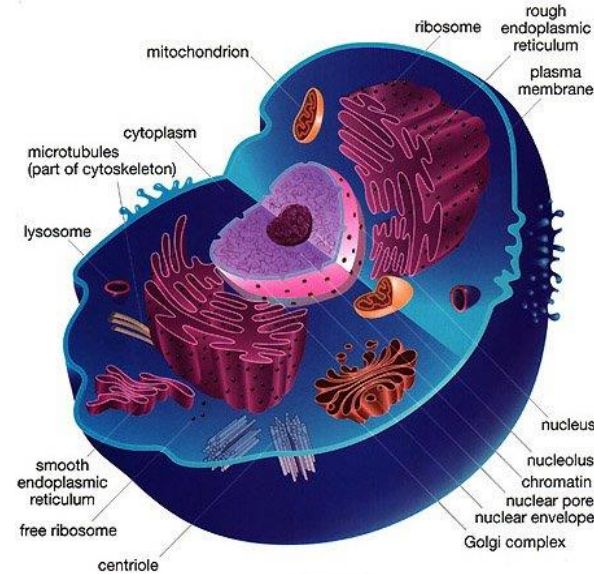
- some viruses are enclosed by a bubble of lipid (fat)

Viruses are NOT Considered Living

Viruses do not belong to any kingdom...



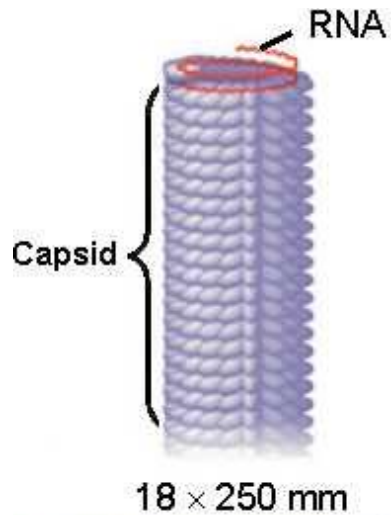
VS



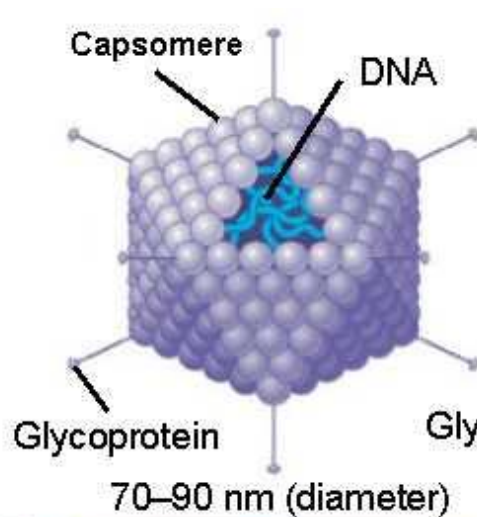
- Have no nucleus, no organelles, no cytoplasm or cell membrane.
- Can not carry out cellular functions – they are **not living cells**!
- Cannot reproduce outside the host cells: need to use the organelles and enzymes of the invaded cells.

Virus Shapes

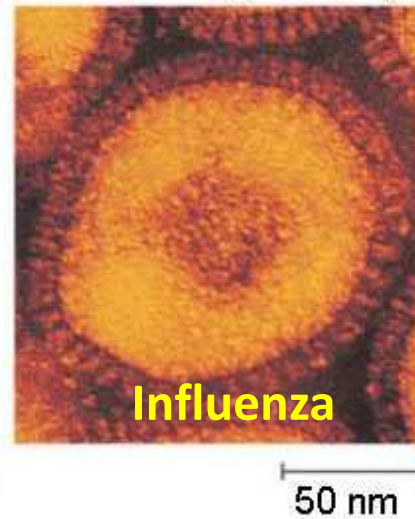
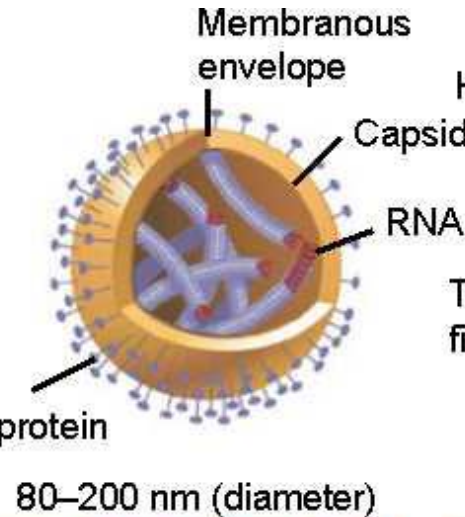
Helical



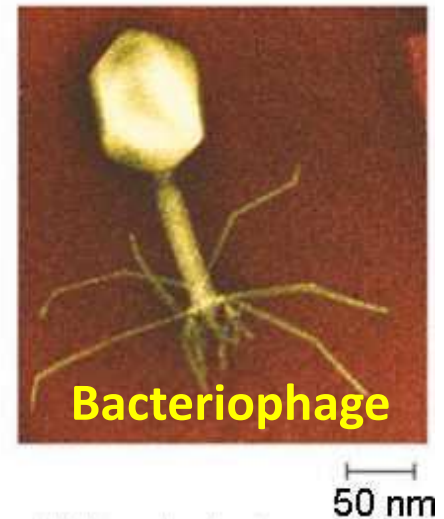
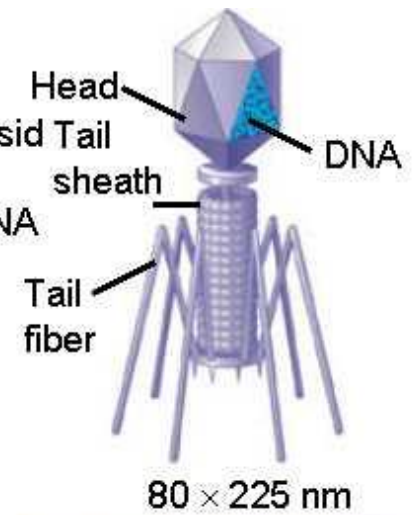
Polyhedral



Spherical



Complex



Scale Sense



Coronavirus (SARS-COV-2)
~60-140 nm



Adenovirus
90 nm



Bacteriophage T4
225 nm



Rhinovirus
30 nm



Bacteriophage M13
800 × 10 nm



Rabies virus
170 × 70 nm



Chlamydia elementary body
300 nm



Bacteriophages
f2, MS2
24 nm



Tobacco mosaic virus
250 × 18 nm



Viroid
300 × 10 nm



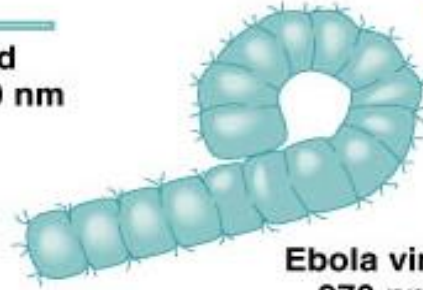
Poliovirus
30 nm



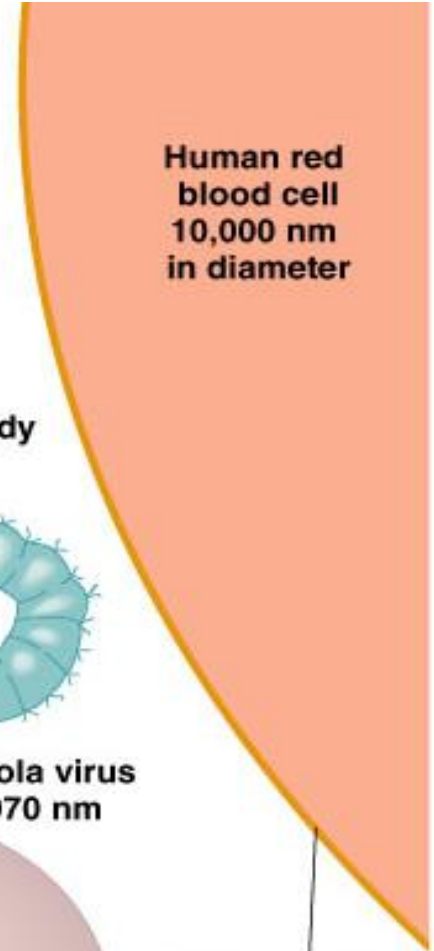
Prion
200 × 20 nm



Vaccinia virus
300 × 200 × 100 nm



Ebola virus
970 nm



Human red
blood cell
10,000 nm
in diameter

Most viruses

range in size from

20 nm to 300 nm;

some are almost 1 μm!

E. coli
(a bacterium)
3000 × 1000 nm

Plasma membrane
of red blood cell
10 nm thick