

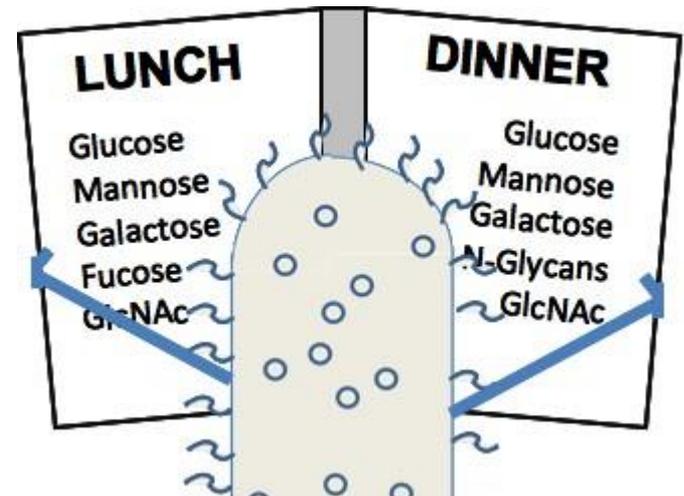
What do bacteria eat?

Autotrophic bacteria **create their own food**:

- Some make food from sunlight by **photosynthesis** - involves the use of *sunlight*, *carbon dioxide* and *water* to create energy and building materials.
- Other manufacture food through **chemosynthesis** - the process of using *water*, *carbon dioxide* and *other inorganic chemicals* like ammonia, sulfur, phosphorus, nitrogen, and metallic elements, to synthesize organic components.

Heterotrophic bacteria must **consume organic compounds**:

- They eat **other organisms** and absorb **dead organic material** from its surroundings.
- Some of these *parasitic* bacteria feed by **killing their hosts**, while others **coexist with or even help** their hosts.



How do bacteria digest food?

Bacteria employ extra-cellular digestion.

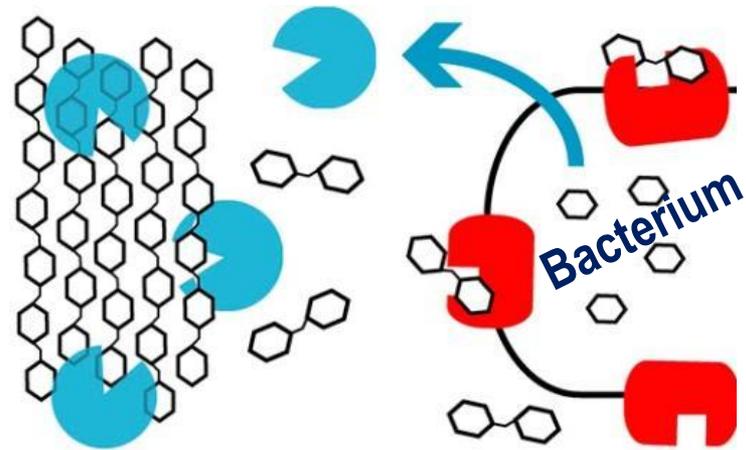
- Make proteins called *enzymes* inside the cell.

- Enzymes **travel through the cell wall** into the surrounding medium, **catch the food and break it down** into tiny subunits (most bacteria need *oxygen* to do it).

- Resulting simple compounds are **taken into** the bacteria cell.

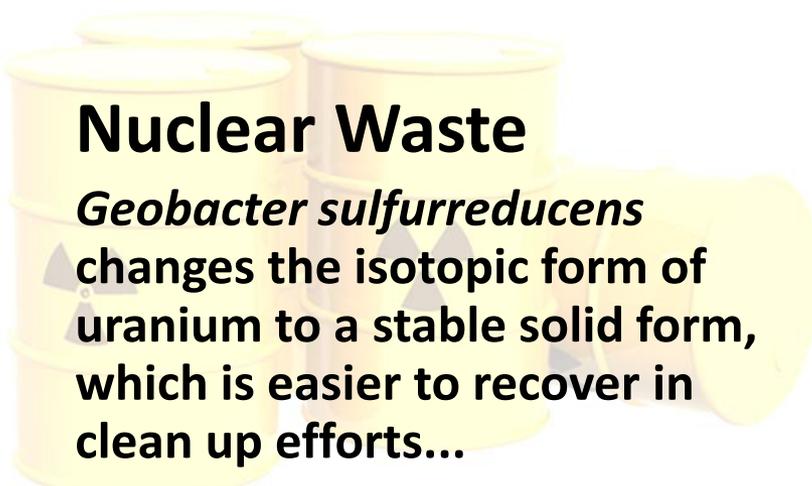
- Each specific food requires a specific enzyme:

- Some bacteria produce many kinds of enzymes and can eat many kinds of foods.
- Other bacteria have few enzymes and are able to digest very few kinds of food (however they can still live off a given food by growing where other bacteria have already broken the food down).



Unusual Foods

Nuclear Waste



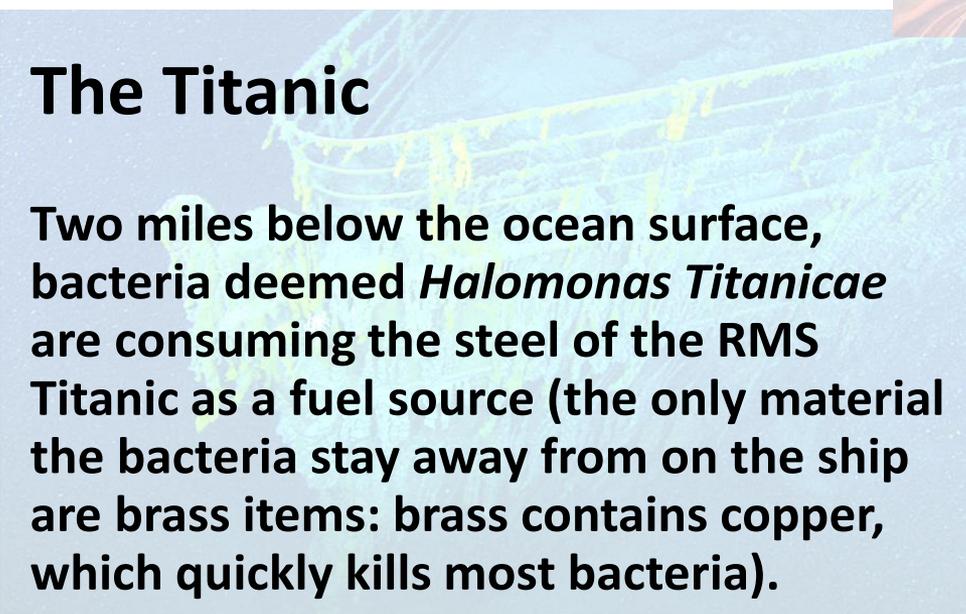
Geobacter sulfurreducens changes the isotopic form of uranium to a stable solid form, which is easier to recover in clean up efforts...

Crude Oil



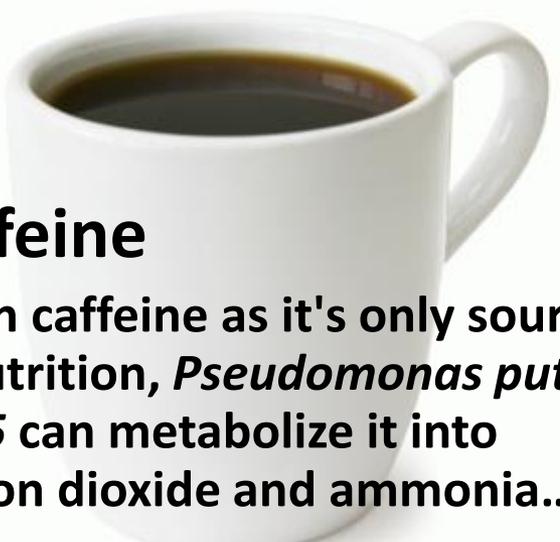
Several types of bacteria naturally consume oil (*Alcanivorax* naturally appeared and consumed oil plumes generated from the 2010 Deepwater Horizon spill), but an engineered form of *Pseudomonas putida* is capable of doing it in a very efficient manner!

The Titanic



Two miles below the ocean surface, bacteria deemed *Halomonas Titanicae* are consuming the steel of the RMS Titanic as a fuel source (the only material the bacteria stay away from on the ship are brass items: brass contains copper, which quickly kills most bacteria).

Caffeine

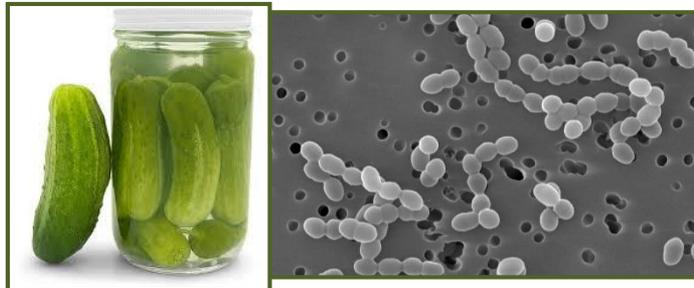


Given caffeine as it's only source of nutrition, *Pseudomonas putida* CBB5 can metabolize it into carbon dioxide and ammonia...

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.



- **Actinomycetes**: 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.



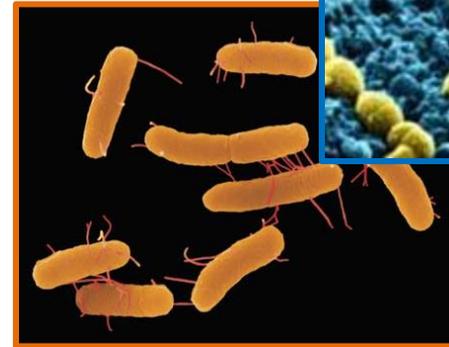
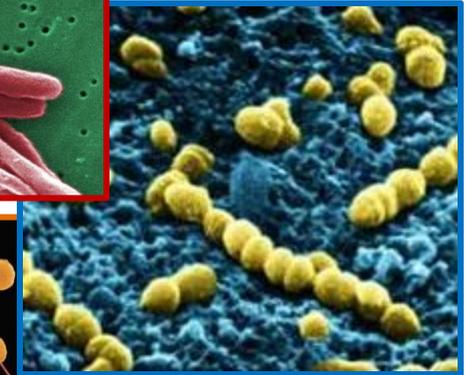
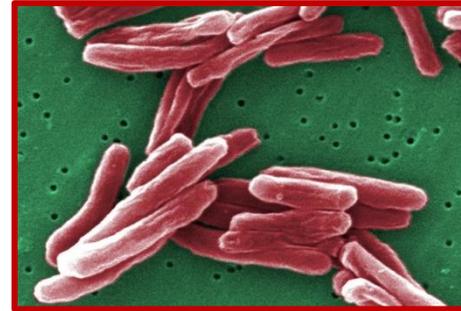
Illustration: Don Smith



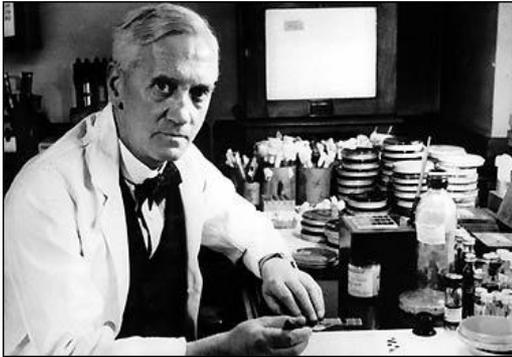
- How do they make us sick:
 - **Iron** competition.
 - **Direct damage** to host cells.
 - Production of **toxins** - poisonous substances that work by destroying particular parts of the host cell or by inhibiting certain metabolic functions (*release of toxins* after death of bacterial cells often 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

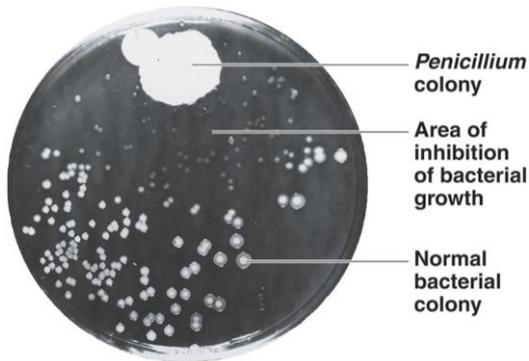
- Tuberculosis (*Mycobacterium tuberculosis*) still kills about 2 million people a year!
- Pneumonia can be caused by *Streptococcus* and *Pseudomonas*.
- Foodborne illnesses can be caused by *Shigella*, *Campylobacter*, and *Salmonella*.
- **Other:** tetanus, typhoid fever, diphtheria, syphilis, borelliosis and leprosy.
- **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

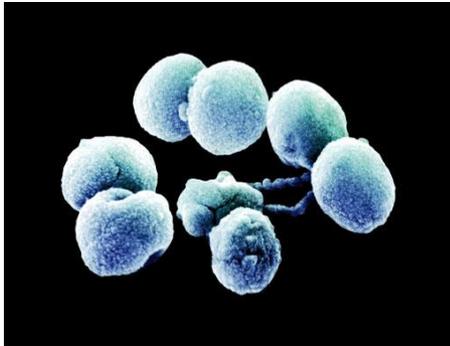
- A **fungus spore** that the wind might have blown into his lab while Fleming was on vacation in 1928, **forever changed the course of medicine...**
- **Fleming** observed that a number of disease-causing bacteria were killed by a fungus of the genus *Penicillium*.
- He **named the substance Penicillin** (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?

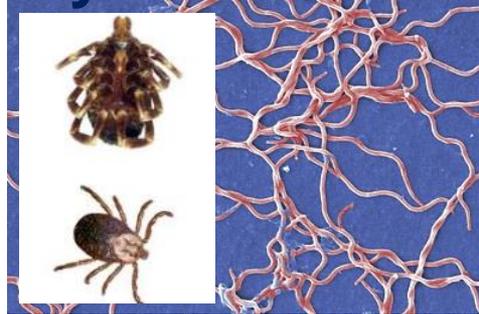
An antibiotic is given for the treatment of an infection caused by **bacteria**. However, **they are not effective against viruses**.

BACTERIAL

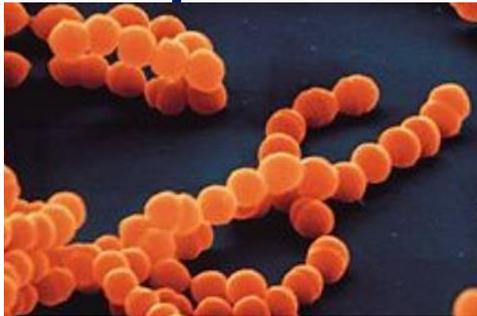
Pneumonia



Lyme Disease



Strep Throat



Ear Infection (Otitis)

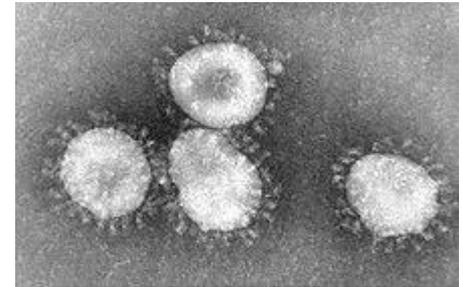


VIRAL

Flu (Influenza)



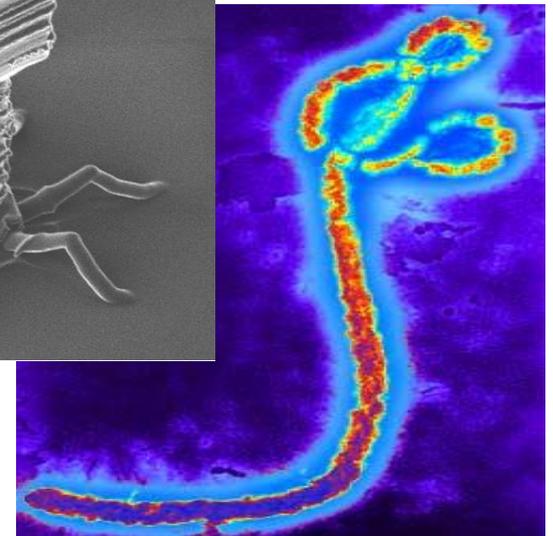
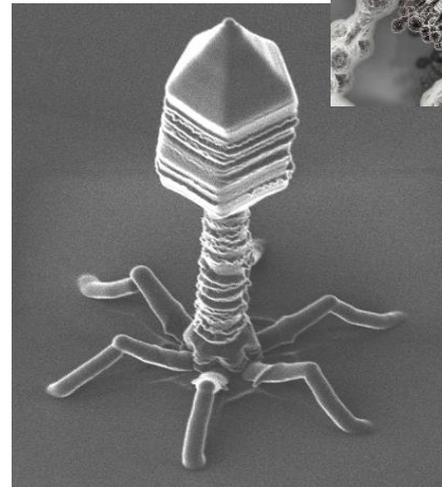
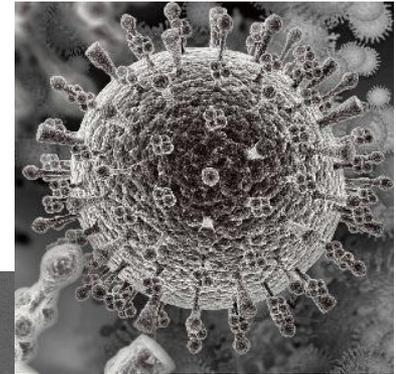
Common Cold



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

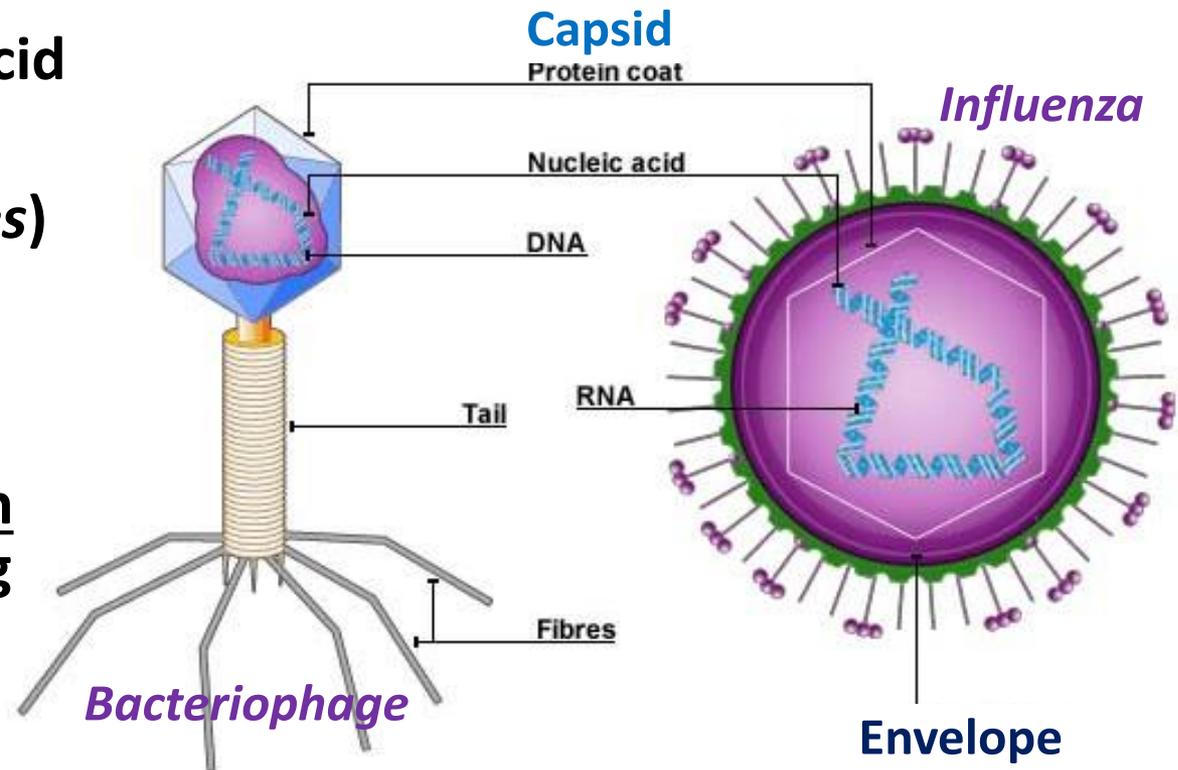
A virus particle, called a *virion*, consists of:

- **Genes** – nucleic acid

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

- **Capsid**

- a specific protein coat surrounding the nucleic acid

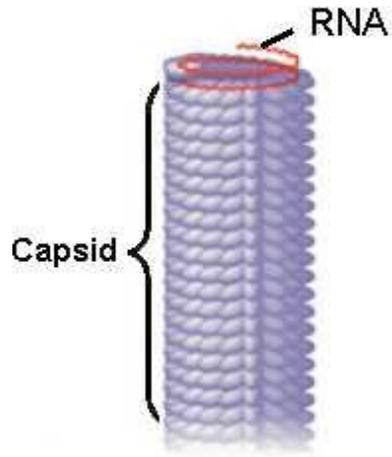


- **(Optional) Envelope**

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

Virus Shapes

Helical

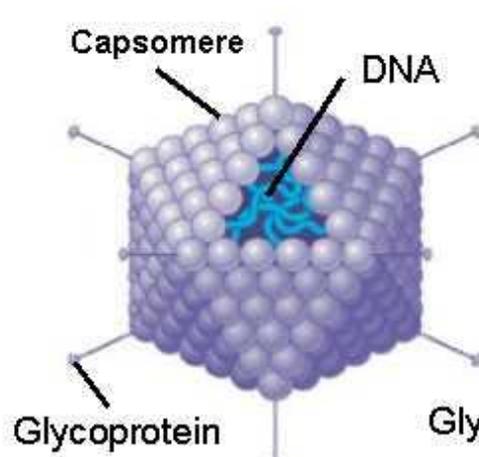


18 × 250 nm



20 nm

Polyhedral

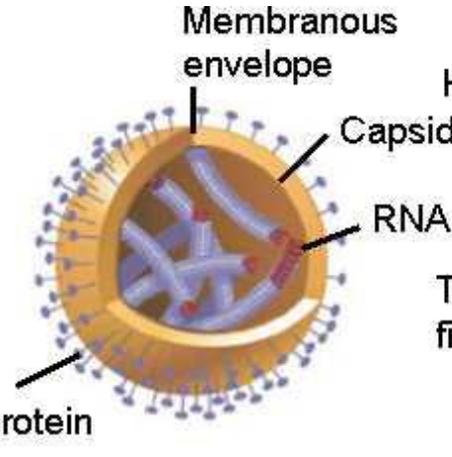


70–90 nm (diameter)

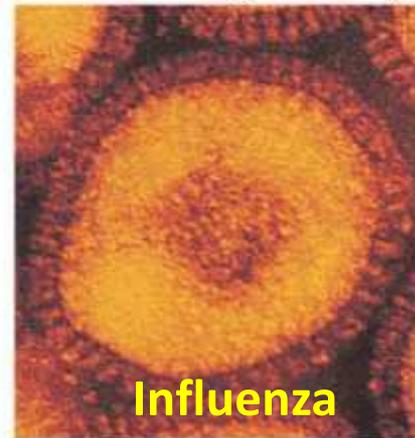


50 nm

Spherical

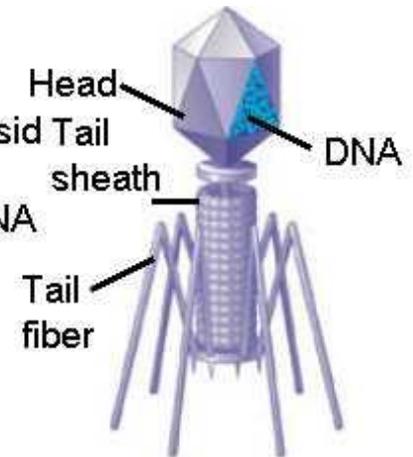


80–200 nm (diameter)

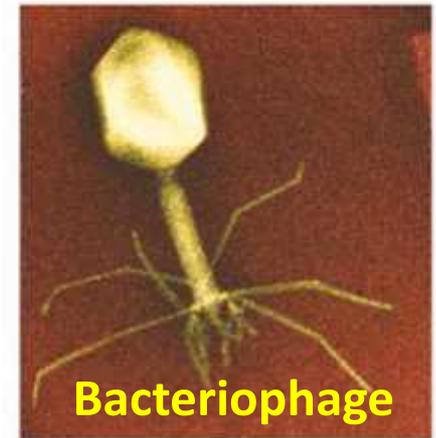


50 nm

Complex



80 × 225 nm



50 nm

Scale Sense



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



Adenovirus
90 nm



Bacteriophage T4
225 nm



Rabies virus
170 × 70 nm



Rhinovirus
30 nm



Bacteriophage M13
800 × 10 nm



Chlamydia elementary body
300 nm



Bacteriophages
f2, MS2
24 nm



Tobacco mosaic virus
250 × 18 nm



Viroid
300 × 10 nm



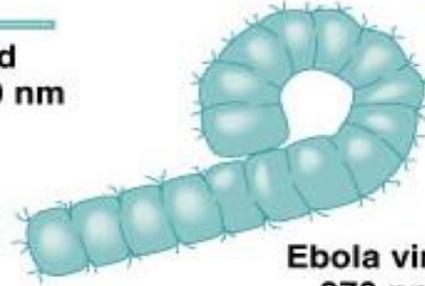
Poliovirus
30 nm



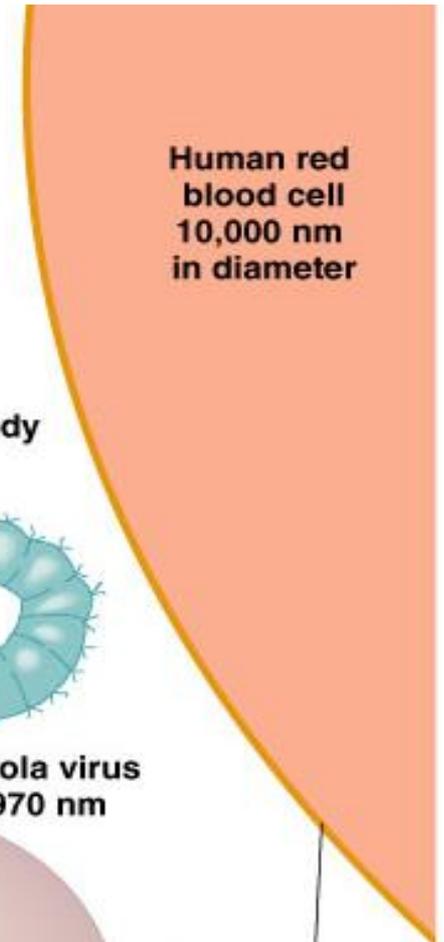
Prion
200 × 20 nm



Vaccinia virus
300 × 200 × 100 nm



Ebola virus
970 nm



Human red blood cell
10,000 nm in diameter

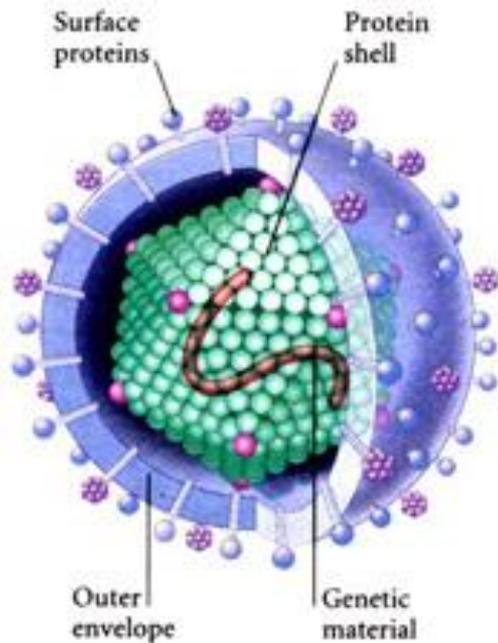
Plasma membrane of red blood cell
10 nm thick

E. coli
(a bacterium)
3000 × 1000 nm

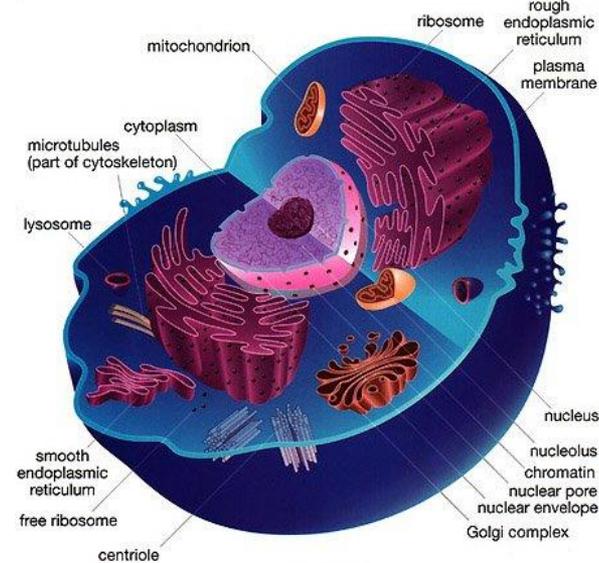
Most viruses
range in size from
20 nm to 300 nm;
some are almost 1 μm!

Viruses are NOT Considered Living

Viruses do not belong to any kingdom...



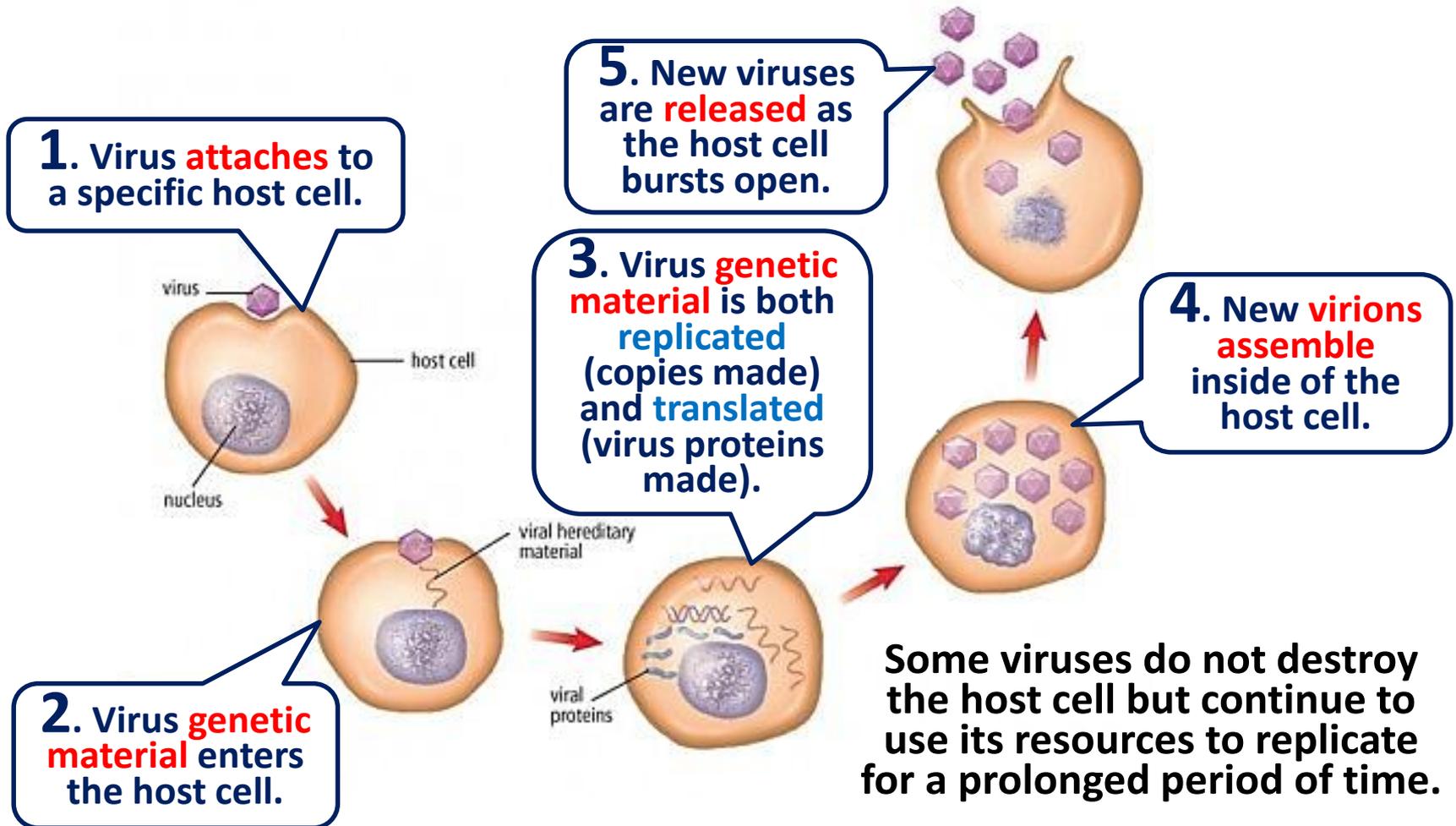
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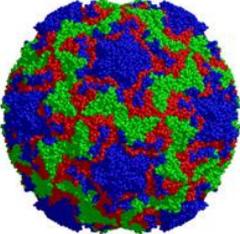
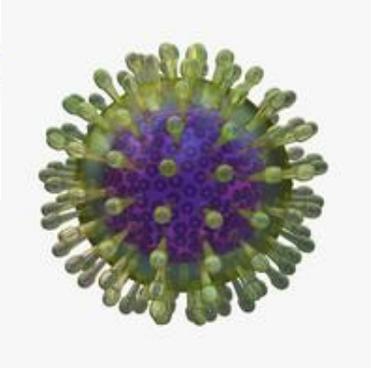
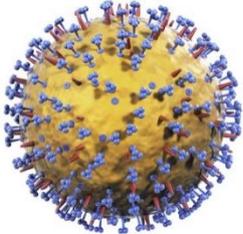
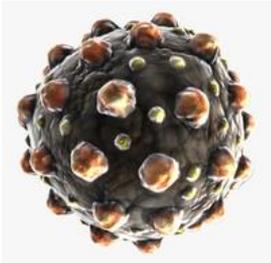
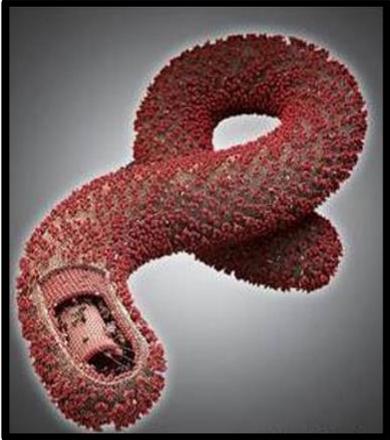
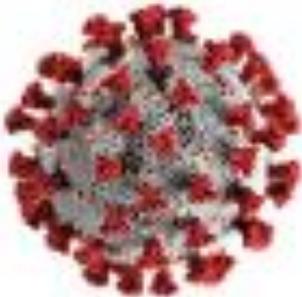


- Have no nucleus, no organelles, no cytoplasm or cell membrane.
- Can not carry out cellular functions – they are **not living cells!**
- Cannot reproduce outside the host cells: need to use the organelles and enzymes of the invaded cells.

Virus Replication

Viruses can **only reproduce inside the cells of living organisms**: invade living cells and force them produce many thousands of identical copies of the original virus.



DISEASE	VIRUS causing the illness	
Cold	Rhinovirus	 
Warts, Cold Sores	Herpes Simplex Virus	
Flu	Influenza	 
Measles	Morbillivirus	
Ebola	Ebolavirus	
COVID-19	Coronavirus	