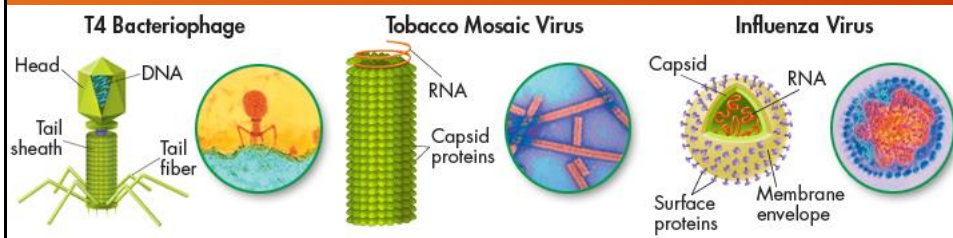




What is a virus?

- A **virus** is a non-living particle made up of nucleic acid, protein, and in some cases lipids.
 - They can replicate only by infecting living cells
 - 100% of viruses are pathogenic
 - Viruses are non-living!!!



Are Viruses Alive?

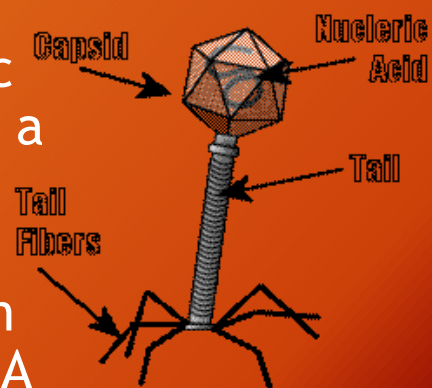
- Remember CHARGER!
- They are not made up of **cells**
- Cannot live independently outside of a **host**
- They don't do cellular respiration, grow or develop

Only after infecting a living cell:

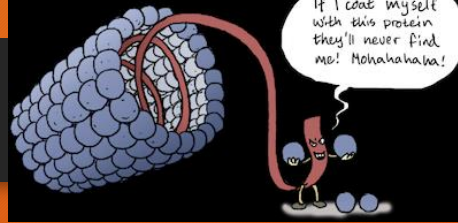
- They can **reproduce/replicate**
- Regulate **gene** expression
- Evolve/**mutate**

Structure of a Virus

- All viruses are composed of nucleic acids surrounded by a protein coating (capsid).
- The nucleic acid can be either DNA or RNA



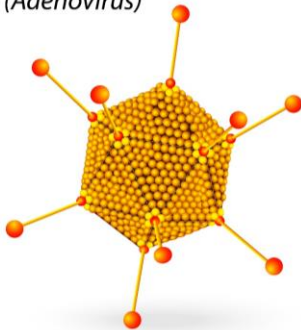
Capsids



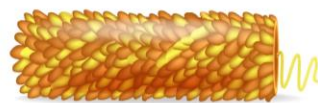
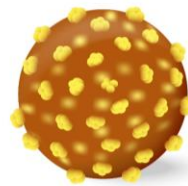
- A capsid is a virus's protein coat/shell
- Capsids serve 3 main functions:
 1. It protects the nucleic acid from digestion by enzymes
 2. Contains special sites that allow the virus to attach to a host cell
 3. Provides proteins that enable the virus to get through the host cell membrane

VIRAL SHAPES

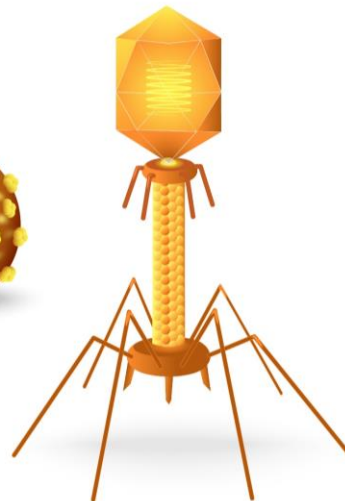
Polyhedral
(Adenovirus)



Spherical
(Influenza)



Helical
(Tobacco mosaic virus)



Complex
(Bacteriophage)

Viruses are specific

- The **structure and shape** (*morphology*) of viruses play an important role in how they work
- Each virus can only infect certain host cells because of their specific attachment **proteins**
- A virus identifies its host by fitting its surface proteins to receptor molecules on the host cell
 - It works like a lock & key!

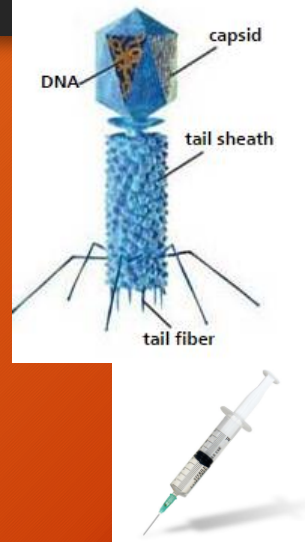
Bacteriophages

- **Bacteriophages** are viruses that infect bacteria
- The T-bacteriophage infects *E.coli* - (commonly found in the intestines of mammals)



Bacteriophages

- The tail and its spikes help attach the virus to the host cell
- Once attached, the tail releases an enzyme that breaks down part of the bacterial cell wall
- The tail core then punches through the cell wall, injecting the phage's DNA.
 - It works like a syringe!



Influenza

- Influenza virus attacks cells in the upper and lower respiratory system
- This virus can have either DNA or RNA as their nucleic acid
- Symptoms include: high fever, runny nose, sore throat, muscle pains & headaches



Retroviruses

- Contain **RNA** instead of DNA as their nucleic acid
 - HIV is a retrovirus
- It's called a retrovirus because genetic information is copied backwards
 - It produces a DNA copy from the RNA
- Reverse transcriptase is an enzyme carried in the capsid of a retrovirus that helps produce viral DNA from viral RNA
- The DNA is then integrated into the host cell's chromosome.

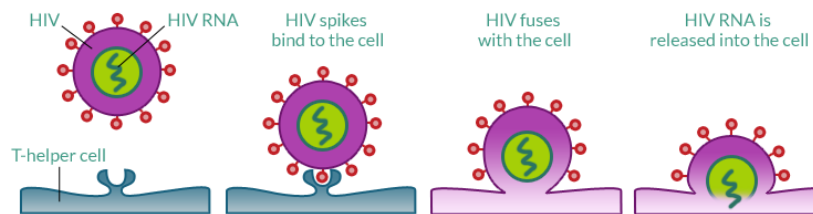
Retroviruses

- HIV (human immunodeficiency virus), some cancers, hepatitis, Ebola are caused by **retroviruses**
- HIV infects & destroys **helper T cells** in the immune system.
- HIV can incubate (*lysogenic*) for years before it becomes activated (*lytic*).
- AIDS - acquired immunodeficiency syndrome - infected people cannot fight off other diseases because the helper T cell count is SO low!

How does HIV enter cells?

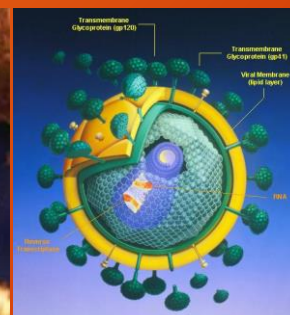
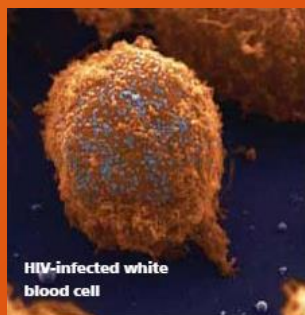
- Some viruses, like HIV, may enter cells by **endocytosis**
- If the viruses are enveloped, they can enter the host cell by fusing with its plasma membrane and releasing the capsid into the cell's cytoplasm

What HIV looks like



HIV- Infection of White Blood Cells

- Most people with an HIV infection eventually get AIDS because, over time, more white blood cells are infected and produce new viruses.
 - Viral DNA is propagated (spread) by the cell cycle!
- White blood cells are a part of the body's disease-fighting system. Their destruction interferes with the body's ability to protect itself from organisms that cause disease, a symptom of AIDS.



Ebola- Retrovirus



A hemorrhagic rash appears over entire body



KidneyADAM

- The incubation period: 2 to 21 days.

- Onset is abrupt and is characterized by:

- Fever, headache, joint and muscle aches, sore throat, and weakness, followed by diarrhea, vomiting, and stomach pain. A rash, red eyes, hiccups and internal and external bleeding may be seen in some patients.

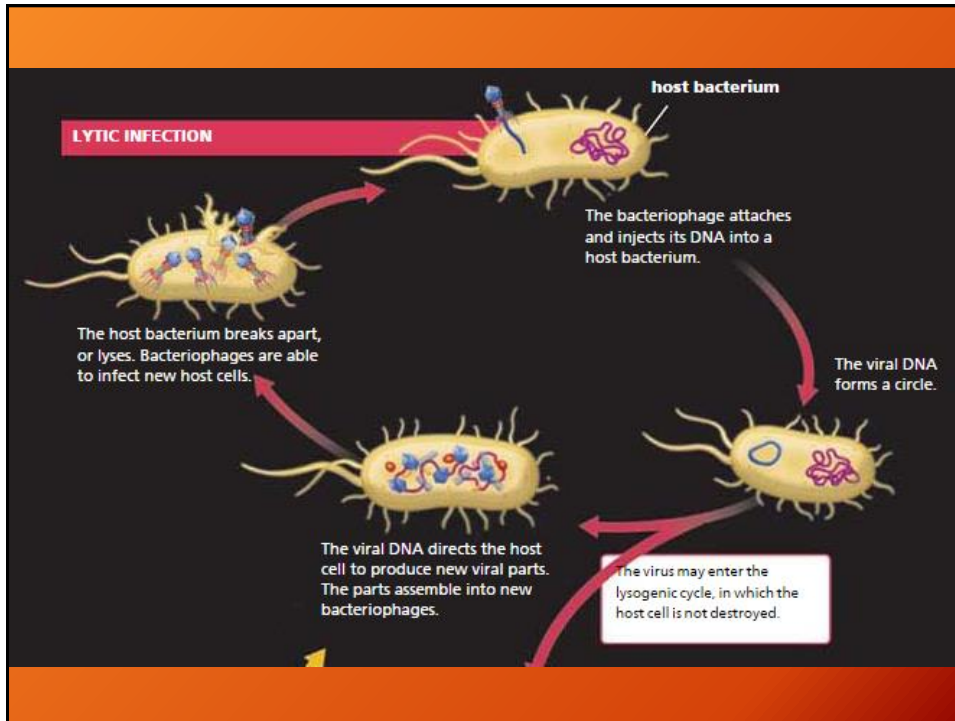


Two Types of Infections

- Once inside the host cell, phages follow one of two general paths in causing disease
- Path 1-(Lytic): Phage will act like a bad houseguest
 - It takes over the household, eats all the food and then blows up the house when it leaves
- Path 2-(Lysogenic): More subtle
 - Instead of destroying the house, the phage becomes a permanent guest.

Lytic Infection

1. Once inside, the virus takes control of the host cell's DNA
 - It'll turn on the genes necessary to copy the viral genes
2. Under direction of the viral genes, the host's DNA undergoes transcription & translation and produces capsids and enzymes
3. The enzymes then help in copying the viral DNA
4. The capsids and viral DNA assemble into new viruses
5. Viral enzymes dissolve the cell membrane and release the new viruses into the bloodstream of the host



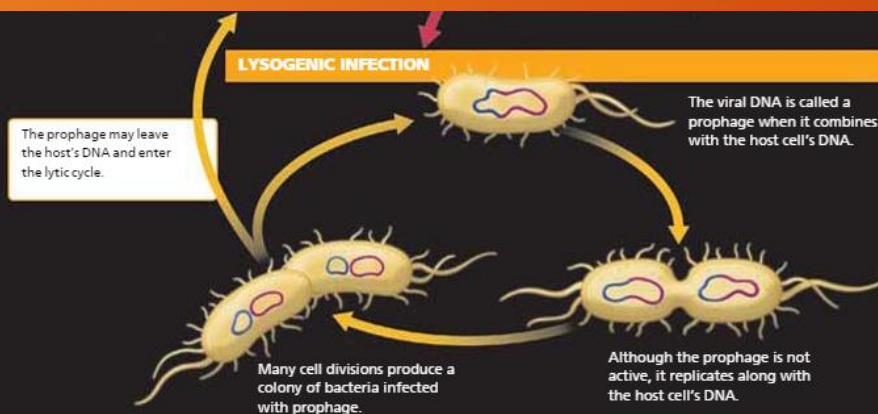
Lysogenic Infection

- Viral replication cycle in which a virus's nucleic acid is integrated into a host cell's chromosome.
- Virus remains **inactive (dormant)** for a period of time.
- The host cell is not killed until the **lytic** cycle is activated.

Lysogenic Infection

- After entering the host cell, the viral DNA combines with the host's DNA. This forms a new set of genes called a **prophage**.
- This prophage is copied and passed to daughter cells, with the host's own DNA, when the host cell undergoes mitosis.
- This process doesn't destroy the host cell, but it can change the cell's traits.

Lysogenic Infection

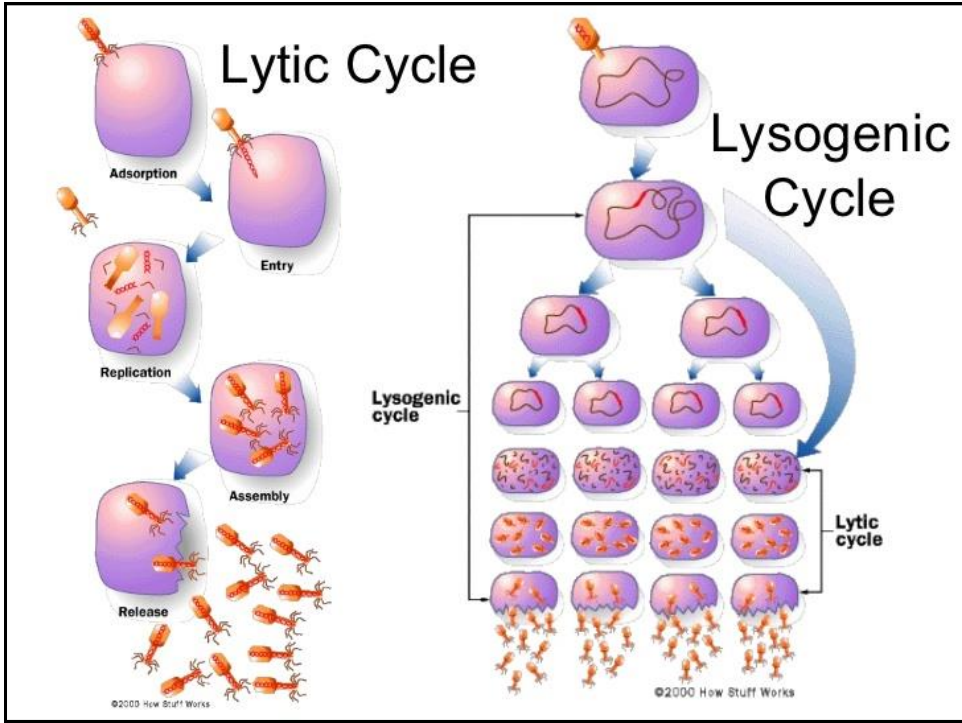


Lysogenic Infection

- After the cell has been copied, the prophage faces two possible paths.
 - 1. A trigger, such as stress, can activate the prophage to enter the lytic cycle, which then uses the cell to produce new viruses.
 2. If the prophage is not activated, it can remain as a permanent gene (it stays dormant).

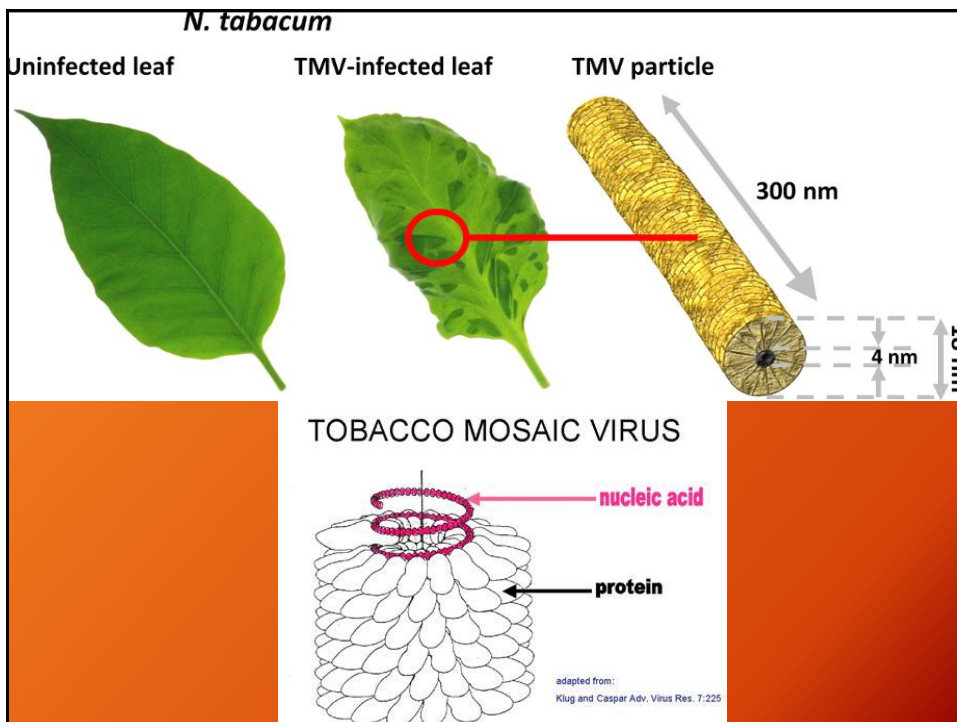
Lysogenic Infection

- Once the lytic cycle is activated, sickness can ensue in sometimes as fast as 30 minutes
 - These symptoms exist due to the popping of cells and the resulting immune response
 - Examples: Common cold, influenza, measles, polio
 - You can develop an immunity after a lytic cycle



Viroid

- **Viroids** are infectious particles that cause disease in plants
- They are made of single-stranded RNA without a protein coat
- They are passed through seeds or pollen
- They have a major impact on agriculture because they can stunt the growth of plants



Prions

- A prion is an infectious particle made only of proteins that can cause other proteins to fold incorrectly.
- When proteins misfold, the protein will not work properly.
 - They have no genetic material.
- Prions play a part in certain diseases of the brain such as mad cow disease (bovine spongiform encephalopathy).
- Humans become infected with BSE when they eat meat from animals that are infected.
- Prion diseases can incubate for a long time with no effect on their host. However, once symptoms appear, they worsen quickly and are always fatal
 - This is because the body has no immune response against a protein.

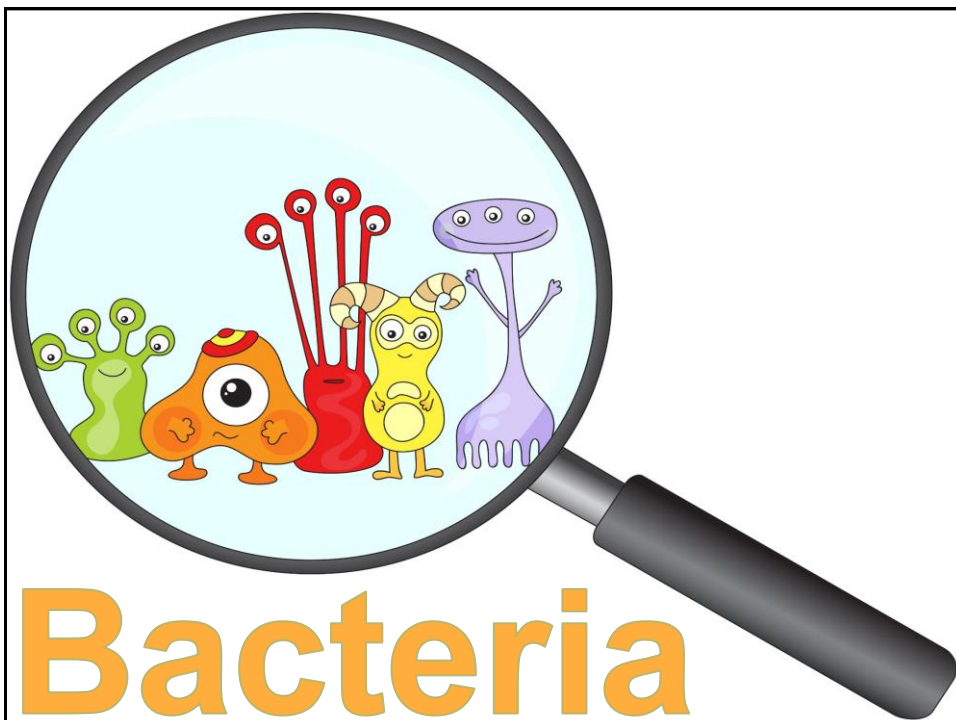
Vaccines

Vaccines are used to **prevent** viral infections

- Vaccines are made with weakened versions of the virus, or parts of the virus, that will cause the body to produce an immune response
- This help's prepare the host's immune system for a future attack

Treating Viruses

- Antibiotics are **ineffective** against viral infections because antibiotics interfere with metabolic processes that viruses do not perform.
 - Remember, viruses are **NON-LIVING!!**
- **Anti-virals** are used to treat viruses
 - Unlike most antibiotics, antiviral drugs do not destroy their target pathogen; instead they inhibit their development.
 - They work by targeting proteins not found in host cells, but found in the viral particles

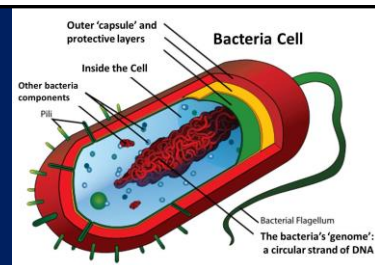


Bacteria are everywhere!

- Bacteria can be found in and on your own body!
- The relationship between you and the microorganisms in your body is usually mutually beneficial.
- Under certain conditions, these microorganisms can cause disease.

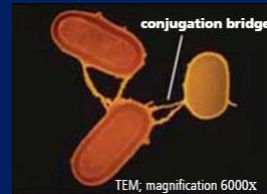
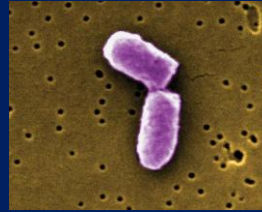
Bacteria

- Prokaryotic- lack a **nucleus**
- Microscopic
- **Unicellular**
- Motile
 - **Flagella**- whip-like tail
 - **Cilia**- short, thin, hair-like projection
- Cell membrane & cell wall present
- Classified into two Kingdoms:
 - **Eubacteria**
 - **Archaeobacteria**



Growth & Reproduction

- Prokaryotes reproduce by a type of cell division called **binary fission** (division in half)
 - Makes 2 identical daughter cells
 - Does not involve the exchange or recombination of genetic information = asexual reproduction
- Although prokaryotes reproduce asexually, they are still able to exchange genetic material in several ways.
 - Bacterial cells such as *E. Coli* transfer pieces of genetic material in a process called **conjugation**
 - A hollow bridge forms between 2 bacterial cells & genes move from one cell to the other
 - Increases genetic diversity in populations of bacteria



Surviving Harsh Conditions

- During conditions unfavorable for survival some bacteria can produce an **endospore**, a specialized cell with a thick, protective wall.
- To form an **endospore**, the bacteria copies its chromosome and produces a wall around the copy
- This thick wall around the bacterial DNA helps it survive harsh conditions like:
 - Drying out
 - Temperature change
 - Disinfectants
- Endospores can last for centuries!

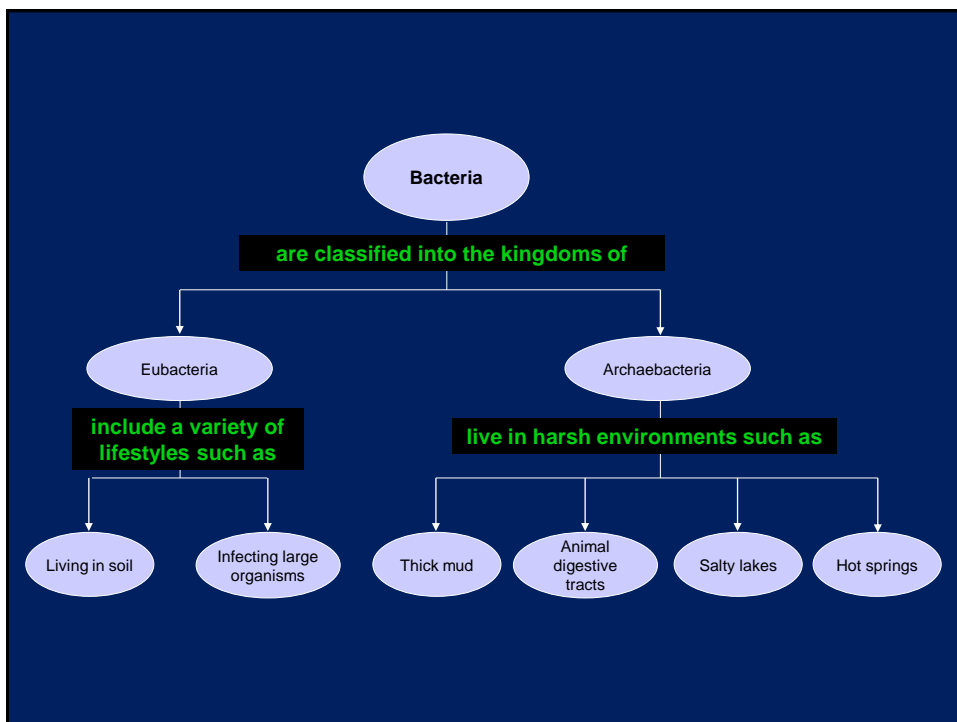
Prokaryotic Kingdoms

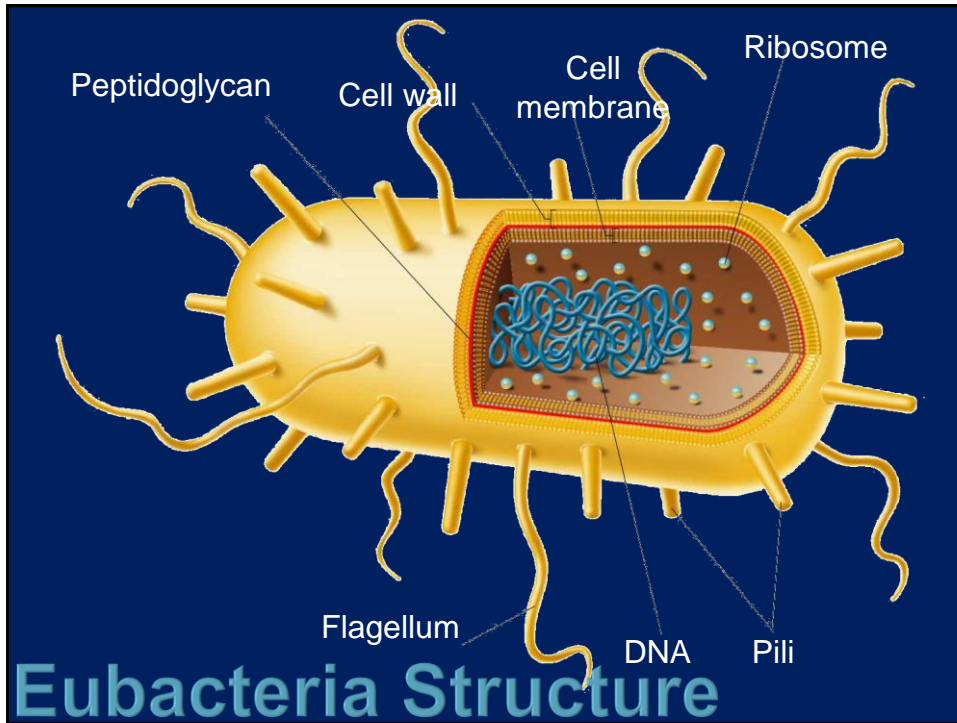
Archaeobacteria

- Old, ancient
 - Cell wall **NOT** made of peptidoglycan
 - Live mostly in **extreme** environments

Eubacteria

- True bacteria
 - Cell wall made of **peptidoglycan**
 - Live almost **everywhere**
 - Most numerous





Metabolic Diversity

- **Chemoheterotrophs**- heterotrophic prokaryotes that must take in organic molecules for both energy and a supply of carbon
- **Photoheterotrophs**- photosynthetic, using sunlight for energy, but they also need to take in organic compounds as a carbon source
- **Photoautotrophs**- use light energy to convert carbon dioxide and water to carbon compounds and oxygen through photosynthesis
 - Found where light is plentiful (near surfaces of lakes, streams, etc)
 - Ex: **cyanobacteria**- found throughout world in fresh and salt water, even on land; they are often the very first species to recolonize the site of a natural disaster such as a volcanic eruption
- **Chemoautotrophs**- make organic carbon molecules from carbon dioxide
 - Do not require light as a source of energy
 - Use energy directly from chemical reactions involving ammonia, hydrogen sulfide, nitrites, sulfur or iron
 - Some live deep in the darkness of the ocean near volcanic vents

Bacteria & Oxygen

- **Obligate aerobes**- organisms that require a constant supply of oxygen in order to live
 - “Obligate” means the organisms are obligated, or required, by their life processes to live only in that particular way
 - Ex: *Mycobacterium tuberculosis*- the bacterium that causes tuberculosis
- **Obligate anaerobes**- must live in absence of oxygen
 - Ex: *Clostridium botulinum*- found in soil and can grow in canned food that has not been properly sterilized
- **Facultative aerobes**- can survive with or without oxygen; can live just about anywhere
 - Ex: E. Coli

Bacteria are Beneficial

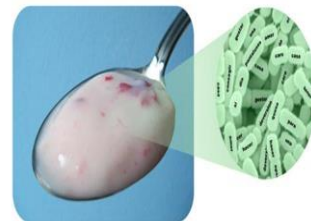
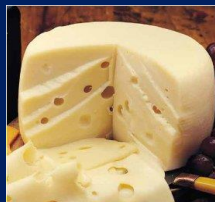
- Bacteria are a key part of animal digestive systems
 - A balanced community of bacteria in our bodies is important for our health
 - Bacteria and animals they live inside of have a **mutualistic** relationship
 - Bacteria help **break down** food while getting a place to live
- Bacteria also make **vitamins** and other compounds and keep away harmful microbes by filling **niches** that might otherwise be filled by disease-causing bacteria

Importance of Bacteria

- Bacteria are vital to maintaining the living world.
 - Some are **producers** that capture energy by photosynthesis (cyanobacteria).
- **Benefits:** microorganisms recycle nutrients
 - Others are **decomposers**- break down the organic matter of dead plants and animals- this frees carbon, hydrogen, phosphorus, nitrogen & other nutrients for use by living organisms
 - **Lives, secretes enzymes into & consumes dead organic matter without oxygen = decomposer**
 - Some types of bacteria that inhabit the ocean floor feed on **oil** that seeps from the ground- this prevents the leaking oil from building up in the oceans and damaging the ecosystem

Bacterial Uses

- Bacteria are used to make some food products such as **cheese and yogurt**
- Archaeobacteria can be used to purify **water** in sewage systems and after oil spills
- Used to **add flavors** and aromas in the production of food
 - Pickles, soy sauce, vinegar, etc.
- Used to **increase crop yields** (how much produced)
- **Probiotics**- bacteria you take as dietary supplement to help with digestion- many bacteria live in our digestive system and are considered normal flora
- Mine minerals from the ground



Bacterial Diseases in Humans

- **Pathogens**- cause disease in a host
- Bacteria produce disease in one of two general ways
 1. Damage **cells** and tissues. Ex: **strep throat, tuberculosis, bubonic plague**
 - Tuberculosis- infection in lungs, breathing in air, can be dormant for years
 - Bubonic plague- carried by rodents, spread by fleas, infects lymph nodes, flu like symptoms
 2. Produce **toxins**. Ex: **Salmonella, botulism**
 - Botulism- improperly canned foods, entered through wounds, releases toxins

Some Human Bacterial Diseases

Disease	Effect on Body	Transmission
Lyme Disease	Bull's-eye rash at site of tick bite, fever, fatigue, headache	Ticks transmit the bacterium
Tetanus	Lockjaw, stiffness in neck & abdomen, difficulty swallowing, fever, elevated blood pressure, severe muscle spasms	Bacteria enter the body through a break in the skin
Tuberculosis	Fatigue, weight loss, fever, night sweats, chills, appetite loss, bloody sputum from lungs	Bacterial particles are inhaled
Bacterial Meningitis	High fever, headache, stiff neck, nausea, fatigue	Bacteria are spread in respiratory droplets caused by coughing & sneezing
Strep Throat	Fever, sore throat, headache, fatigue, nausea	Direct contact w/mucus from infected person or direct contact with infected wounds or breaks in skin

Preventing Bacterial Diseases

- **Antibiotics**: compounds that block the growth and reproduction of bacteria. Antibiotics work only on **BACTERIAL diseases**! (do NOT work on viral infections).
- Antibiotics do not work on viral infections because antibiotics interfere with metabolic processes that viruses do not perform
- Some antibiotics cause patients to exhibit digestive side effects- this is most often the result of bacteria being killed in the digestive tract

Remember! Always be sure to finish your full dose of antibiotics to prevent bacterial resistance to the antibiotic



Controlling Bacteria

There are various methods used to control bacterial growth:

- Sterilization: exposure to **high heat**
- Disinfectants: **chemical** solutions that kill bacteria.
 - Ex: **soaps and cleaners**
- Food Processing: **canning**, using chemicals (preservatives)
- Storing food in a refrigerator