Bacteria outline-- CHAPTER 19

- **Bacteria**

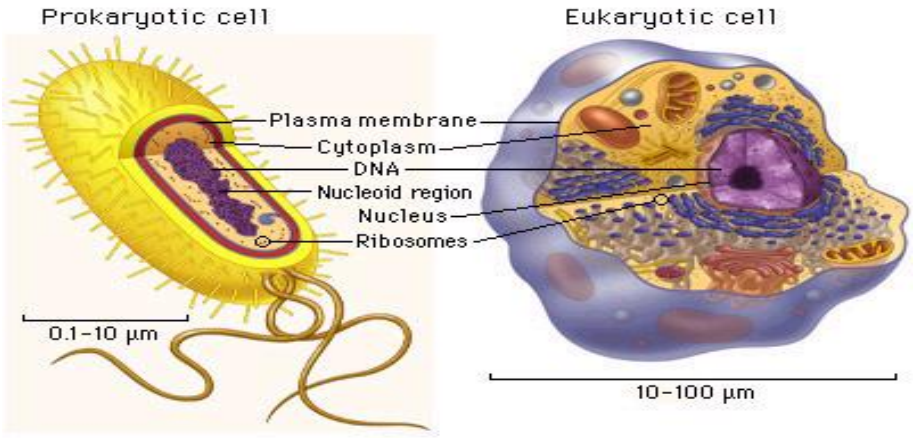
Structure and Function

- Prokaryote & Eukaryote Evolution

Cellular Evolution

- Current evidence indicates that eukaryotes evolved from prokaryotes between 1 and 1.5 billion years ago

- Two theories:
  1. Infolding theory
  2. Endosymbiotic theory
- Infolding Theory
  - The infolding of the prokaryotic plasma membrane gave rise to eukaryotic organelles.
- Endosymbiotic Theory
  - Endosymbiosis refers to one species living within another(the host)
  - Movement of smaller photosynthetic & heterotrophic prokaryotes into larger prokaryotic host cells
  - Formed cell organelles
- Prokaryotic & Eukaryotic Cells



- Earliest Prokaryotes
  - Most numerous organisms on Earth
  - Include all bacteria
  - Earliest fossils date 2.5 billion years old
- Classification of Life
  - Three Domains of Life
    - Archaea – prokaryotes living in extreme habitats
    - Bacteria- Cyanobacteria and eubacteria
    - Eukarya – Protozoans, fungi, plants, & animals
  - Kingdoms of Bacteria

Archaebacteria:

- ✓ Found in harsh environments
- ✓ Undersea volcanic vents, acidic hot springs, salty water

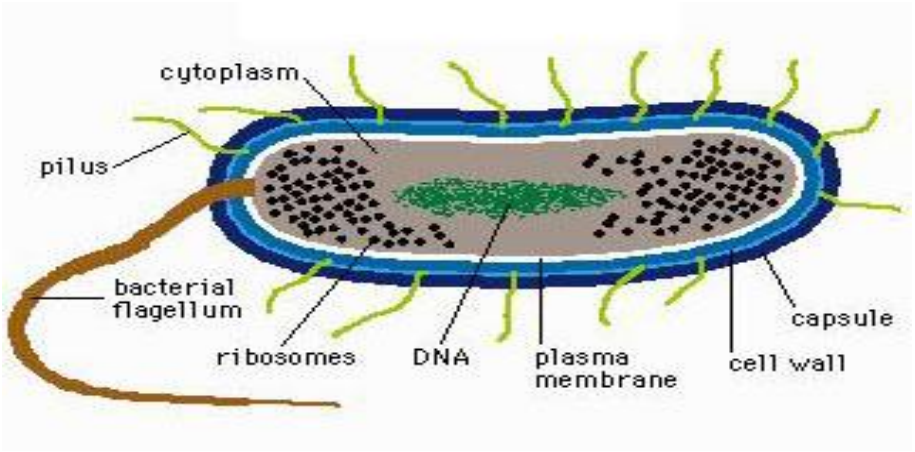
Eubacteria:

- ✓ Called the true bacteria
- ✓ Most bacteria are in this group
- ✓ Include photosynthetic Cyanobacteria

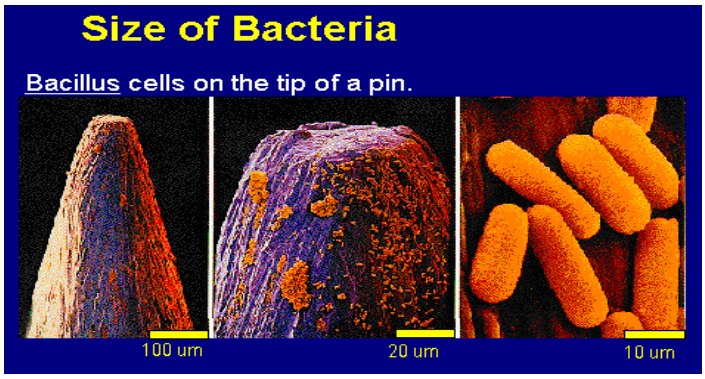
Characteristics of Bacteria

- Bacterial Structure

- Microscopic prokaryotes
- No nucleus or membrane-bound organelles
- Contain ribosomes
- Single, circular chromosome in nucleoid region

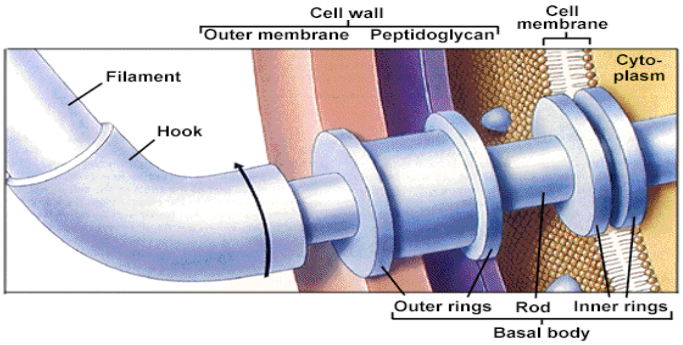


- Protection
  - Cell Wall made of Peptidoglycan
  - May have a sticky coating called the Capsule for attachment to host or other bacteria
  - Sticky Bacterial Capsule
- Bacterial Structure
  - Have small rings of DNA called Plasmids
  - Unicellular
  - Small in size (0.5 to 2µm)



- Bacterial Structure
  - Infoldings of cell membrane carry on photosynthesis & cellular respiration
  - Infoldings called Mesosomes
- Bacterial Structure
  - Most grow best at pH of 6.5 to 7.0
    Many act as decomposers recycling nutrients
  - Some cause disease
    - Staphylococcus Bacterial (aka --Staph infection)
- Useful Bacteria
  - Industry--Some bacteria can degrade oil, Used to clean up oil spills
    - Clean poison, wastes from water
    - Mine minerals from the ground
  - Food, beverages--Other uses for bacteria include making yogurt, cheese, and buttermilk.
  - Agriculture--Nitrogen fixers
  - Synthesize drugs through genetic engineering—insulin
  - Decomposers—like we saw in food web

- Flagella
    - Bacteria that are motile have appendages called flagella
    - Attached by Basal Body



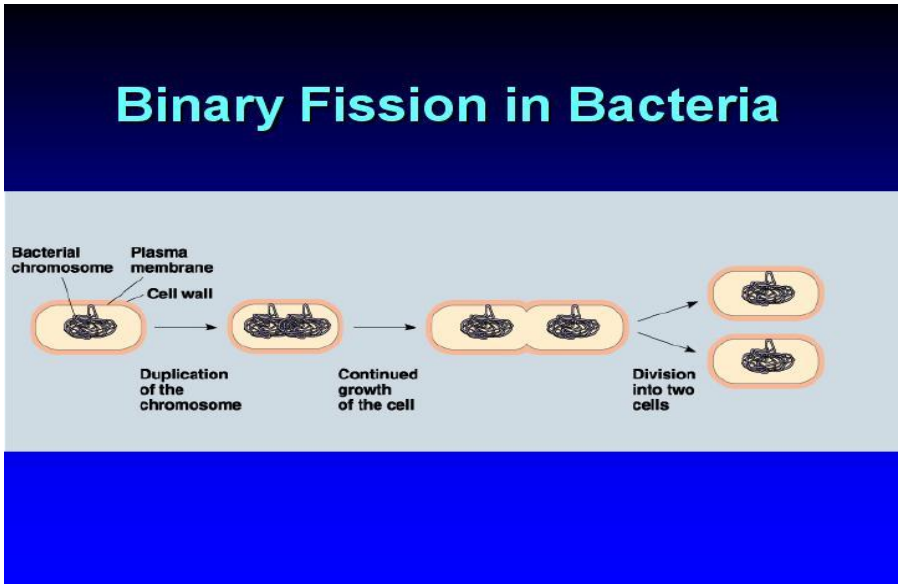
    - A bacteria can have one or many flagella
    - Made of Flagellin
    - Used for Classification
        - Monotrichous: 1 flagella
        - Lophotrichous: tuft at one end
        - Amphitrichous: tuft at both ends
        - Peritrichous: all around bacteria
- Pili
    - Short protein appendages
    - Smaller than flagella
    - Adhere bacteria to surfaces
    - Used in conjugation for Exchange of genetic information
    - Aid Flotation by increasing buoyancy
- Pili in Conjugation
- Bacterial Shapes
    - Shapes Are Used to Classify (DRAW shapes next to bacteria type)
        - Bacillus: Rod shaped
        - Coccus: Spherical (round)
        - Vibrio: Comma shaped with flagella
        - Spirillum: Spiral shape
        - Spirochete: wormlike spiral shape
- Grouping of Bacteria
    - Diplo- Groups of two
    - Strepto- chains
    - Staphylo- Grapelike clusters
        - Diplococcus
        - Staphylococcus
        - Streptobacilli
        - Spirillum
        - Spirochetes
        - *Leptospira*
- Bacterial Kingdoms
    - Archaebacteria
        - Lack peptidoglycan in cell walls
        - Have different lipids in their cell membrane
        - Different types of ribosomes
        - Very different gene sequences

        - Archaebacteria can live in extremely harsh environments
        - They do not require oxygen and can live in extremely salty environments as well as extremely hot environments
        - Called the Ancient bacteria
        - Subdivided into 3 groups:
            - ✓ Methanogens
            - ✓ Thermoacidophiles
            - ✓ Extreme Halophiles
- Methanogens
    - Live in anaerobic environments (no oxygen)
    - Get energy by changing H_2 & CO_2 into methane gas
    - Found in swamps, sewage treatment plants, digestive tracts of animals
    - Break down cellulose in a cow's stomach
    - Produce marsh (methane) gas
- Extreme Halophiles
    - Live in very salty water
    - Use salt to generate ATP (energy)
    - Dead Sea, Great Salt Lake inhabitants
- Thermoacidophiles or Thermophiles
    - Live in extremely hot environments
    - Found in volcanic vents, hot springs, cracks on ocean floor that leak acid
- Kingdom Eubacteria—True bacteria (See p 472, FIGURE 19-2 in book)
    - Characteristics
        - 3 basic shapes (coccus, bacillus, spirilla)
        - Most are heterotrophic (can't make their own food)
        - May be aerobic or anaerobic
        - Identified by Gram staining
- Gram Staining
    - Developed in 1884 by Hans Gram
    - Bacteria treated with purple Crystal Violet & red Safranin stains
    - Cell walls either stain purple or reddish pink
- Gram Positive
    - Have thick layer of peptidoglycan (protein-sugar complex)
    - Single lipid layer
    - Stain purple
    - Can be treated with antibiotics
- Gram Positive Bacteria
    - ✓ Lactobacilli (makes yogurt & buttermilk)
    - ✓ Actinomycetes (make antibiotics)
    - ✓ Clostridium (lockjaw bacteria)
    - ✓ Streptococcus (strep throat)
    - ✓ Staphylococcus (staph infections)
- Gram Negative Bacteria
    - Thin layer of peptidoglycan in cell wall
    - Extra thick layer of lipids
    - Stain pink or reddish
    - Hard to treat with antibiotics
    - Some photosynthetic but make sulfur not oxygen
    - Some fix nitrogen for plants

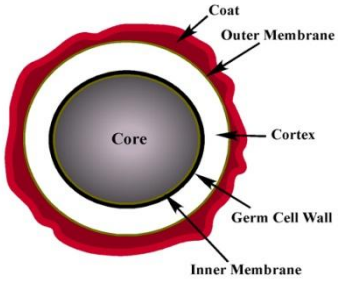
- Gram Negative
    - Rhizobacteria grow in root nodules of legumes (soybeans, peanuts)
    - Fix N_2 from air into usable ammonia
    - Rickettsiae are parasitic bacteria carried by ticks
    - Cause Lyme disease & Rocky Mountain Spotted Fever
- Cyanobacteria
    - Gram negative
    - Photosynthetic
    - Called blue-green bacteria
    - Contain phycocyanin (red-blue) pigments & chlorophyll
    - May be red, yellow, brown, black, or blue-green
    - May grow in chains (*Oscillatoria*)
    - Have Heterocysts to help fix N_2
    - First to re-enter devastated areas
    - Some cause Eutrophication (use up O2 when die & decompose in water)
- Spirochetes
    - Gram positive
    - Flagella at each end
    - Move in corkscrew motion
    - Some aerobic; others anaerobic
    - May be free living, parasitic, or symbiotic
- Enteric Bacteria
    - Gram negative
    - Can live in aerobic & anaerobic habitats
    - Includes *E. coli* in intestines
    - *Salmonella* – causes food poisoning
- Chemoautotrophs
    - Gram negative
    - Obtain energy from minerals like iron
    - Found in freshwater ponds

Nutrition, Respiration, and Reproduction

- Modes of Nutrition
    - Saprobes – feed on dead organic matter
    - Parasites – feed on a host cell
    - Photoautotroph – use sunlight to make food
    - Chemoautotroph – oxidize inorganic matter such as iron or sulfur to make food
- Methods of Respiration
    - Obligate Aerobes – require O_2 (tuberculosis bacteria)
    - Obligate Anaerobes – die if O_2 is present (tetanus)
    - Facultative Anaerobes – don't need O_2, but aren't killed by it (*E. coli*)
- Bacterial Respiration
    - Anaerobes carry on fermentation
    - Aerobes carry on cellular respiration
- Reproduction
    - Bacteria reproduce asexually by binary fission
    - Single chromosome replicates & then cell divides
    - Rapid
    - All new cells identical (clones)
- Binary Fission *E. Coli*



- Reproduction
  - Bacteria reproduce sexually by Conjugation
  - Form a tube between 2 bacteria to exchange genetic material
  - Held together by pili
  - New cells NOT identical
- Spore Formation
  - Form endospore whenever when habitat conditions become harsh (little food)



  - Able to survive for long periods of time as endosperm
  - Difficult to destroy (heat resistant)
- Transduction & Transformation
  - Genetically change bacteria
  - May become antibiotic resistant
  - Transformed bacteria pick up pieces of DNA from dead bacterial cells
  - Transduction – viruses carry foreign DNA to bacteria; used to make insulin

Pathenogenic Bacteria

- Pathogens
  - Called germs or microbes
  - Cause disease
  - May produce poisons or toxins
  - Endotoxins released after bacteria die (*E. coli*)
  - Exotoxins released by Gram + bacteria (C. tetani)
- GERM theory: Infectious diseases are caused microorganisms of different types.
  - Some diseases are caused by viruses, bacteria, and fungi.
  - Others caused by materials in the environment
  - Others are inherited
- Diseases caused by bacteria—see p 486 FIG 19-13
- Diseases caused by viruses—see p 488 FIG 19-14