Cellular Basis of Microbiology

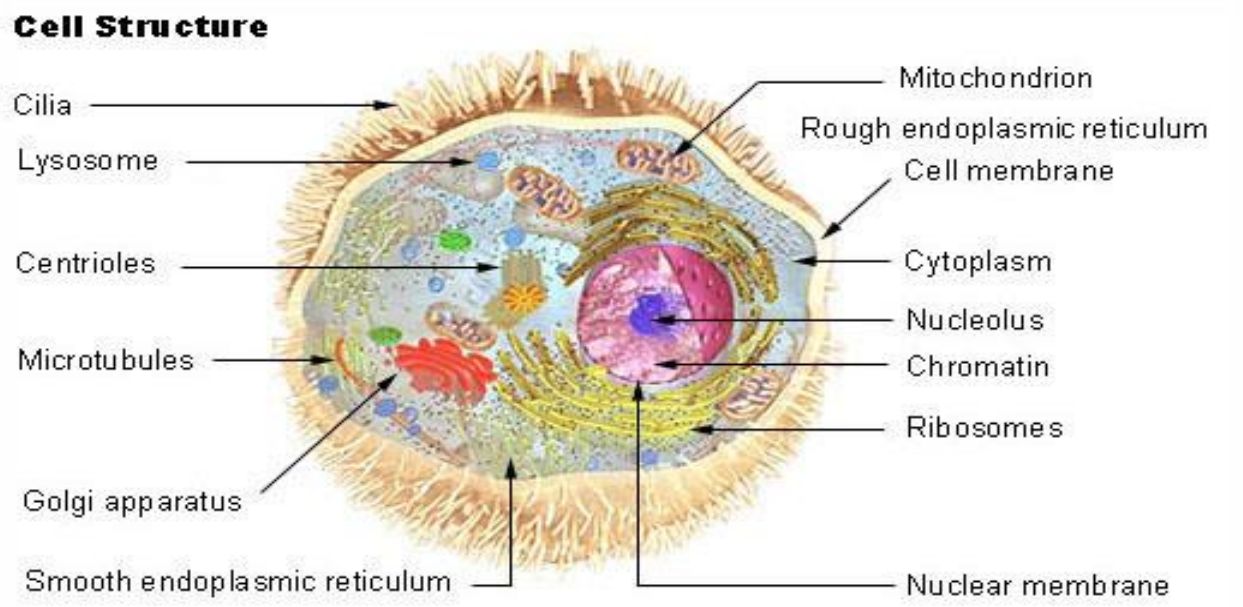
Lecture #3 – Dr. Gary Mumaugh

Subjects Covered

- Microorganism: Structurecvb
  - Structure of Prokaryotic Cell
  - Structure of Eukaryotic Cell
- Microorganism: Varieties of Shapes
- Microorganism: Classification

Microorganism: Structure

- Internal structure comprised of mitochondria, lysosomes, centrioles, microtubules and filaments



Mitochondria

- Major energy producing part of the cell
- Membrane-like structure & contain enzymes
- The mitochondria's matrix substance contains DNA, RNA, and ribosomes

Lysosome

- Responsible for inter-cellular digestion
- Contains digestive enzymes
- Two types of lysomes are known to exist:
  - Primary - have already begun enzymatic processes
    - Encompass phagosomes
  - Secondary--have not started enzymatic processes
    - Contains a variety of structures that result from the fusion of a primary lysome and a vacuole

Centrioles

- Short, fibrous rod-shaped organelles
- Existing in pairs called diplosomes
- Centrioles are located near the nucleus
- The centrioles occur in eukaryotic cells only
- Responsibilities of centrioles
    - Determining polarity during cell division
    - Playing a pivotal role in the creation of such cellular extensions as: basal bodies, cilia and flagella

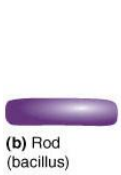
Microtubules (Cytoskeleton)

- Found in virtually every cell
- Maintain cell shape & aids in intercellular transport
- During cell division, they also function to aide in re-directing the chromosomes to different ends of the cells
- Microtubules and Filaments are responsible for four major functions:
    - (Cytoskeleton) Aides in determining the shape
    - (Cytoskeleton) Provides rigidity, as well as, tensile strength for the cell
        - It helps to move organelles around the cell
    - Involved in cell division enable the chromosomes to separate into daughter cells
    - Involved in motility either via the use flagella or amoeboid movement

The Shapes of Microorganisms

- **Cocci** are spheres
    - Cocci are more resistant to drying than rods
        - Staphyloccus aureus
- **Rods** are straight or spiral
    - Cylinders with more surface area than cocci
        - Able to easily take in diluted nutrients obtained from the environment
    - Straight are bacilli
    - Spiral are spirilla
        - Has a corkscrew motion and are less resistant to movement

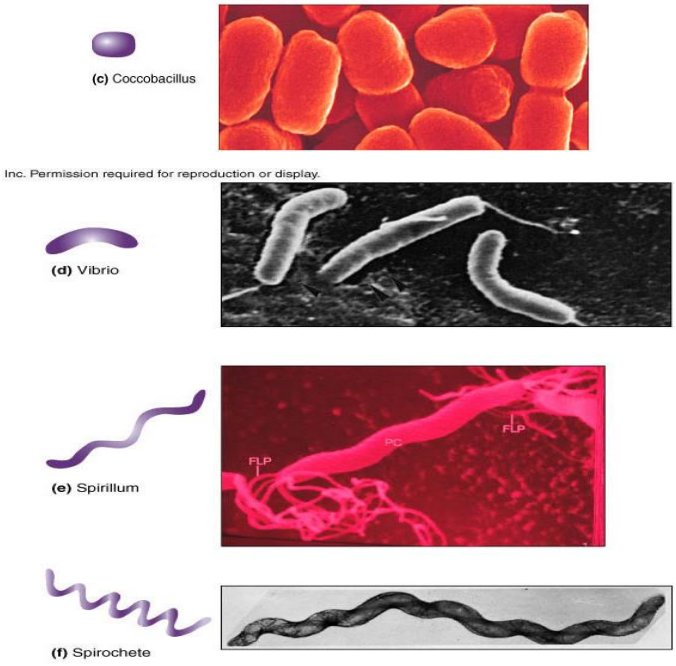
(a) Coccus



(b) Rod (bacillus)

Shapes of Prokaryotic Cells

- Prokaryotes exhibit a variety of shapes
  - Coccus - Spherical
  - Bacillus
    - Rod or cylinder shaped
    - Cell shape not to be confused with *Bacillus* genus
- Prokaryotes exhibit a variety of other shapes
    - Coccobacillus - Short round rod
    - Vibrio - Curved rod
    - Spirillum - Spiral shaped
    - Spirochete - Helical shape
    - Pleomorphic - Bacteria able to vary shap

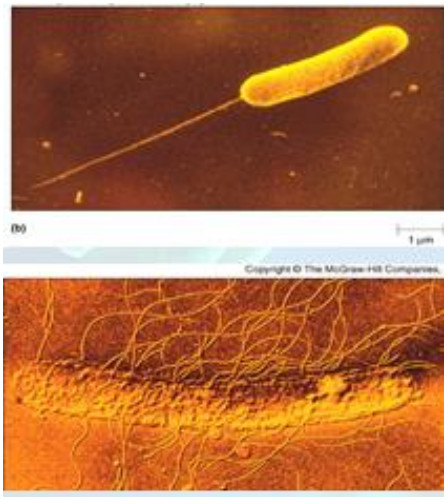


Shape of Prokaryotic Cells

- Division may result in pairs or chains of cells
  - Pairs = diplococci
    - Example: *Neisseria gonorrhoeae*
  - Chains = streptococci
    - Example: species of *Streptococcus*
- Division along two or three perpendicular planes form cubical packets
  - Example: *Sarcina* genus
- Division along several random planes form clusters
  - Example: species of *Staphylococcus*

Morphology of Prokaryotic Cells

- Some bacteria live in groups with other bacterial cells
  - They form multicellular associations
    - Example: myxobacteria
    - Other organisms for biofilms
      - Formation allows for changes in cellular activity



Flagella and Pili

- Some bacteria have protein appendages
  - Not essential for life
    - Aid in survival in certain environments
  - They include
    - Flagella
    - Pili

Flagella

- Long protein structure
- Responsible for motility
    - Use propeller-like movements to push bacteria
    - Can rotate more than 100,00 revolutions/minute (82 mile/hour)
- Bacteria use flagella for motility
    - Motile through sensing chemicals – Chemotaxis
    - If chemical compound is nutrient - Acts as attractant
    - If compound is toxic - Acts as repellent

Pili

- Considerably shorter and thinner than flagella
- Function
    - Attachment - These pili called fimbre
    - Movement

Microorganisms: Classification

- Based upon the taxonomic five kingdom system, microorganisms are divided into the following three kingdoms:
- Monera
    - Contains archaea and bacteria
    - Unicellular organisms with no nuclear membranes
- Protista
    - Contains algae and protozoa
- Fungi
    - Eukaryotic, which are multicellular organisms

5 Major Groups of Microorgansims

- Archaea — Procaryotic
- Bacteria — Procaryotic
- Algae — Eucaryotic
- Protozoa — Eucaryotic
    - Algae and Protozoa are called Protista
- Fungi — Eucaryotic

TABLE 3.7 Comparison of Prokaryotic and Eukaryotic Cell Structures/Functions

	Prokaryotic	Eukaryotic
General Characteristics		
Size	Generally 0.3– 2 μm in diameter.	Generally 5– 50 μm in diameter.
Cell Division	Chromosome replication followed by binary fission.	Mitosis followed by division.
Chromosome location	Located in the nucleoid, which is not membrane-bound.	Contained within the membrane-bound nucleus.
Structures		
Cell membrane	Relatively symmetric with respect to the lipid content of the bilayers.	Highly asymmetric; lipid composition of outer layer differs significantly from that of inner layer.
Cell wall	Composed of peptidoglycan (Bacteria); Gram-negative bacteria have an outer membrane as well.	Absent in animal cells; composition in other cell types may include: chitin, glucans and mannans (fungi), and cellulose (plants).
Chromosome	Single, circular DNA molecule is typical.	Multiple, linear DNA molecules. DNA is wrapped around histones.
Flagella	Composed of protein subunits.	Made up of a 9 + 2 arrangement of microtubules.
Membrane-bound organelles	Absent.	Present; includes the nucleus, mitochondria, chloroplasts (only in plant cells), endoplasmic reticulum, Golgi apparatus, lysosomes, and peroxisomes.
Nucleus	Absent; DNA resides as an irregular mass forming the nucleoid region.	Present.
Ribosomes	70S ribosomes, which are made up of 50S and 30S subunits.	80S ribosomes, which are made up of 60S and 40S subunits. Mitochondria and chloroplasts have 70S ribosomes.
Functions		
Degradation of extracellular substances	Enzymes are secreted that degrade macromolecules outside of the cell. The resulting small molecules are transported into the cell.	Macromolecules are brought into the cell by endocytosis. Lysosomes carry digestive enzymes.
Motility	Generally involves flagella, which are composed of protein subunits. Flagella rotate like propellers, using proton motive force for energy.	Involves cilia and flagella, which are made up of a 9 + 2 arrangement of microtubules. Cilia move in synchrony; flagella propel a cell with a whiplike motion or thrash back and forth to pull a cell forward. Both use ATP for energy.
Protein secretion	A characteristic signal sequence marks proteins for secretion by the general secretory pathway.	Secreted proteins are moved to the lumen of the rough endoplasmic reticulum as they are being synthesized. From there, they are transported to the Golgi apparatus for processing and packaging.
Strength and rigidity	Peptidoglycan-containing cell wall (Bacteria).	Cytoskeleton composed of microtubules, intermediate filaments, and microfilaments. Some have a cell wall; some have sterols in the membrane.
Transport	Primarily active transport. Group translocation.	Facilitated diffusion and active transport. Ion channels.