**Chapter 3**

**Prokaryotic Cells**

* Prokaryotes
  + Do not have membrane surrounding their DNA; lack a nucleus
  + Lack various internal structures bound with phospholipid membranes
  + Are small, ~1.0 µm in diameter
  + Have a simple structure
  + Composed of Bacteria and Archaea

**External Structures of Prokaryotic Cells**

* Glycocalyces
  + Gelatinous, sticky substance surrounding the outside of the cell
  + Composed of polysaccharides, polypeptides, or both
  + Two Types of Glycocalyces
    - Capsule
      * Composed of organized repeating units of organic chemicals
      * Firmly attached to cell surface
      * Protects cells from drying out
      * May prevent bacteria from being recognized and destroyed by host
    - Slime layer
      * Loosely attached to cell surface
      * Water soluble
      * Protects cells from drying out
      * Sticky layer that allows prokaryotes to attach to surfaces
* Flagella
  + Are responsible for movement
  + Have long structures that extend beyond cell surface
  + Are not present on all prokaryotes
  + Structure
    - Composed of filament, hook, and basal body
    - Flagellin protein (filament) deposited in a helix at the lengthening tip
    - Base of filament inserts into hook
    - Basal body anchors filament and hook to cell wall by a rod and a series of either two or four rings of integral proteins
    - Filament capable of rotating 360º
  + Function
    - Rotation propels bacterium through environment
    - Rotation reversible, can be clockwise or counterclockwise
    - Bacteria move in response to stimuli (taxis)
      * Runs
      * Tumbles
* Fimbriae and Pili
  + Rod-like proteinaceous extensions
  + Fimbriae
    - Sticky, bristlelike projections
    - Used by bacteria to adhere to one another, to hosts, and to substances in environment
    - Shorter than flagella
    - May be hundreds per cell
    - Serve an important function in biofilms
  + Pili
    - Tubules composed of pilin
    - Also known as conjugation pili
    - Longer than fimbriae but shorter than flagella
    - Bacteria typically only have one or two per cell
    - Mediate the transfer of DNA from one cell to another (conjugation)

**Prokaryotic Cell Walls**

* Provide structure and shape and protect cell from osmotic forces
* Assist some cells in attaching to other cells or in eluding antimicrobial drugs
* Not present in animal cells, so can target cell wall of bacteria with antibiotics
* Bacteria and archaea have different cell wall chemistry

**Bacterial Cell Walls**

* + Most have cell wall composed of peptidoglycan
  + Peptidoglycan is composed of sugars, NAG, and NAM
  + Chains of NAG and NAM attached to other chains by tetrapeptide crossbridges
    - Bridges may be covalently bonded to one another
    - Bridges may be held together by short connecting chains of amino acids
  + Two basic types of bacterial cell walls:
  + Gram-positive cell walls
    - Relatively thick layer of peptidoglycan
    - Contain unique polyalcohols called teichoic acids
      * Some covalently linked to lipids, forming lipoteichoic acids that anchor peptidoglycan to cell membrane
    - Retain crystal violet dye in Gram staining procedure; so appear purple
    - Up to 60% mycolic acid in acid-fast bacteria helps cells survive desiccation
  + Gram-negative cell walls
    - Have only a thin layer of peptidoglycan
    - Bilayer membrane outside the peptidoglycan contains phospholipids, proteins, and lipopolysaccharide (LPS)
    - May be impediment to the treatment of disease
    - Appear pink following Gram staining procedure

**Archaeal Cell Walls**

* + Do not have peptidoglycan
  + Contains variety of specialized polysaccharides and proteins
  + Gram-positive archaea stain purple
  + Gram-negative archaea stain pink

**Prokaryotic Cytoplasmic Membranes**

* **Structure** 
  + Referred to as phospholipid bilayer; composed of lipids and associated proteins
  + Approximately half composed of proteins that act as recognition proteins, enzymes, receptors, carriers, or channels
    - Integral proteins
    - Peripheral proteins
    - Glycoproteins
  + Fluid mosaic model describes current understanding of membrane structure
* **Function** 
  + Energy storage
  + Harvest light energy in photosynthetic prokaryotes
  + Selectively permeable
  + Naturally impermeable to most substances
  + Proteins allow substances to cross membrane
    - Occurs by passive or active processes
  + Maintain concentration and electrical gradient
    - Chemicals concentrated on one side of the membrane or the other
    - Voltage exists across the membrane

**Cytoplasm of Prokaryotes**

* **Cytosol** – liquid portion of cytoplasm
* **Inclusions** – may include reserve deposits of chemicals
* **Endospores** – unique structures produced by some bacteria that are a defensive strategy against unfavorable conditions
* **Nonmembranous Organelles**
  + Ribosomes – sites of protein synthesis
  + Cytoskeleton – plays a role in forming the cell’s basic shape

**Eukaryotic Cell Walls & Cytoplasmic Membranes**

* Fungi, algae, and some protozoa have cell walls but no glycocalyx
* Composed of various polysaccharides
  + Fungal cell walls composed of cellulose, chitin, and/or glucomannan
  + Algal cell walls composed of cellulose, proteins, agar, carrageenan, silicates, algin, calcium carbonate, or a combination of these