

Study Outline Chapter 04

Comparing Prokaryotic and Eukaryotic Cells: An Overview (p. 76)

- Prokaryotic and eukaryotic cells are similar in their chemical composition and chemical reactions.
- Prokaryotic cells lack membrane-enclosed organelles (including a nucleus).
- Peptidoglycan is found in prokaryotic cell walls but not in eukaryotic cell walls.

The Prokaryotic Cell (pp. 77-97)

- Bacteria are unicellular, and most of them multiply by binary fission.
- Bacterial species are differentiated by morphology, chemical composition, nutritional requirements, biochemical activities, and source of energy.

The Size, Shape, and Arrangement of Bacterial Cells (p. 77)

- Most bacteria are 0.2-2.0 μm in diameter and 2-8 μm in length.
- The three basic bacterial shapes are coccus (spheres), bacillus (rods), and spiral (twisted).
- Pleomorphic bacteria can assume several shapes.

Structures External to the Cell Wall (pp. 77-85)

Glycocalyx (pp. 80-82)

- The glycocalyx (capsule, slime layer, or extracellular polysaccharide) is a gelatinous polysaccharide and/or polypeptide covering.
- Capsules may protect pathogens from phagocytosis.
- Capsules enable adherence to surfaces, prevent desiccation, and may provide nutrients.

Phase-Contrast Microscopy (pp. 59-62)

- A phase-contrast microscope brings direct and reflected or diffracted light rays together (in phase) to form an image of the specimen on the ocular lens.
- It allows the detailed observation of living organisms.

Differential Interference

Contrast (DIC) Microscopy (p. 62)

- The DIC microscope provides a colored, three-dimensional image of the object being observed.
- It allows the detailed observations of living cells.

Fluorescence Microscopy (p. 62)

- In fluorescence microscopy, specimens are first stained with fluorochromes and then viewed through a compound microscope by using an ultraviolet (or near-ultraviolet) light source.
- The microorganisms appear as bright objects against a dark background.
- Fluorescence microscopy is used primarily in a diagnostic procedure called fluorescent-antibody (FA) technique, or immunofluorescence.

Confocal Microscopy (p. 63)

- In confocal microscopy, a specimen is stained with a fluorescent dye and illuminated one plane at a time.
- Using a computer to process the images, two-dimensional and three-dimensional images of cells can be produced.

Flagella (pp. 82-83)

- Flagella are relatively long filamentous appendages consisting of a filament, hook, and basal body.
- Prokaryotic flagella rotate to push the cell.
- Motile bacteria exhibit taxis; positive taxis is movement toward an attractant, and negative taxis is movement away from a repellent.
- Flagellar (H) protein functions as an antigen.

Axial Filaments (p. 83)

- Spiral cells that move by means of an axial filament (endoflagellum) are called spirochetes.
- Axial filaments are similar to flagella, except that they wrap around the cell.

Fimbriae and Pili (p. 83)

- Fimbriae and pili are short, thin appendages.
- Fimbriae help cells adhere to surfaces.
- Pili join cells for the transfer of DNA from one cell to another.

The Cell Wall (pp. 85-88)

Composition and Characteristics (pp. 85-86)

- The cell wall surrounds the plasma membrane and protects the cell from changes in water pressure.
- The bacterial cell wall consists of peptidoglycan, a polymer consisting of NAG and NAM and short chains of amino acids.
- Penicillin interferes with peptidoglycan synthesis.
- Gram-positive cell walls consist of many layers of peptidoglycan and also contain teichoic acids.
- Gram-negative bacteria have a lipoprotein-lipopoly-saccharide-phospholipid outer membrane surrounding a thin peptidoglycan layer.
- The outer membrane protects the cell from phagocytosis and from penicillin, lysozyme, and other chemicals.
- Porins are proteins that permit small molecules to pass through the outer membrane; specific channel proteins allow other molecules to move through the outer membrane.
- The lipopolysaccharide component of the outer membrane consists of sugars (O polysaccharides) that function as antigens and lipid A, which is an endotoxin.

Cell Walls and the Gram Stain Mechanism (pp. 86-88)

- The crystal violet-iodine complex combines with peptidoglycan.
- The decolorizer removes the lipid outer membrane of gram-negative bacteria and washes out the crystal violet.

Atypical Cell Walls (p. 88)

- Mycoplasma is a bacterial genus that naturally lacks cell walls.

- Archaea have pseudomurein; they lack peptidoglycan.

Damage to the Cell Wall (p. 88)

- In the presence of lysozyme, gram-positive cell walls are destroyed, and the remaining cellular contents are referred to as a protoplast.
- In the presence of lysozyme, gram-negative cell walls are not completely destroyed, and the remaining cellular contents are referred to as a spheroplast.
- Protoplasts and spheroplasts are subject to osmotic lysis.
- Antibiotics such as penicillin interfere with cell wall synthesis.

Structures Internal to the Cell Wall (pp. 88-98)

The Plasma (Cytoplasmic) Membrane (pp. 88-91)

- The plasma membrane encloses the cytoplasm and is a phospholipid bilayer with protein (the fluid mosaic model).
- The plasma membrane is selectively permeable.
- Plasma membranes carry enzymes for metabolic reactions, such as nutrient breakdown, energy production, and photosynthesis.
- Mesosomes, irregular infoldings of the plasma membrane, are now considered artifacts.
- Plasma membranes can be destroyed by alcohols and polymyxins.

The Movement of Materials Across Membranes (pp. 91-94)

- Movement across the membrane may be by passive processes, in which materials move from areas of higher to lower concentration and no energy is expended by the cell.
- In simple diffusion, molecules and ions move until equilibrium is reached.
- In facilitated diffusion, substances are transported by carrier proteins (permeases) across membranes from areas of high to low concentration.
- Osmosis is the movement of water from areas of high to low concentration across a selectively semipermeable membrane until equilibrium is reached.
- In active transport, materials move from areas of low to high concentration by permeases, and the cell must expend energy.
- In group translocation, energy is expended to modify chemicals and transport them across the membrane.

Cytoplasm (p. 94)

- Cytoplasm is the fluid component inside the plasma membrane.
- The cytoplasm is mostly water, with inorganic and organic molecules, DNA, ribosomes, and inclusions.

The Nuclear Area (p. 95)

- The nuclear area contains the DNA of the bacterial chromosome.
- Bacteria can also contain plasmids, which are extra-chromosomal DNA circles.

Ribosomes (p. 95)

- The cytoplasm of a prokaryote contains numerous 70S ribosomes; ribosomes consist of rRNA and protein.
- Protein synthesis occurs at ribosomes; it can be inhibited by certain antibiotics.

Inclusions (pp. 95-96)

- Inclusions are reserve deposits found in prokaryotic and eukaryotic cells.

- Among the inclusions found in bacteria are metachromatic granules (inorganic phosphate), polysaccharide granules (usually glycogen or starch), lipid inclusions, sulfur granules, carboxysomes (ribulose 1,5-diphosphate carboxylase), magnetosomes (Fe₃O₄), and gas vacuoles.

Endospores (pp. 96-98)

- Endospores are resting structures formed by some bacteria for survival during adverse environmental conditions.
- The process of endospore formation is called sporulation; the return of an endospore to its vegetative state is called germination.

The Eucaryotic Cell (pp. 98-106)

Flagella and Cilia (pp. 98-100)

- Flagella are few and long in relation to cell size; cilia are numerous and short.
- Flagella and cilia are used for motility, and cilia also move substances along the surface of the cells.
- Both flagella and cilia consist of an arrangement of nine pairs and two single microtubules.

The Cell Wall and Glycocalyx (pp. 100-101)

- The cell walls of many algae and some fungi contain cellulose.
- The main material of fungal cell walls is chitin.
- Yeast cell walls consist of glucan and mannan.
- Animal cells are surrounded by a glycocalyx, which strengthens the cell and provides a means of attachment to other cells.

The Plasma (Cytoplasmic) Membrane (p. 101)

- Like the procaryotic plasma membrane, the eucaryotic plasma membrane is a phospholipid bilayer containing proteins.
- Eucaryotic plasma membranes contain carbohydrates attached to the proteins and sterols not found in procaryotic cells (except Mycoplasma bacteria).
- Eucaryotic cells can move materials across the plasma membrane by the passive processes used by procaryotes, in addition to active transport and endocytosis (phagocytosis and pinocytosis).

Cytoplasm (p. 101)

- The cytoplasm of eucaryotic cells includes everything inside the plasma membrane and external to the nucleus.
- The chemical characteristics of the cytoplasm of eucaryotic cells resemble those of the cytoplasm of procaryotic cells.
- Eucaryotic cytoplasm has a cytoskeleton and exhibits cytoplasmic streaming.

Organelles (p. 101-106)

- Organelles are specialized membrane-enclosed structures in the cytoplasm of eucaryotic cells.
- The nucleus, which contains DNA in the form of chromosomes, is the most characteristic eucaryotic organelle.
- The nuclear envelope is connected to a system of parallel membranes in the cytoplasm called the endoplasmic reticulum (ER).

- The ER provides a surface for chemical reactions, serves as a transporting network, and stores synthesized molecules. Protein synthesis and transport occur on rough ER; lipid synthesis occurs on smooth ER.
- 80S ribosomes are found in the cytoplasm or attached to the rough ER.
- The Golgi complex consists of flattened sacs called cisterns. It functions in membrane formation and protein secretion.
- Mitochondria are the primary sites of ATP production. They contain 70S ribosomes and DNA, and they multiply by fission.
- Chloroplasts contain chlorophyll and enzymes for photosynthesis. Like mitochondria, they contain 70S ribosomes and DNA and multiply by fission.
- Lysosomes are formed from Golgi complexes. They store powerful digestive enzymes.
- Vacuoles are membrane-enclosed cavities derived from the Golgi complex usually found in plant cells that store various substances, help bring food into the cell, increase cell size, and provide rigidity to leaves and stems.
- A pair of cylindrical structures called centrioles, which are involved in cell division, are near the nucleus.

The Evolution of Eucaryotes (p.106-107)

- According to the endosymbiotic theory, organelles (for example, mitochondria and chloroplasts) evolved from symbiotic procaryotes living inside other procaryoitc celss.