Cytology: The Study of Cells

Chapter 2

Introduction

- **Cell** – structural and functional unit of an organism
- Sizes vary
- Two subdivisions
  - Cell membrane
  - Cytoplasm

Cell Membrane

- **Structure**
  - Lipid bilayer
  - Proteins float among the phospholipids
  - Molecules are constantly moving
    - Fluid mosaic model
- **Functions**
  - Encloses components
  - Boundary through which substances enter or exit
  - Selectively permeable

Membrane Transport

- **Passive processes**
  - Molecules spread from an area of greater concentration to an area of lower concentration
  - Do not use cellular energy
- **Active processes**
  - Molecules move from an area of lower concentration to an area of greater concentration
  - Use cellular energy
    - From high energy bonds of ATP

Passive Transport Processes

- **Diffusion**
- **Osmosis**
- **Facilitated diffusion**
- **Filtration**

Diffusion

- Molecules move from an area of high concentration to an area of low concentration until they are uniformly distributed
Osmosis

- Water molecules move from an area of lower solute concentration to higher solute concentration through a semipermeable membrane.

Facilitated Diffusion

- Molecules move across a membrane with the aid of a carrier protein.

Filtration

- Molecules are forced through membranes by mechanical pressure.

Active Transport Processes

- Ion pumps
- Endocytosis
- Exocytosis

Ion Pumps

- Molecule attaches to a carrier protein in the membrane
- The molecule moves through the protein from low concentration to high concentration.

Endocytosis & Exocytosis

- Endocytosis
  - Materials move into the cell by their inclusion into vesicles
  - Phagocytosis
  - Pinocytosis
- Exocytosis
  - Materials move out of the cell
  - Cellular secretion
Inside the Cell Membrane

- **Cytoplasm**
  - **Cytosol**
    - Fluid of the cell
  - **Cytoskeleton**
    - Structural component
  - **Organelles**
    - Specific functions
  - **Inclusions**
    - Non-essential structures

- **Cytoplasm**
  - Contents
    - Mostly water
  - Function
    - Substance in which chemical reactions occur
    - Packages chemicals
    - Excretion of waste materials

**Organelles**

- Perform specific functions necessary for cell structure, maintenance, and metabolism
- **Membranous or nonmembranous**

**Membranous Organelles**

**Nucleus**

- Largest organelle
- Contains chromosomes
- Genetic control center
- **Nuclear envelope**
  - Nuclear pores
- **Nucleoplasm**
  - Chromosomes
  - **Nucleolus**
    - Composed of RNA
    - Produces ribosomes

**Chromatin**
Endoplasmic Reticulum (ER)

- Network of channels running through the cytoplasm
- **Rough ER**
  - Phospholipids
  - Proteins of plasma membrane
  - Lysosomes
- **Smooth ER**
  - Cells that detoxify
  - Cells that synthesize steroids

Golgi Complex

- Composed of *cisternae*
- Transport vesicles from RER to Golgi complex
- Golgi vesicles – packaged proteins
  - Lysosomes
  - To plasma membrane
  - Secretory vesicles

Lysosomes

- “Suicide packets”
- Produced by Golgi complex
- Contain digestive enzymes
  - Defense against disease
  - Break down cellular debris
  - Recycling of useful molecules in the cell

Mitochondria

- “Powerhouse” of the cell
  - Production of ATP
- Double walled
  - Cristae
  - Matrix
- mtDNA
  - Inherited from the mother

Nonmembranous Organelles
**Cytoskeleton**
- Support cell
- Determine shape
- Organize contents
- Move substances
- Move cell
- Protein framework
  - Microfilaments
  - Microtubules
  - Intermediate filaments

**Cilia**
- Projections of cell membrane
  - Short, many
- Formed from microtubules
- Cause currents at cell surface
  - Move substances along surface of cell or move entire cell

**Flagella**
- Projections of cell membrane
  - Few, long
- Cause currents at cell surface
  - Move entire cell

**Ribosomes**
- Attached to rough ER
- Scattered throughout cytoplasm
- Sites of protein synthesis
  - Receive messages from RNA
  - Assembly of amino acids into proteins

**Centrioles**
- Near nucleus
- 9 bundles of microtubules
- Function in cell reproduction

**Cell Junctions**
- Gap junctions
  - Allow small molecules to pass through
- Tight Junctions
  - Block water and solutes
- Desmosomes
  - Very strong, resist stretching and twisting
Cell Growth and Replacement

• Cell division
  – Mitosis
    • Occurs in somatic cells
    • Results in diploid cells
  – Meiosis
    • Occurs in reproductive cells
    • Results in haploid cells

Stem Cells

• Immature cells that can develop into one or more types of mature, specialized cells
  – Developmental Plasticity
• Adult Stem (AS) cells
  – In most body organs
  – Produce cells for normal turnover
  – Multipotent (e.g. bone marrow cells)
• Embryonic stem (ES) cells
  – Embryo up to 150 cells
  – Pluripotent
  – Excess of in vitro fertilization