Chapter 5:
Cell Membrane Structure and Function

**Plasma Membrane:** Thin barrier separating inside of cell (cytoplasm) from the outside environment

**Function:**
1) Isolate cell's content from outside environment
2) Regulate exchange of substances between inside / outside cell
3) Communicate with other cells
4) Create attachments within / between cells
5) Regulate biochemical reactions

**The Fluid Mosaic Model**
(Singer & Nicolson, 1972)

Membrane consists of embedded proteins that 'shift and flow' within a layer of phospholipids

Note:
Membranes also exist within cells forming various compartments

Figure 5.1 – Audesirk & Byers
Phospholipid Bilayer: Double layer of phospholipids
  • Hydrophilic ends form outer border
  • Hydrophobic tails form inner layer

Cell Membrane Proteins:
1) **Receptor Proteins:** Trigger cell activity when molecule from outside environment binds to protein
2) **Recognition Proteins:** Allow cells to recognize one another
   • Glycoproteins = proteins with attached carbohydrate groups
3) **Enzymes:** Catalyze chemical reactions on the inner surface of membranes
4) **Attachment Proteins:** Anchor membrane to internal framework and external surface of neighboring cells
5) **Transport Proteins:** Regulate movement of hydrophilic molecules through membrane
What Drives the Movement of Substances Across Membranes?

**Answer:** Concentration Gradients

**Definitions of Interest:**

Concentration = Number of molecules in a given unit of volume

Gradient = Physical difference in a property between two adjacent regions of space

**Diffusion:** Movement of molecules from an area of [high] to an area of [low]

- Greater the concentration gradient, the faster diffusion occurs
- Diffusion will continue until gradient eliminated (dynamic equilibrium)
- Diffusion cannot move molecules rapidly over long distances

**Types of Movement Across Membranes** (see Table 5.1):

1) **Passive Transport**
   - Requires no energy
   - Substances move down concentration gradients
     
     A) **Simple Diffusion**
     - Small molecules pass directly through the phospholipid bilayer

     Rate depends on:
     1) Molecule size
     2) Concentration gradient
     3) Lipid solubility
Types of Movement Across Membranes (see Table 5.1):

1) **Passive Transport**
   - Requires no energy
   - Substances move down concentration gradients

B) **Facilitated Diffusion**
   - Molecules require assistance of transport proteins
     - **Channel Proteins** (form pores; e.g., ion channels / water channels)
     - **Carrier Proteins** (require shape change; e.g., glucose / amino acid carriers)

C) **Osmosis**
   - Movement of water from an area of high [water] to an area of low [water] across a semi-permeable membrane
Osmosis:

**Isotonic Solution:**
- Outside of cell has **SAME** [solute] as inside of cell

**Hypertonic Solution:**
- Outside of cell has **HIGHER** [solute] than inside of cell

**Hypotonic Solution:**
- Outside of cell has **LOWER** [solute] than inside of cell

Tonicity is relative to the inside of the cell.
Osmosis in Action:

Types of Movement Across Membranes (see Table 5.1):

1) **Passive Transport**

2) **Active Transport**
   - Requires energy (in the form of ATP…)
   - Moves substances against concentration gradients (aka 'pumps')
Types of Movement Across Membranes (see Table 5.1):

1) **Passive Transport**
2) **Active Transport**
3) **Endocytosis**
   - Movement of large volumes into cells (via *vesicle* formation; requires ATP)

4) **Exocytosis**
   - Movement of large volumes out of cells (via *vesicles*; requires ATP)

---

**Endocytosis**

- **a) Pinocytosis** ("cell drinking")
  - Uptake of fluid droplets
- **b) Receptor-mediated Endocytosis**
  - Uptake of molecules via coated pits
- **c) Phagocytosis** ("cell eating")
  - Uptake of large particles

**Exocytosis**

(e.g., hormones)
How are Cell Surfaces Specialized?

Answer: Junctions allow cells to connect and communicate

1) Connection Junctions:

a) **Desmosomes**
   - Hold cells together via protein filaments

b) **Tight Junctions**
   - Protein “seals” prevent leakage (cell to cell)

2) Communication Junctions:

a) **Gap Junctions** (animals)
   - Protein channels allow for signals to pass between cells

b) **Plasmodesmata** (plants)
   - Cytoplasmic bridges allow for signals to pass between cells
How are Cell Surfaces Specialized?

**Answer:** Cell walls offer support and protection

**Cell Walls:**

- Found in bacteria, plants, fungi, & some protists
- Composed of carbohydrates (e.g., cellulose / chitin), proteins, or inorganic molecules (e.g., silica)
- Produced by the cell it protects/supports