Cell membrane & Transport

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Cell Membrane

- To enclose organelles and other contents in cytoplasm.
- To protect the cell.
- To allow substances into and out of the cell.
- To have metabolic reactions on its surface.

"Fluid mosaic model suggests" that the phospholipids form a bilayer framework, with their hydrophilic (polar) heads on the surface and their hydrophobic (nonpolar) tails on the inside. Proteins are embedded in the phospholipids bilayers. Experimental data have indicated that the proteins the in this model are securely held to the phospholipids, making the structure very stable.
Fluid Mosaic Model
Functions of Membrane Proteins

- Transport
- Enzymatic activity
- Receptors for signal transduction
Membrane permeability

- small, hydrophobic or **fat-soluble** molecules, such as oxygen, cross the cell membrane quite readily because of "fat dissolving fat" interaction.

- small, uncharged, hydrophilic or **water-soluble** molecules, such as water and carbon dioxide, would also be able to cross the cell membrane although there is no "fat dissolving fat" interaction.

- large, hydrophilic molecules are usually impermeable to cell membrane.

- Any molecules carrying strong electrical charges (i.e. ions) are always impermeable to cell membrane, unless transported by special mechanisms.
Movements across the cell membrane

Simple diffusion

- Spontaneous phenomenon where small, hydrophobic molecules move from a higher concentrated area to lower concentrated area.

- All molecules have motion called **Brownian Movement**, and a **concentration gradient** (the difference in two concentrated areas) will always move molecules to the less concentrated area.

- No external energy is required.

- Diffusion stops when **equilibrium** is achieved (no concentration gradient).

- Factors that affect diffusion rate includes temperature, concentration, molecular size, and diffusion distance.
DIFFUSION

Left compartment: Solution with lower osmolarity
Right compartment: Solution with greater osmolarity
Both solutions have the same osmolarity; volume unchanged

(a) Membrane permeable to both solute molecules and water

Extracellular fluid

Factors affecting rate of diffusion through a cell membrane:
- Lipid solubility
- Molecular size
- Cell membrane thickness
- Concentration gradient
- Membrane surface area
- Composition of lipid layer

Intracellular fluid
Facilitated diffusion

- allow large, hydrophilic molecules to cross the cell membrane.

- molecules bind with a specific **protein carrier** at the cell membrane. The combined molecule is now fat soluble and can diffuse to the other side.

- Movement is from a higher concentrated area to a lower concentrated area.

- No external energy is required.

Diffusion rate depends largely on the number of protein carriers available; when all proteins carriers are bound "saturation" occurs and the diffusion rate stabilizes.
Diffusion Through the Plasma Membrane

- Diffusion
- Facilitated diffusion
- Active transport

Passive transport
Osmosis

- movement of **water** molecules from a higher concentrated area to a lower concentrated area.

- usually goes to the opposite direction of solute movement.

- water always diffuses to an area with a higher **osmotic pressure** (where there is more solutes and less water).

- Because of osmosis, cells respond differently when they are placed in different osmotic pressure settings.
Filtration

- passage of substances through a membrane (e.g. capillary wall) by diffusion or osmosis, aided by hydrostatic pressure.

- usually referred to as the separation of solute from solvent in a solution.

- **hydrostatic pressure** forces water to the other side of the membrane.

- Important in absorption and excretion processes.
- Molecules move across the cell membrane from a lower concentrated area to a higher concentrated area.

- Requires external energy and a protein carrier.

- Critical in maintaining homeostasis by allowing important substances (e.g. nutrient molecules) to move against their concentration gradients.

The Na⁺-K⁺-ATPase uses energy from ATP to pump Na⁺ out of the cell and K⁺ into the cell.
Binding of cytoplasmic Na+ to the pump protein stimulates phosphorylation by ATP. Phosphorylation causes the protein to change its shape. K+ is released and Na+ sites are ready to bind Na+ again; the cycle repeats. Phosphorylation causes the protein to change its shape. The shape change expels Na+ to the outside, and extracellular K+ binds. K+ binding triggers release of the phosphate group. Loss of phosphate restores the original conformation of the pump protein. Concentration gradients of K+ and Na+

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Functions of Membrane Proteins

- Intercellular adhesion
- Cell-cell recognition
- Attachment to cytoskeleton and extracellular matrix
• **Endocytosis**: allows large molecule that cannot be transported by other methods to enter the cell by membrane vesicles.

• **Pinocytosis**: transports liquid substances, while "phagocytosis" transports solid substances.

• Divided into 3 main phases – adhesion, ingestion, and digestion.
- **Exocytosis** Allows large molecule that cannot be transported by other methods to exit the cell membrane.