MEMBRANES

Structure of a Generalized Cell

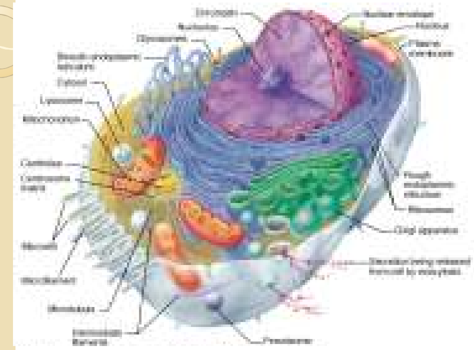

Figure 3.1

Plasma Membrane

- Separates intracellular fluids from extracellular fluids
- Plays a dynamic role in cellular activity
- Glycocalyx is a glycoprotein area abutting the cell that provides highly specific biological markers by which cells recognize one another

Fluid Mosaic Model

- Double bilayer of lipids with imbedded, dispersed proteins
- Bilayer consists of phospholipids, cholesterol, and glycolipids
    - Glycolipids are lipids with bound carbohydrate
    - Phospholipids have hydrophobic and hydrophilic bipoles

Fluid Mosaic Model

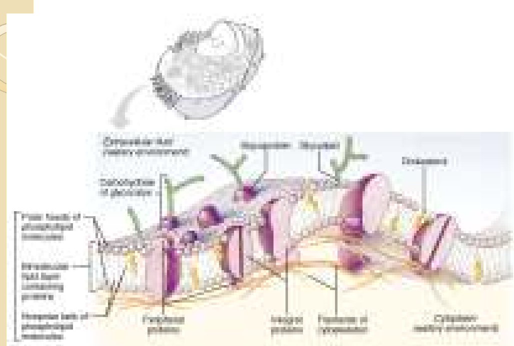

Figure 3.2

Functions of Membrane Proteins

- Transport
- Enzymatic activity
- Receptors for signal transduction

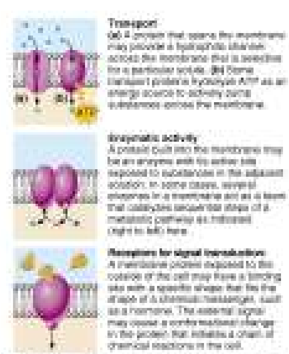

Figure 3.3

Functions of Membrane Proteins

- Intercellular adhesion
- Cell-cell recognition
- Attachment to cytoskeleton and extracellular matrix

Figure 3.3 continued

Membrane Junctions

- Tight junction – impermeable junction that encircles the cell
- Desmosome – anchoring junction scattered along the sides of cells
- Gap junction – a nexus that allows chemical substances to pass between cells

Membrane Junctions

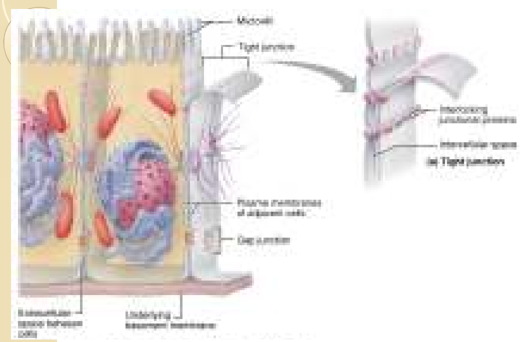

Figure 3.4a

Membrane Junctions

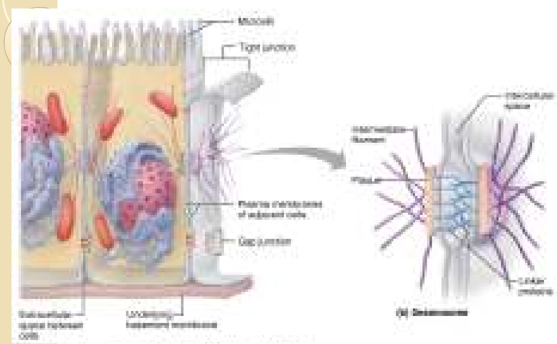

Figure 3.4b

Membrane Junctions

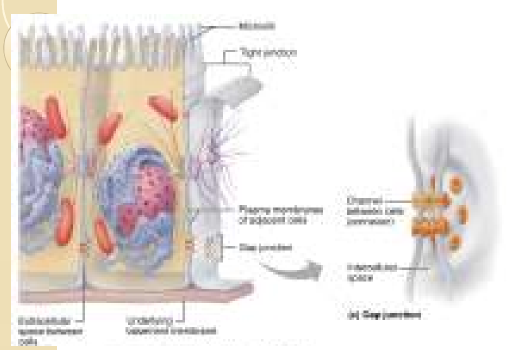

Figure 3.4c

Passive Membrane Transport: Diffusion

- Simple diffusion – nonpolar and lipid-soluble substances
  - Diffuse directly through the lipid bilayer
  - Diffuse through channel proteins

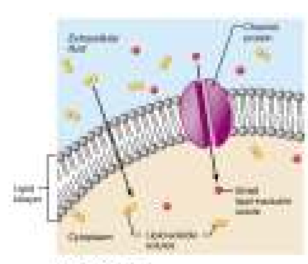

Figure 3.6a

Passive Membrane Transport: Diffusion

- Facilitated diffusion – large, polar molecules such as simple sugars
  - Combine with protein carriers

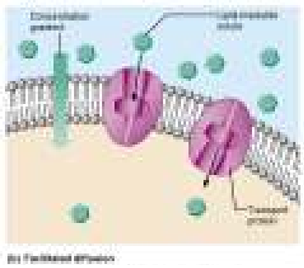

Figure 3.6b

Passive Membrane Transport: Osmosis

- Occurs when the concentration of solvent is different on opposite sides of a membrane
- Diffusion of water across a semipermeable membrane
- Osmolarity – total concentration of solute particles in a solution

Effect of Membrane Permeability on Diffusion and Osmosis

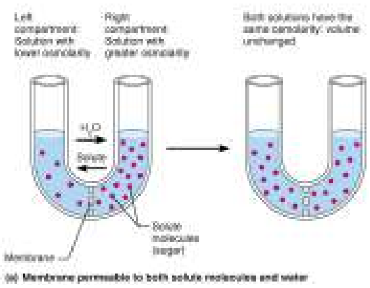

Figure 3.7a

Effect of Membrane Permeability on Diffusion and Osmosis

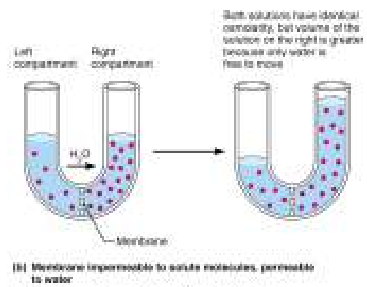

Figure 3.7b

Passive Membrane Transport: Filtration

- The passage of water and solutes through a membrane by hydrostatic pressure
- Pressure gradient pushes solute-containing fluid from a higher-pressure area to a lower-pressure area

Tonicity

- Isotonic – solutions with the same solute concentration as that of the cytosol
- Hypertonic – solutions having greater solute concentration than that of the cytosol
- Hypotonic – solutions having lesser solute concentration than that of the cytosol

Sodium-Potassium Pump

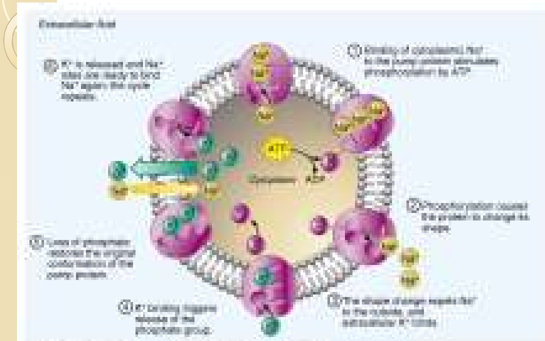

Figure 3.9

Active Transport

- Uses ATP to move solutes across a membrane
- Requires carrier proteins

Types of Active Transport

- Symport system – two substances are moved across a membrane in the same direction
- Antiport system – two substances are moved across a membrane in opposite directions
- Primary active transport – hydrolysis of ATP phosphorylates the transport protein causing conformational change

Types of Active Transport

- Secondary active transport – use of an exchange pump (such as the Na^+-K^+ pump) indirectly to drive the transport of other solutes

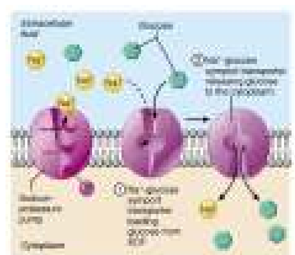

Figure 3.10

Vesicular Transport

- Transport of large particles and macromolecules across plasma membranes
  - Exocytosis – moves substance from the cell interior to the extracellular space
  - Endocytosis – enables large particles and macromolecules to enter the cell
  - Phagocytosis – pseudopods engulf solids and bring them into the cell's interior

Vesicular Transport

- Bulk-phase endocytosis – the plasma membrane infolds, bringing extracellular fluid and solutes into the interior of the cell
- Receptor-mediated transport – uses clathrin-coated pits as the major mechanism for specific uptake of macromolecules

Vesicular Transport

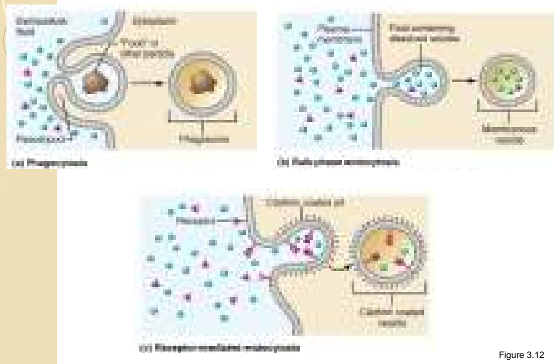

Figure 3.12

Passive Membrane Transport – Review

Process	Energy Source	Example
Simple diffusion	Kinetic energy	Movement of O2 through membrane
Facilitated diffusion	Kinetic energy	Movement of glucose into cells
Osmosis	Kinetic energy	Movement of H_2O in & out of cells
Filtration	Hydrostatic pressure	Formation of kidney filtrate

Active Membrane Transport – Review

Process	Energy Source	Example
Active transport of solutes	ATP	Movement of ions across membranes
Exocytosis	ATP	Neurotransmitter secretion
Endocytosis	ATP	White blood cell phagocytosis
Bulk-phase endocytosis	ATP	Absorption by intestinal cells
Receptor-mediated endocytosis	ATP	Hormone and cholesterol uptake

Membrane Potential

- Voltage across a membrane
- Resting membrane potential
  - Ranges from –20 to –200 mV
  - Results from Na^+ and K^+ concentration gradients across the membrane
  - Differential permeability of the plasma membrane to Na^+ and K^+

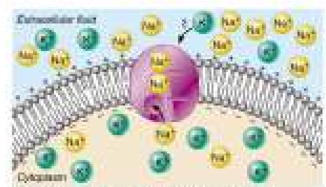

Figure 3.13

Cell Adhesion Molecules (CAMs)

- Anchor cells to the extracellular matrix
- Assist in movement of cells past one another
- Rally protective white blood cells to injured or infected areas

Roles of Membrane Receptors

- Contact signaling – important in normal development and immunity
- Electrical signaling – voltage-regulated "ion gates" in nerve and muscle tissue
- Chemical signaling – neurotransmitters bind to chemically gated channel-linked receptors in nerve and muscle tissue
- G protein-linked receptors – ligands bind to a receptor which activates a G protein, causing the release of a second messenger, such as cyclic AMP

Operation of a G protein

- An extracellular ligand (first messenger), binds to a specific plasma membrane protein
- The receptor activates a G protein that relays the message to an effector protein

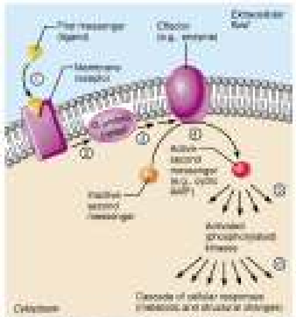

Figure 3.14

Operation of a G protein

- The effector is an enzyme that produces a second messenger inside the cell
- The second messenger activates a kinase
- The activated kinase can trigger a variety of cellular responses

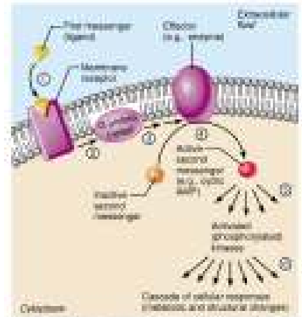

Figure 3.14