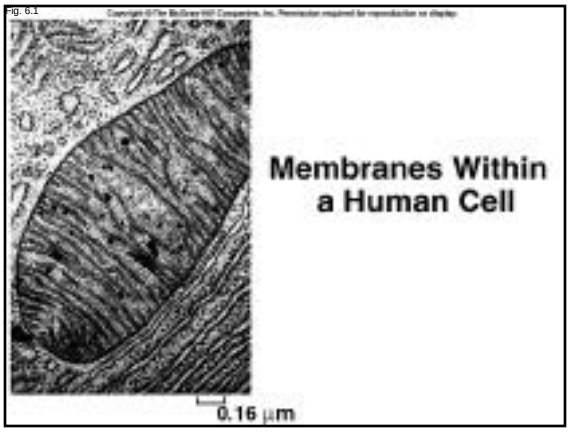
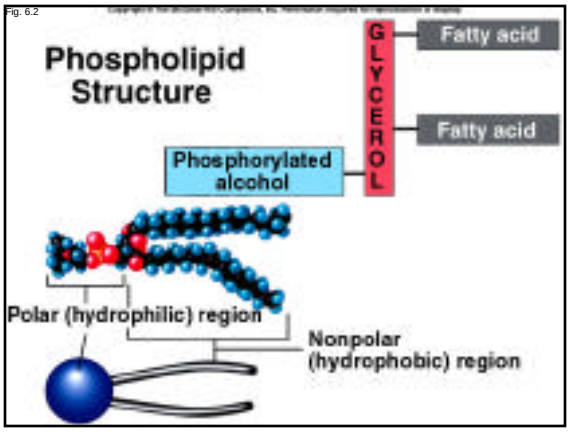
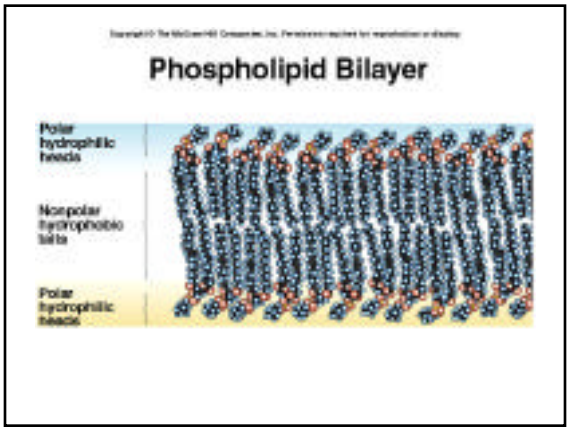
Membranes

Plasma membrane

- ✓Regulation of movement of materials in and out of the cell
- ✓Receives and translates chemical and environmental signals from outside of the cell.







Membranes

- ✓Phospholipid bilayer.
- ✓Contains proteins, glycoproteins, glycolipids.
- ✓"Fluid mosaic" structure.
  - ⇨Both protein and lipids move freely within the plane of the membrane
- ✓Serve as a hydrophobic barrier. Hydrophilic molecules are contained either outside or inside of the cell.
- ✓Membranes are selectively permeable.
  - ⇨Water will transport (diffuse) across the membrane
  - ⇨Membrane proteins help transport specific molecules across the membrane

Fig. 6.3

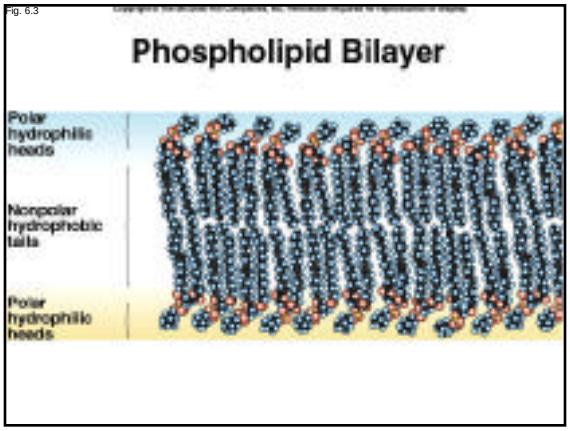
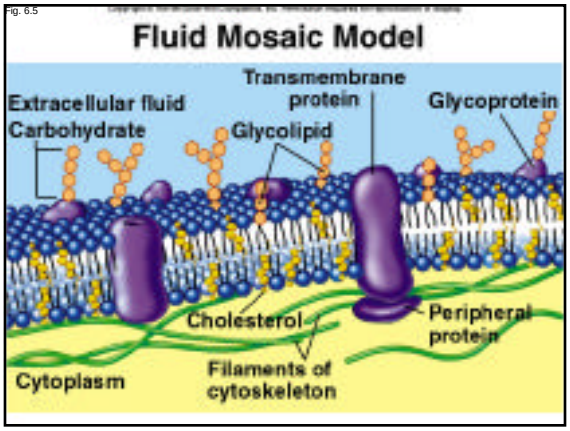


Fig. 6.5



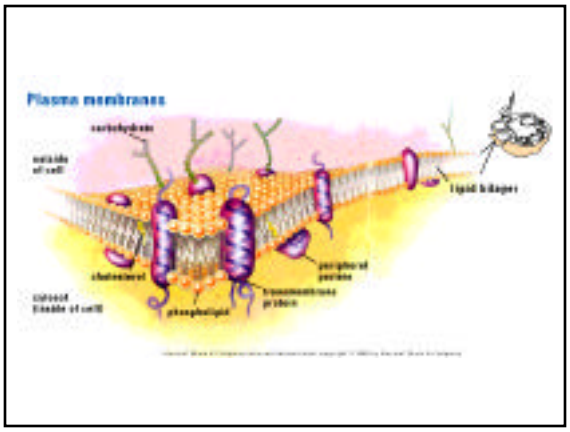


Fig. 6.4

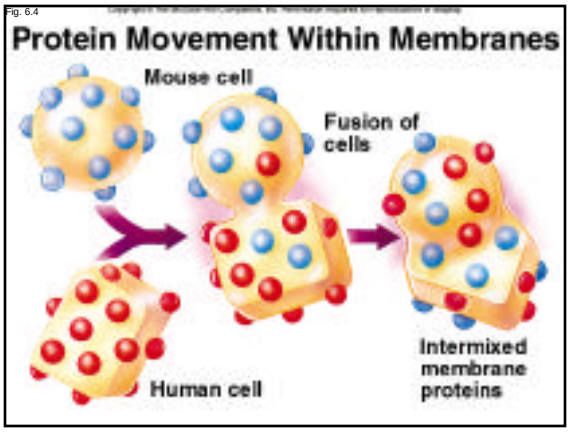
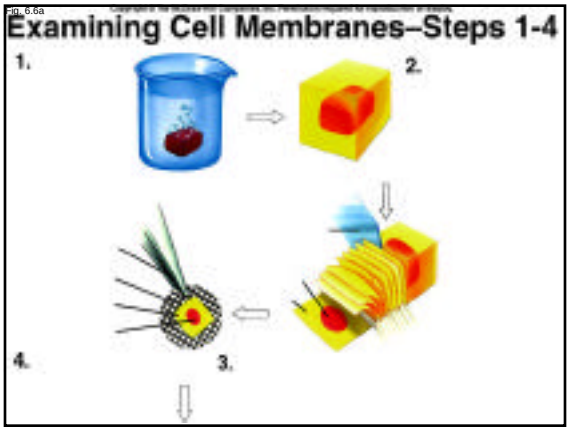


Table 6.1 Components of the Cell Membrane

Component	Composition	Function	How It Works	Example
Phospholipid bilayer	Phospholipid molecules	Provides permeability barrier, matrix for proteins	Excludes water-soluble molecules from nonpolar interior of bilayer	Bilayer of cell is impermeable to water-soluble molecules, like glucose
Transmembrane proteins	Carriers	Active and passive transport of molecules across membrane	"Escort" molecules through the membrane in a series of conformational changes	Glycophorin carrier for sugar transport; sodium-potassium pump
	Channels	Passively transport molecules across membrane	Create a tunnel that acts as a passage through membrane	Sodium and potassium channels in nerve cells
	Receptors	Transmit information into cell	Signal molecules bind to cell-surface portion of the receptor protein; this alters the portion of the receptor protein within the cell, inducing activity	Specific receptors bind peptide hormones and neurotransmitters
Interior protein network	Spectrins	Determine shape of cell	Form supporting scaffold beneath membrane, anchored to both membrane and cytoskeleton	Red blood cell
	Clathrins	Anchor certain proteins to specific sites, especially on the exterior cell membrane in receptor-mediated endocytosis	Proteins line coated pits and facilitate binding to specific molecules	Localization of low-density lipoprotein receptor within coated pits
Cell surface markers	Glycoproteins	"Self"-recognition	Create a protein/carbohydrate chain shape characteristic of individual	Major histocompatibility complex protein recognized by immune system
	Glycolipid	Tissue recognition	Create a lipid/carbohydrate chain shape characteristic of tissue	A, B, O blood group markers

Fig. 6.6a



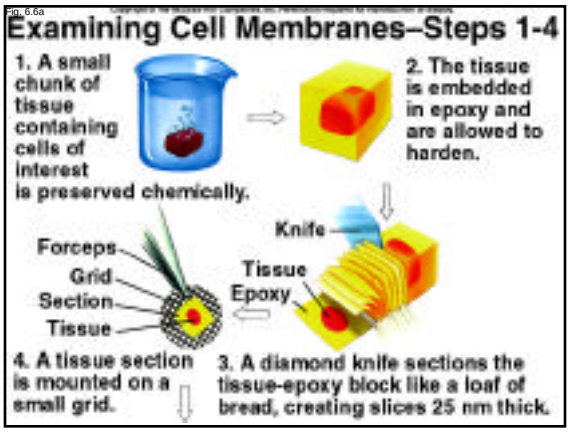


Fig. 6.6a
Examining Cell Membranes–Steps 1-4
1. A small chunk of tissue containing cells of interest is preserved chemically.
2. The tissue is embedded in epoxy and are allowed to harden.
Forceps
Grid
Section
Tissue
Knife
Tissue Epoxy
4. A tissue section is mounted on a small grid.
3. A diamond knife sections the tissue-epoxy block like a loaf of bread, creating slices 25 nm thick.

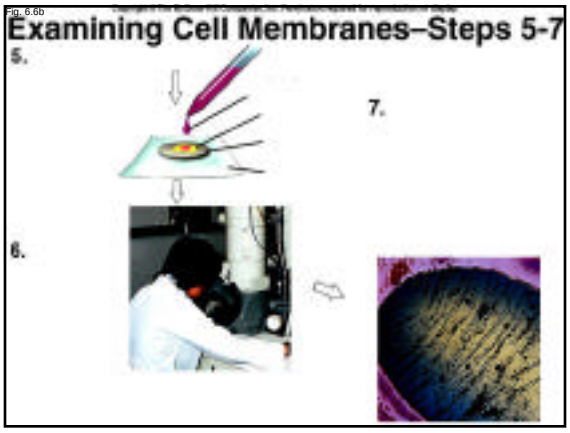


Fig. 6.6b
Examining Cell Membranes–Steps 5-7
5.
7.
6.

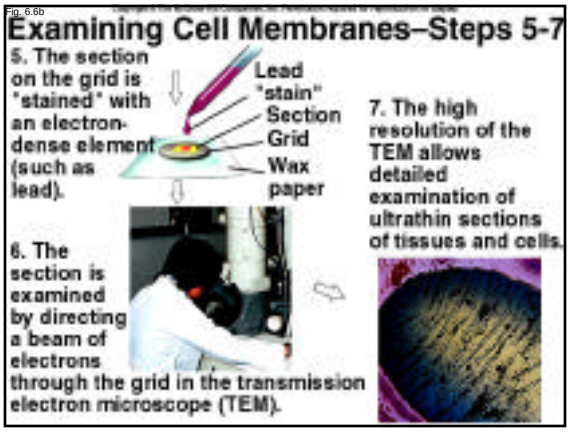


Fig. 6.6b
Examining Cell Membranes–Steps 5-7
5. The section on the grid is "stained" with an electron-dense element (such as lead).
Lead "stain"
Section
Grid
Wax paper
7. The high resolution of the TEM allows detailed examination of ultrathin sections of tissues and cells.
6. The section is examined by directing a beam of electrons through the grid in the transmission electron microscope (TEM).

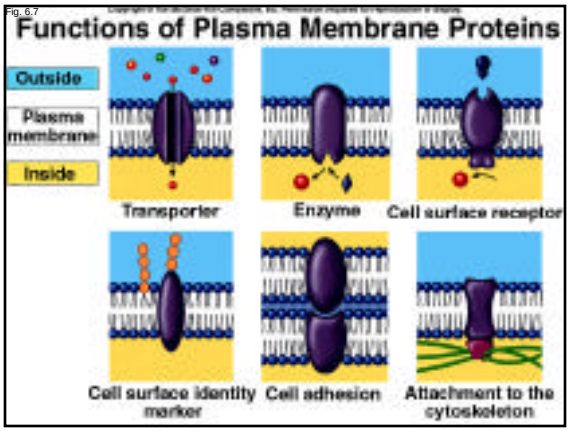


Fig. 6.7
Functions of Plasma Membrane Proteins
Outside
Plasma membrane
Inside
Transporter
Enzyme
Cell surface receptor
Cell surface identity marker
Cell adhesion
Attachment to the cytoskeleton

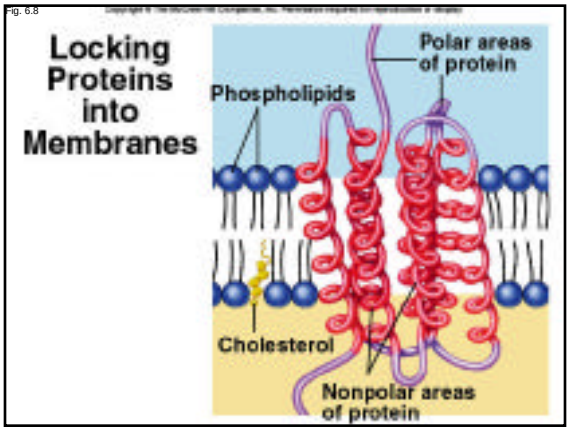


Fig. 6.8
Locking Proteins into Membranes
Polar areas of protein
Phospholipids
Cholesterol
Nonpolar areas of protein

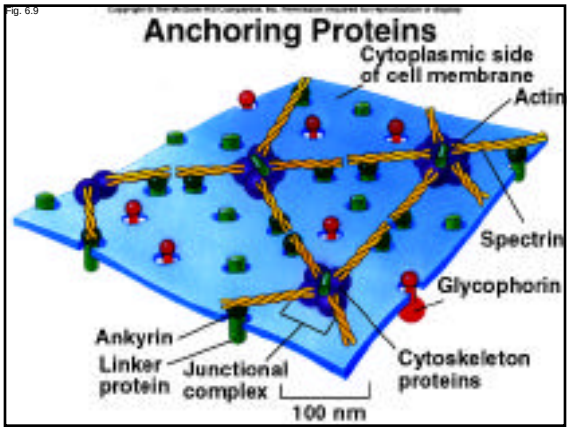
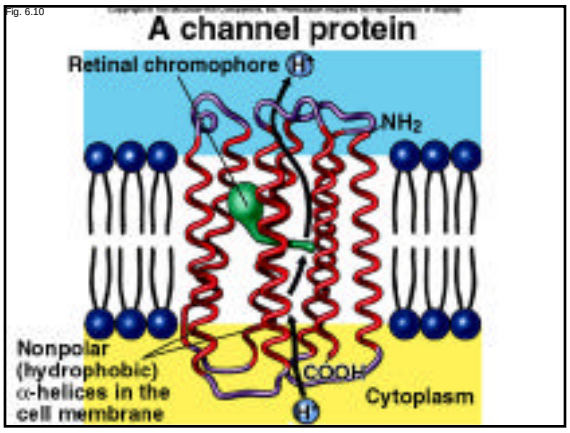
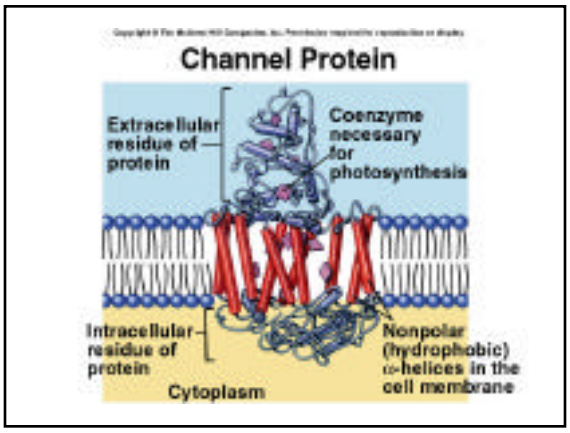
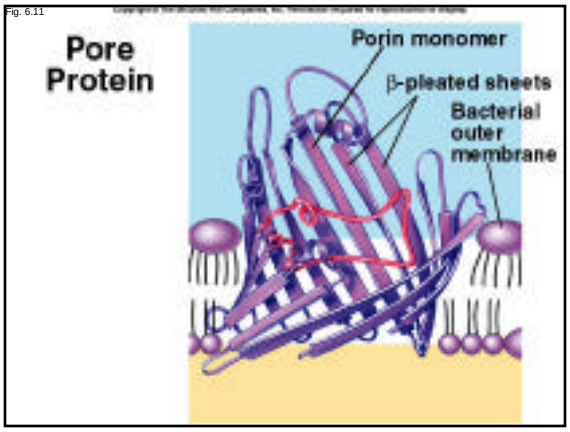


Fig. 6.9
Anchoring Proteins
Cytoplasmic side of cell membrane
Actin
Spectrin
Glycophorin
Ankyrin
Linker protein
Junctional complex
Cytoskeleton proteins
100 nm







Movement of molecules through the membrane

- ✓Passive Transport
  - ✒Simple diffusion
  - ✒Facilitated diffusion
- ✓Active Transport

Passive transport

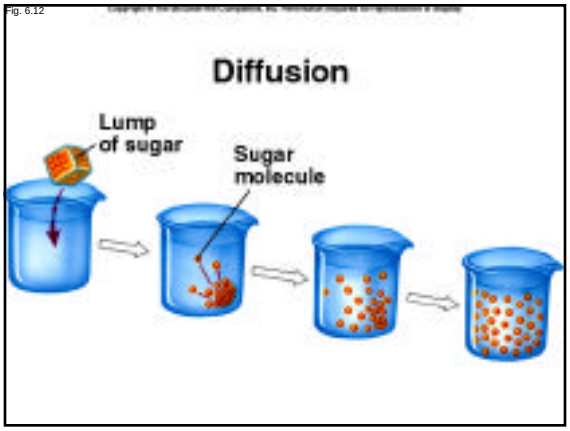
- ✓Spontaneous movement of molecules through the plasma membrane without the expenditure of energy.

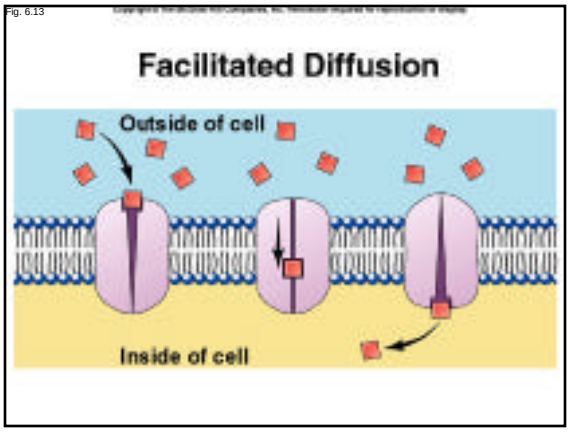
Active transport

- ✓Movement of molecules through the plasma membrane against a concentration gradient.
- ✓Requires energy.

Factors influencing movement of molecules across the membrane

- ✓Lipid solubility (hydrophobicity)
- ✓Size of molecule.
- ✓Electrical charge of molecule.
- ✓Presence of membrane proteins that facilitate movement of large and electrically-charged molecules.





Simple diffusion

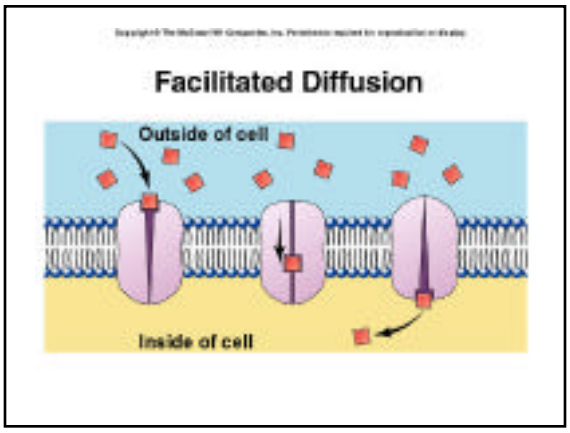
- ✓Diffusion is the random movement of molecules, ions, or atoms from an area of high concentration to an area of low concentration.
- ✓The space between the two areas is called a concentration gradient.
- ✓Eventually equilibrium is established.

Simple diffusion through membranes.

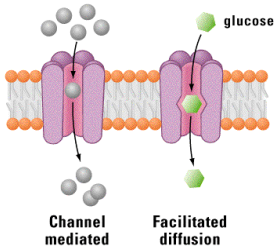
- ✓For most lipid-soluble molecules, diffusion occurs through the plasma membrane without help of proteins.
- ✓For large or electrically-charged molecules or ions, diffusion can be channel-mediated.

Facilitated diffusion

- ✓Increases the rate of passive transport.
- ✓Specific proteins within the membrane facilitate the movement of molecules into and out of the cell.
- ✓Movement is down a concentration gradient.



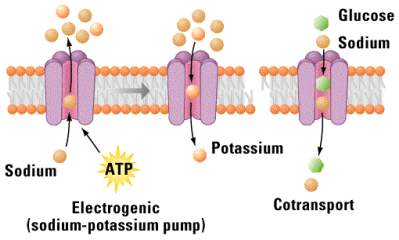
Channel-mediated vs. facilitated diffusion

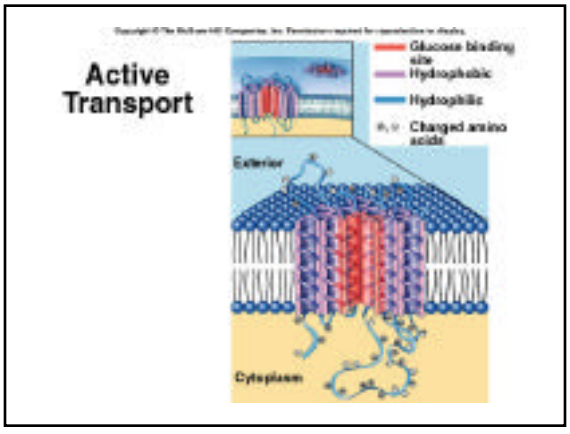


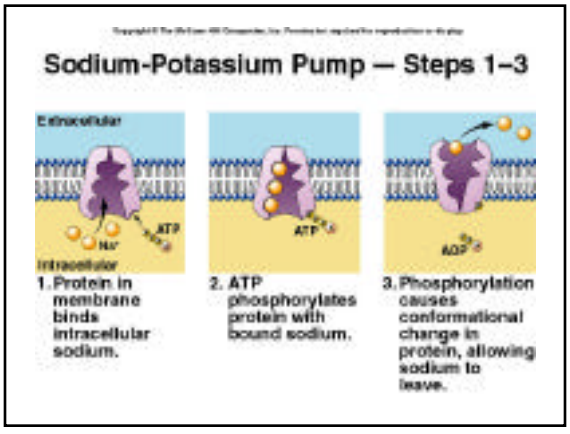
Active Transport

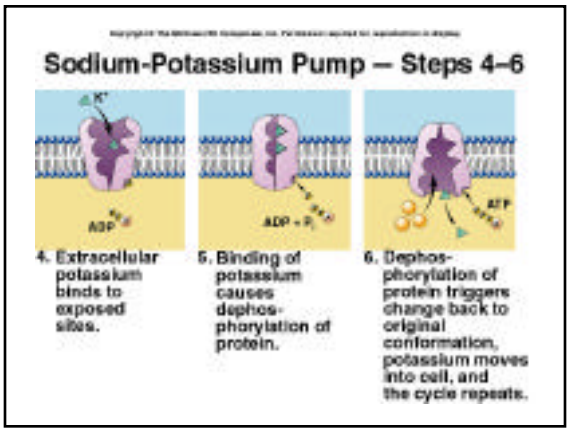
✓A pump mechanism that moves molecules and ions through the membrane.

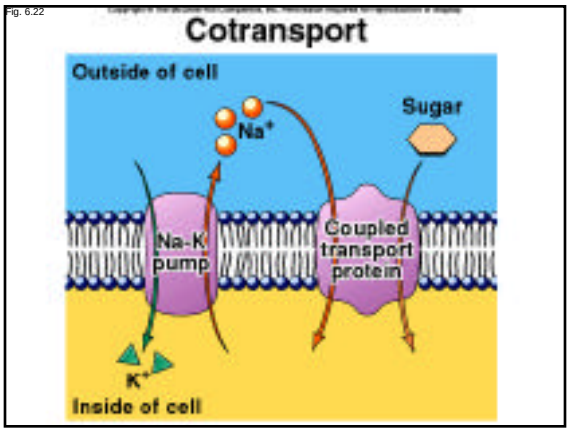
Sodium-Potassium Pump

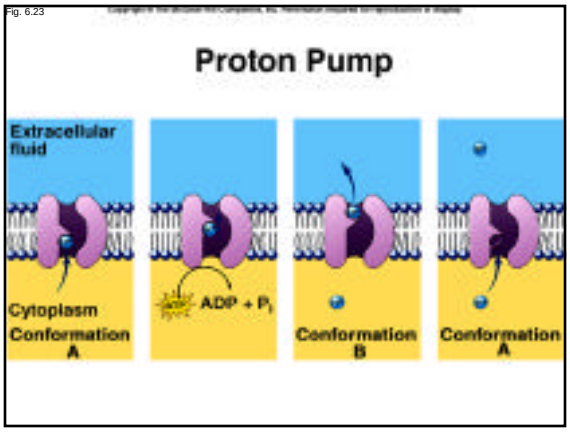






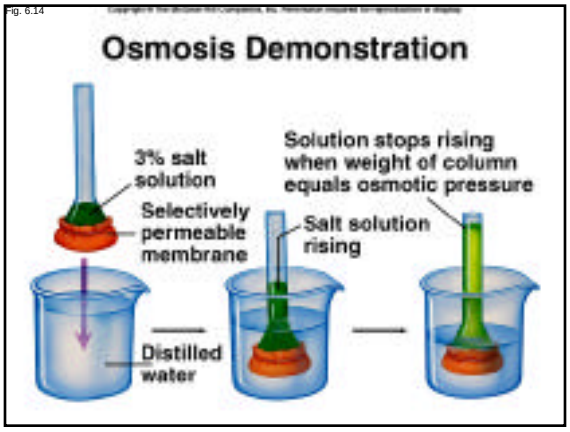


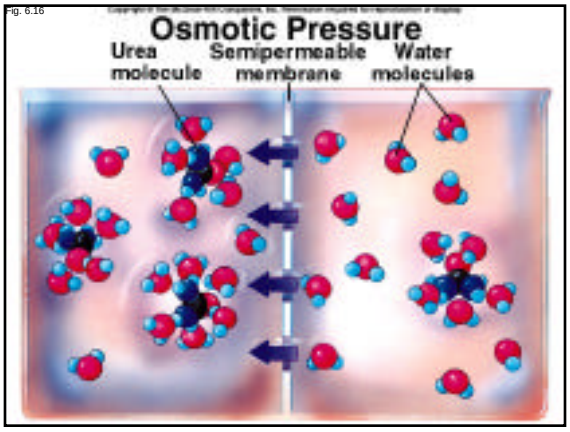




Osmosis

- ✓Movement of water across a selectively permeable membrane in response to a concentration gradient.
- ✓Movement of water is towards the zone of high solute concentration.
- ✓The pressure associated with the movement of water is called osmotic pressure.





Isotonic

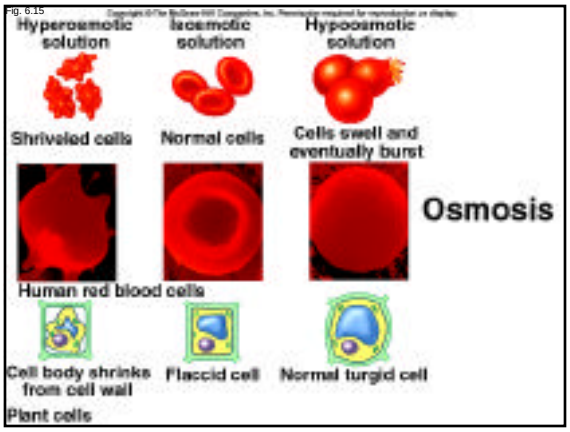
- ✓ Solute concentration is the same on both sides of the plasma membrane.
- ✓ Movement of water is equal in both directions.

Hypertonic

- ✓ Solute concentration is greater on the outside of cell.
- ✓ Movement of water is towards the greater solute concentration.
- ✓ Water moves OUT of the cell.

Hypotonic

- ✓ Solute concentration is greater on the inside of cell.
- ✓ Movement of water is towards the greater solute concentration.
- ✓ Water moves INTO the cell.



Other mechanisms

- ✓ Membrane fusion
  - ✒ Endocytosis
    - ➪ pinocytosis
    - ➪ receptor mediated pinocytosis
  - ✒ Phagocytosis
  - ✒ Exocytosis

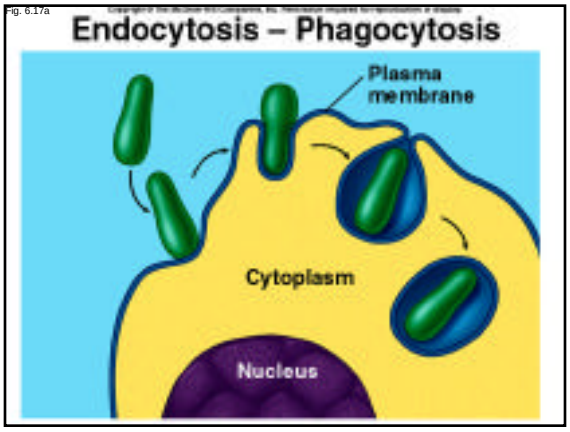


Fig. 6.17b

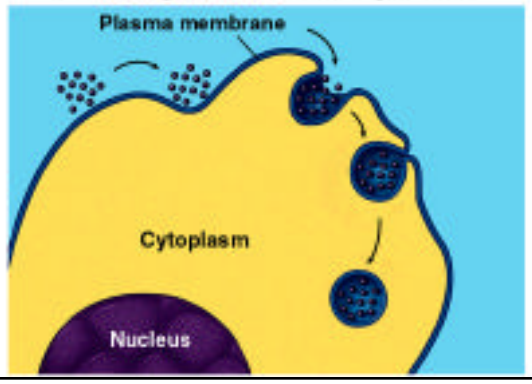


Fig. 6.18

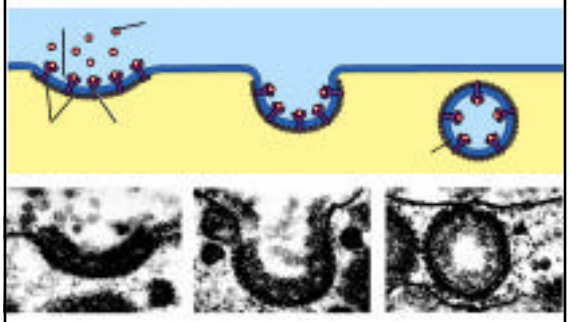


Fig. 6.18

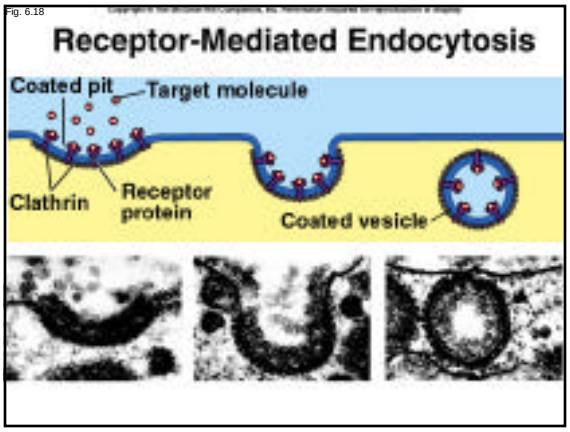


Fig. 6.19

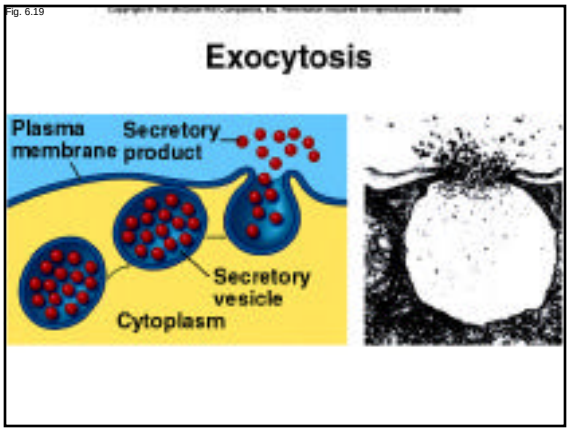


Table 6.2 Mechanisms for Transport across Cell Membranes

Process	Passage through Membrane	How It Works	Example
PASSIVE PROCESSES			
Diffusion	Direct	Random molecular motion produces net migration of molecules toward region of lower concentration	Movement of oxygen into cells
	Protein channel	Polar molecules pass through a protein channel	Movement of ions in or out of cell
Facilitated diffusion	Protein carrier	Molecule binds to carrier protein in membrane and is transported across; net movement is toward region of lower concentration	Movement of glucose into cells
Osmosis	Direct	Diffusion of water across differentially permeable membrane	Movement of water into cells placed in a hypotonic solution
ACTIVE PROCESSES			
Endocytosis			
Phagocytosis	Membrane vesicle	Particle is engulfed by membrane, which folds around it and forms a vesicle	Ingestion of bacteria by white blood cells
Pinocytosis	Membrane vesicle	Fluid droplets are engulfed by membrane, which forms vesicles around them	"Nursing" of human egg cells
Carrier-mediated endocytosis	Membrane vesicle	Endocytosis triggered by a specific receptor	Cholesterol uptake
Exocytosis	Membrane vesicle	Vesicles fuse with plasma membrane and eject contents	Secretion of mucus
Active transport			
Na^+/K^+ pump	Protein carrier	Carrier expends energy to export Na^+ against a concentration gradient	Coupled uptake of glucose into cells against its concentration gradient
Proton pump	Protein carrier	Carrier expends energy to export protons against a concentration gradient	Chemiosmotic generation of ATP

Plasmodesmata

✓Intercellular channels that allow molecules to pass directly from one plant cell to another.

Cell to cell comunication

- ✓Gap junctions
  - ✒Intercellular connections between animal cells.
- ✓Adhering junctions
  - ✒resist mechanical stress without affecting intercellular communication.
  - ✒Desmosomes connect cells together
- ✓Tight junctions are fused membranes
  - ✒Seal cells together to prevent leakage