MEMBRANE STRUCTURE AND FUNCTION

Membrane transport

“Got to get it there”

Chapter 7 Continued

Objectives

- Understand what factors influence membrane permeability
- Understand the difference between passive and active transport
- Be able to discuss the processes of: Diffusion, Osmosis, Facilitated diffusion Pumps, Cotransport, Exocytosis and Endocytosis

Why do materials move?

- Molecules are in motion
- The motion of molecules increases the entropy of the system (less order)
- Molecular collisions result in molecules being moved along a gradient (concentration gradient or free energy gradient)
- Through random molecular collisions directional motion can be accomplished

Membrane Permeability

- Hydrophobic middle of the bilayer inhibits the passage of ions and polar molecules that are hydrophilic
- Transport proteins may assist ions and polar molecules across the membrane

- **Can cross** lipid bilayer = nonpolar, small uncharged polar molecules
- **Cannot** cross lipid bilayer = large polar and charged molecules

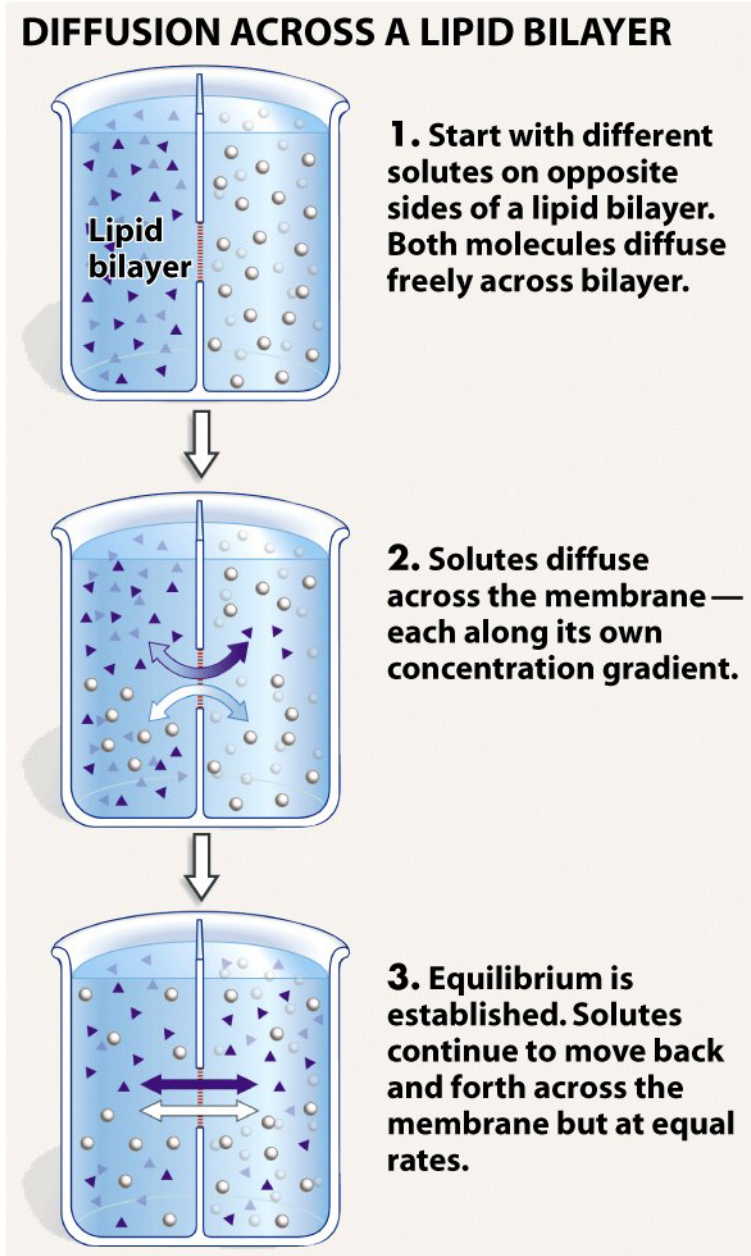
Transport Mechanisms

The movement of materials across membranes takes many routes but the mechanisms are categorized as either passive or active transport mechanisms

- Passive Transport
  - moves molecules along a concentration gradient
  - no cellular energy required
- Active transport
  - moves molecules against a concentration gradient
  - requires cellular energy

Passive Transport Mechanism

- **Simple Diffusion**: the movement of a substance from higher concentration to lesser concentration
- Simple diffusion occurs across the lipid bilayer
- The bilayer is selectively permeable as not everything can get across



Specific examples of diffusion: Osmosis

- **Osmosis**: the diffusion of water (solvent) across a membrane
  - influenced by total solute concentration
- **Osmotic pressure**: pressure exerted on a membrane due to an imbalance of solute between the inside and outside of the membrane

✓ **Water always moves toward the side with a greater concentration of solute**

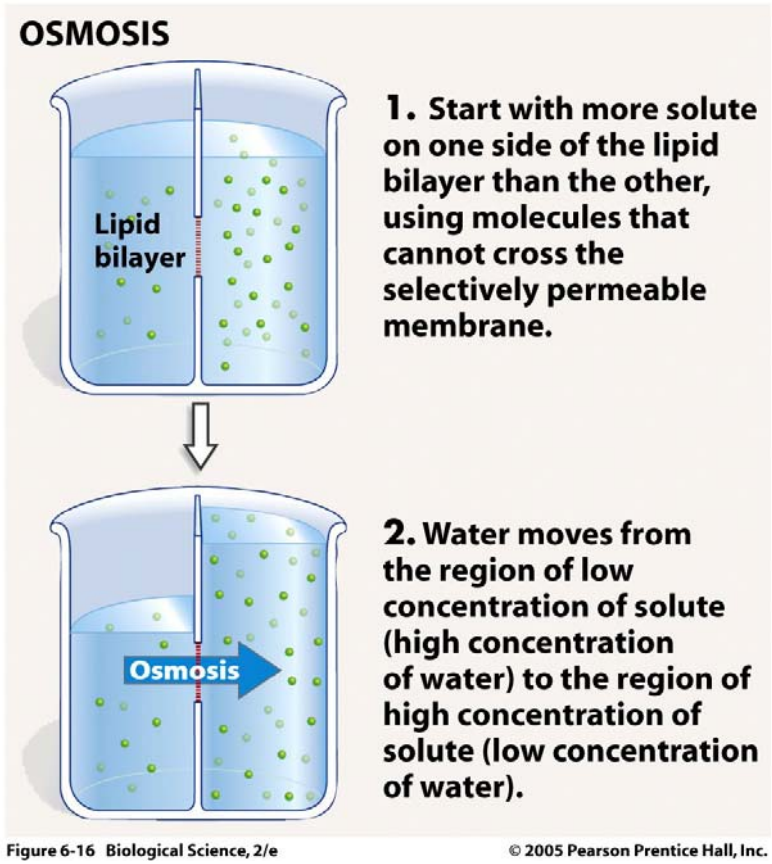
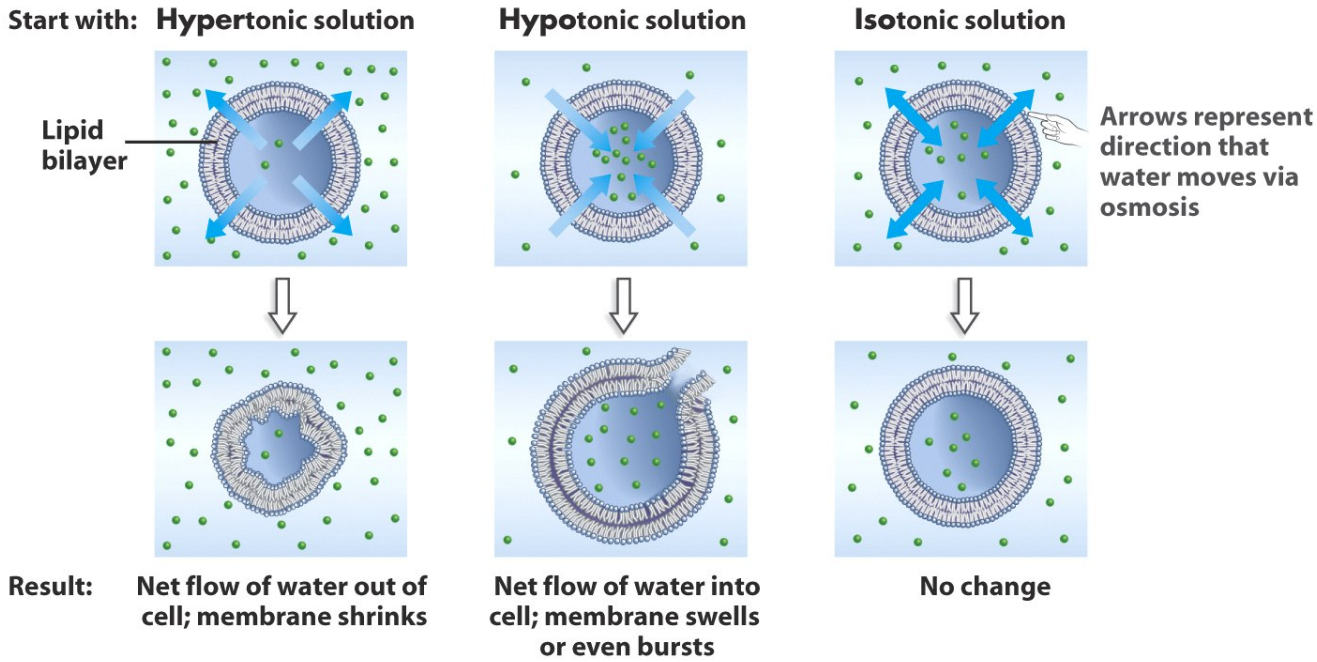


Figure 6-16 Biological Science, 2/e

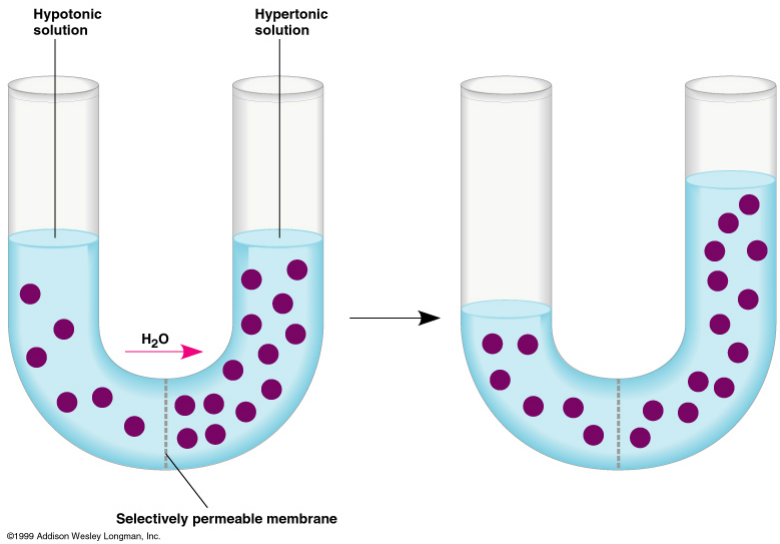
Cells respond to osmosis, so what?



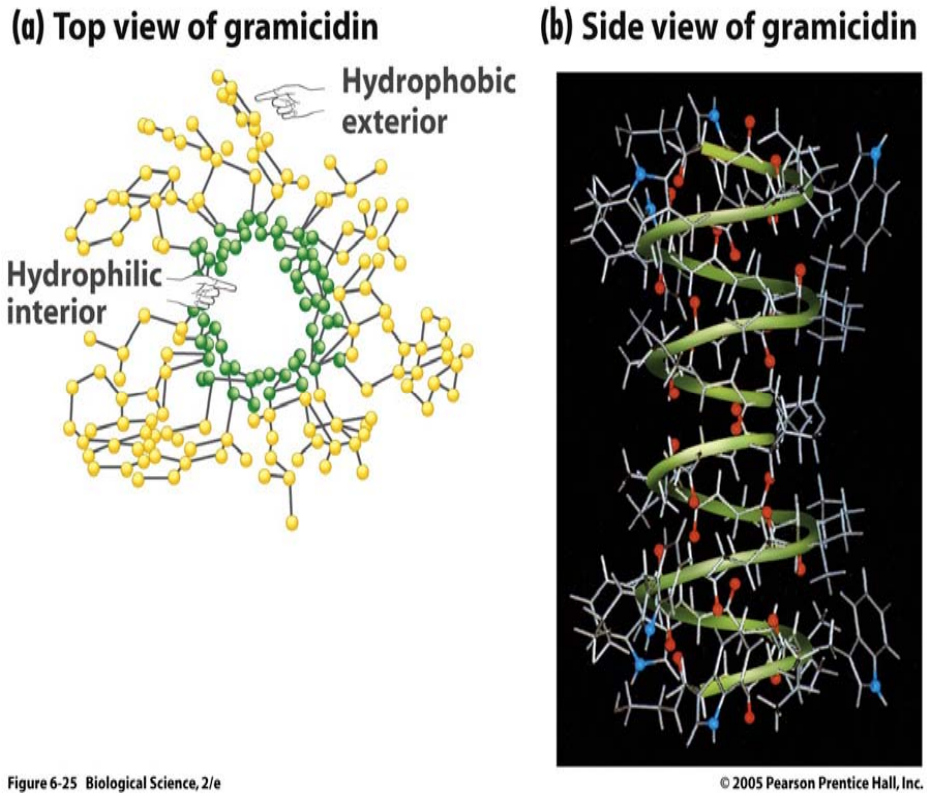
- **Tonicity**: the ability of a solution to move water
  - Hypertonic: Greater ability to move H_2O; gains water
  - Hypotonic: Lesser ability to move H_2O; loses water
  - Isotonic: equal ability to move H_2O; no net water movement

The Importance of Osmoregulation

- Living things must balance water uptake and loss
- If cells lose water they crenate
- If cells gain water they lyse
- Expulsion vacuole
- Turgor pressure

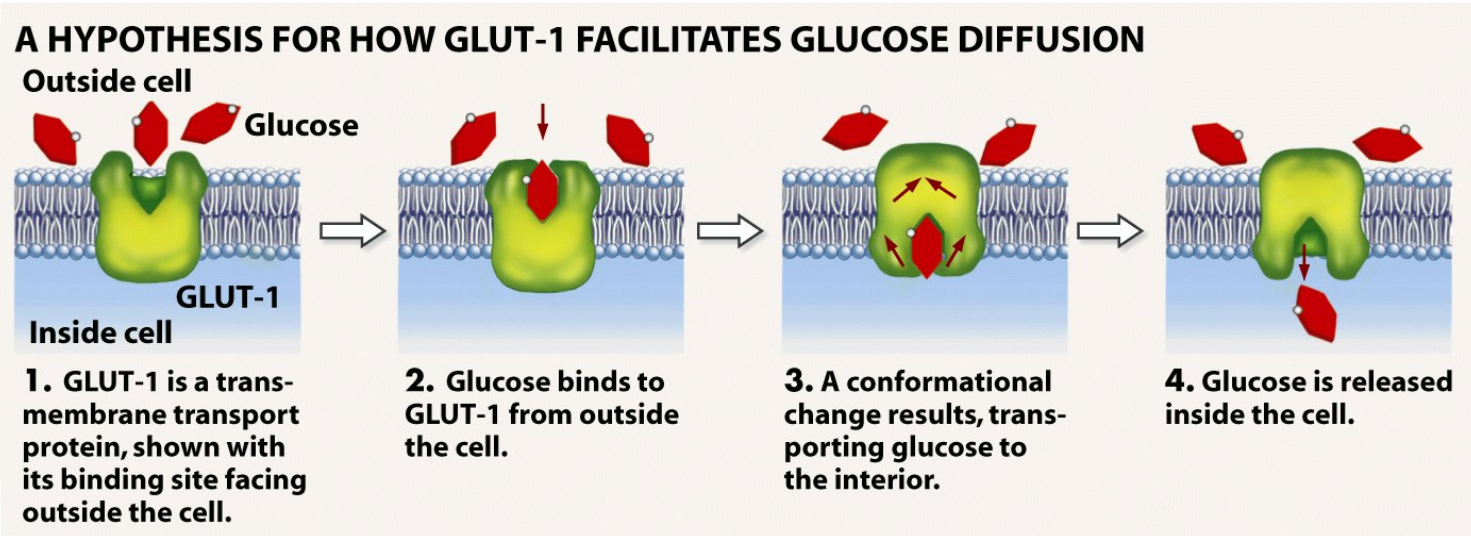


Transport Proteins: Facilitated Diffusion Via Channel Proteins



- Involves transport proteins moving a solute along a concentration gradient
- May be specific
- May be saturated (can only work so fast) or inhibited
- Passive mechanism

Transport Proteins: Facilitated Diffusion Via Carrier Proteins



- Molecule causes a controlled denaturation resulting in a molecule being transported
- May be specific
- May be saturated or inhibited
- Protein assists the process of diffusion; passive mechanism

Regulation of Facilitated Diffusion

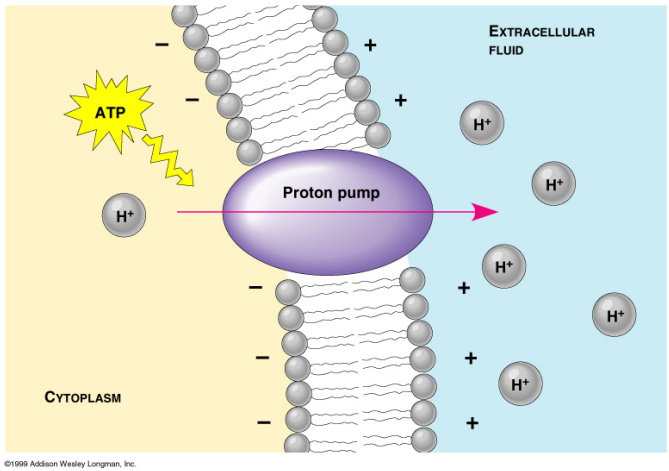
- Some transport proteins are regulated by chemical or electrical stimuli
- Usually these proteins are permanent channels that are opened or closed via other proteins (gated channels)

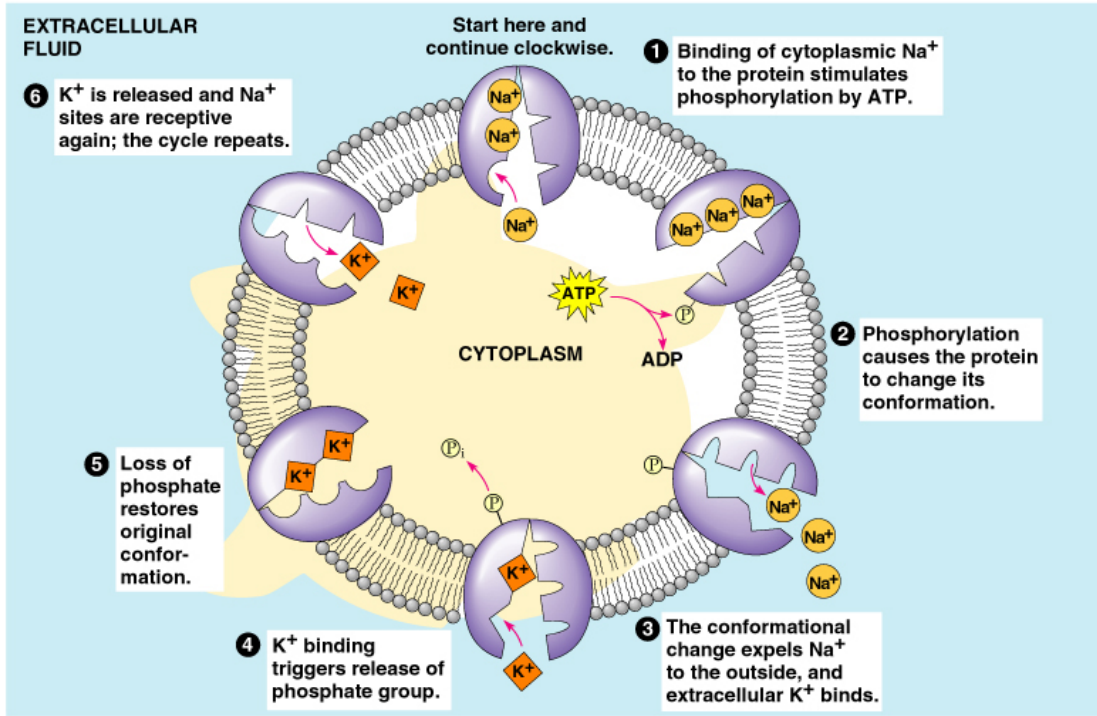
Active Transport: Pumps

- Moves solute uphill and requires energy
- Always requires carrier proteins
- Major factor that allows the cell to regulate the concentration of solute within the cell
- May result in an **imbalance of solute** across a membrane that the cell can utilize

Kinds of Pumps

- Na^+/K^+
- H^+
- Ca^{2+}





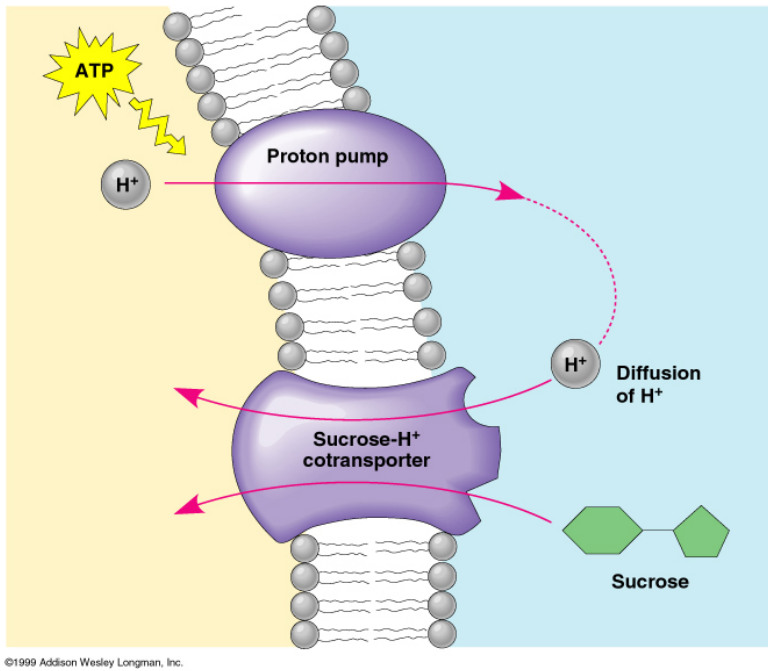
Some pumps create electrical differences across a membrane (**electrogenic pumps**)

Electrochemical Gradient

- The difference in voltage across a membrane resulting from electrogenic pumps is called **membrane potential**
- This electrical force affects the transport of charged solutes
- Cations are favored because interior of cell is usually negative compared to the outside
- Resulting **Electrochemical Gradient** affects ion transport:
  - electrical = membrane potential
  - chemical = concentration gradient

Cotransport (secondary active transport)

- Two solutes transported at one time via a transport protein
  - one with a gradient
  - one against a gradient
- Solute moving with the gradient does so because of an earlier active transport event (pump)

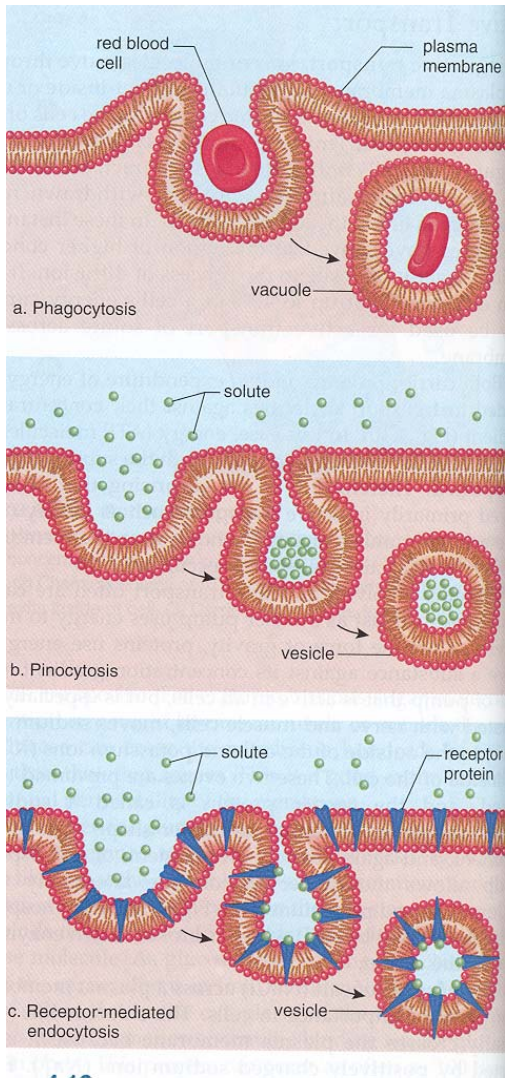


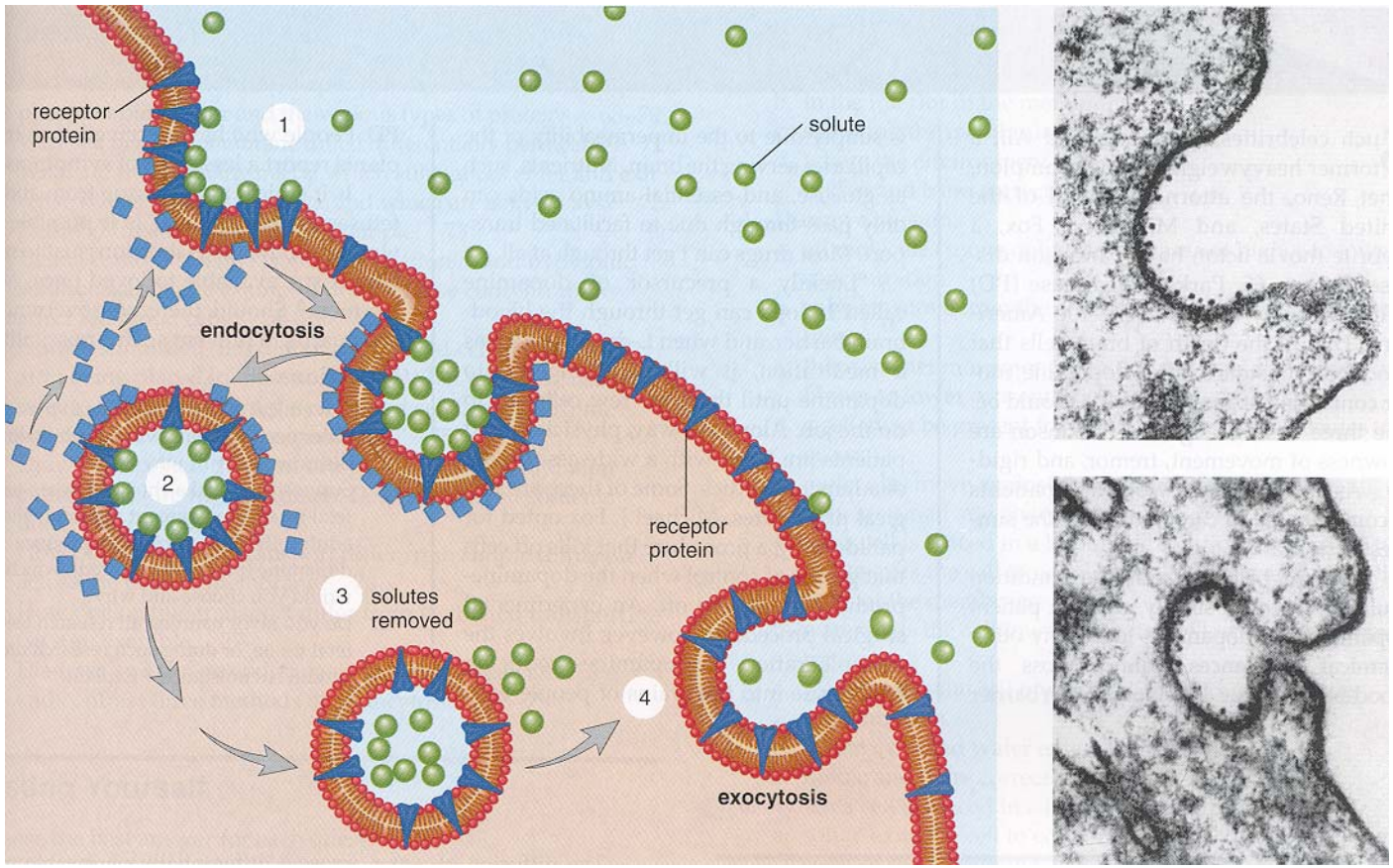
Exocytosis and Endocytosis

- Exocytosis involve the movement of macromolecules out of the cell by the fusion of membrane bound vesicles to the plasma membrane
- Endocytosis involves the movement of macromolecules into the cell by the pinching of the plasma membrane into membrane bound vesicles
  - Phagocytosis
  - Pinocytosis
  - Receptor-mediated pinocytosis

Endocytosis

- Phagocytosis: ingestion of large particle
- Pinocytosis: ingestion of small mixed solutes
- Receptor-mediated pinocytosis: ingestion of specific solutes (ligands) with the aid of binding proteins; areas called coated pits




receptor protein
1
solute
endocytosis
2
receptor protein
3 solutes removed
4
exocytosis