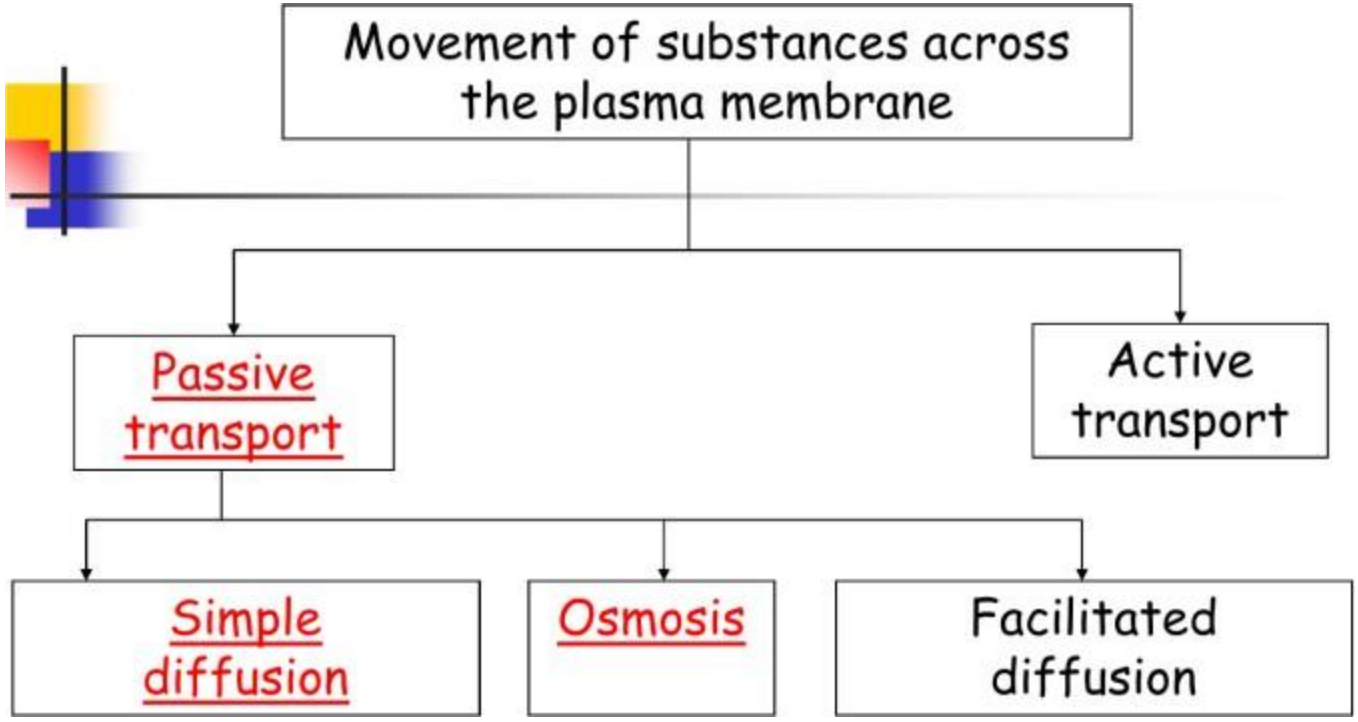
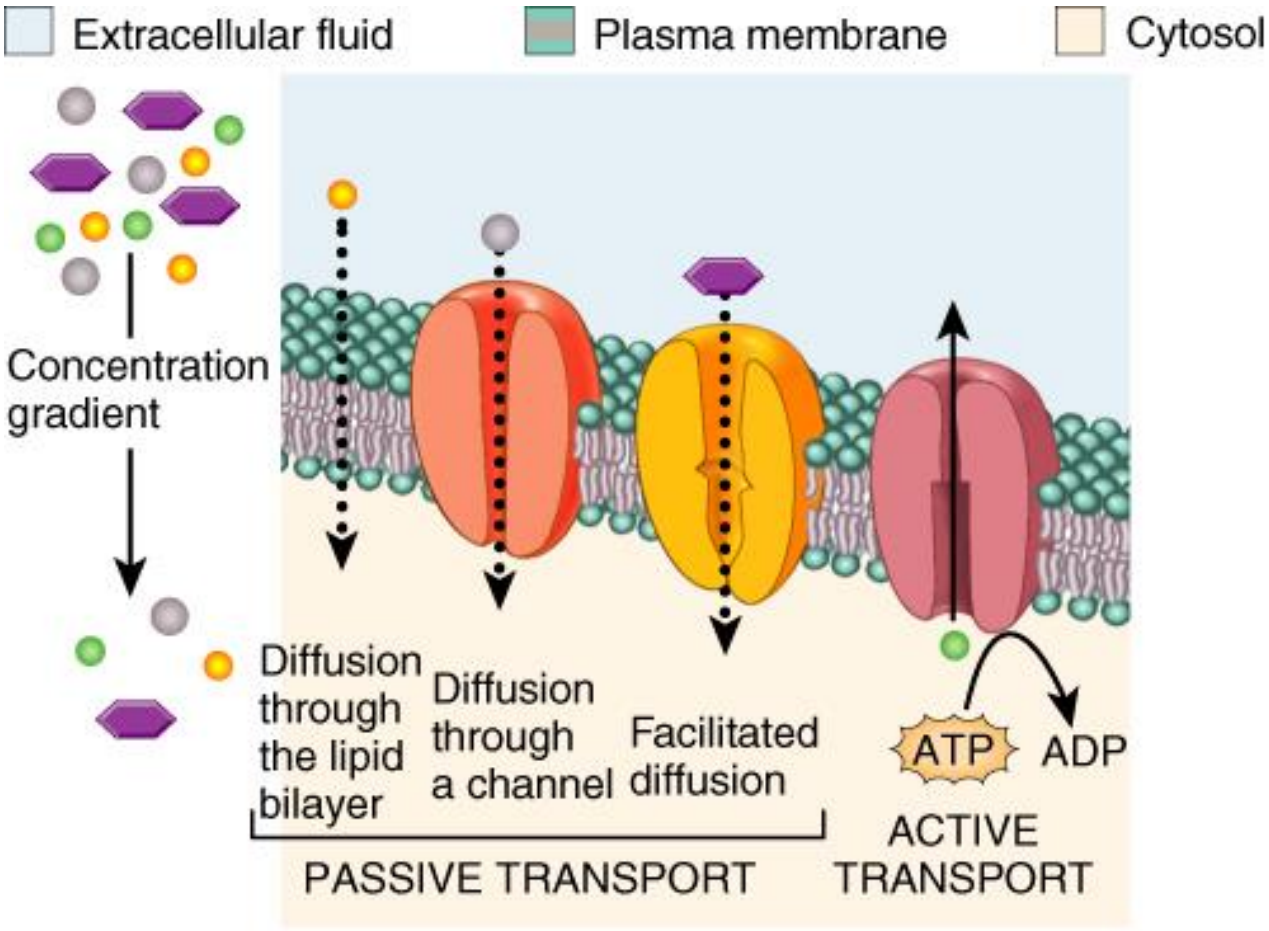
Transport across Plasma Membranes

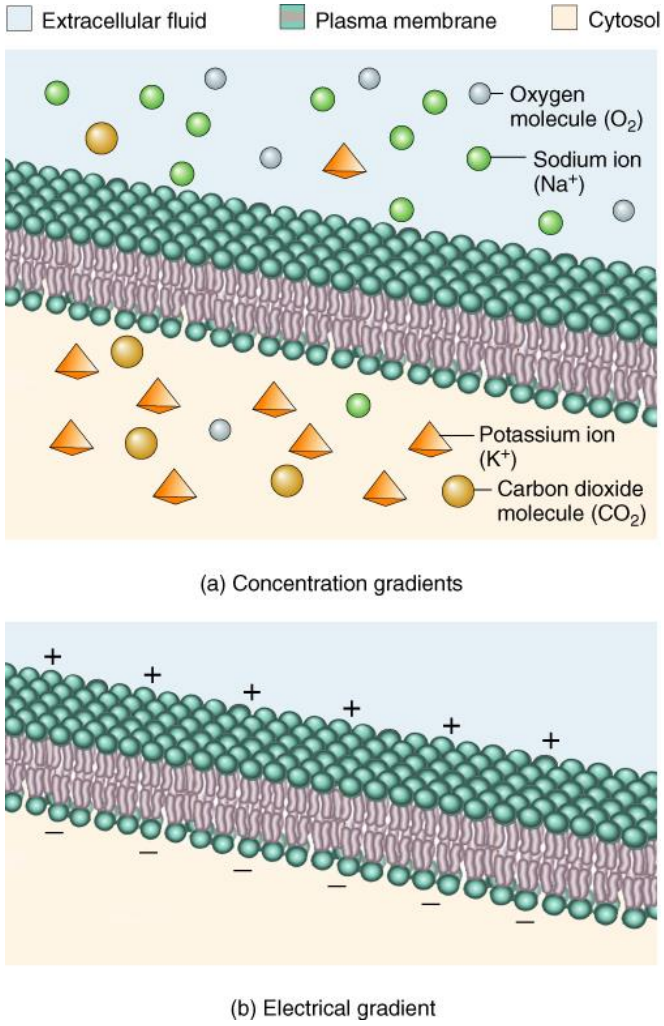
Transport across Plasma Membranes



Transport across Plasma Membranes



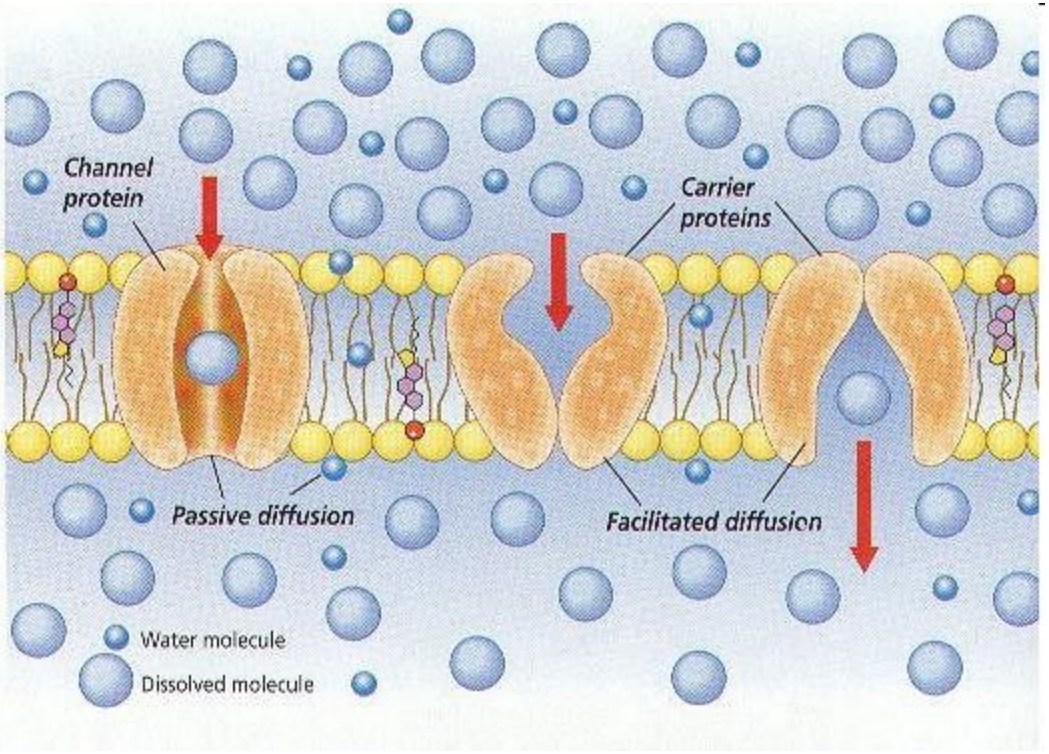
Diffusion through lipid bilayer



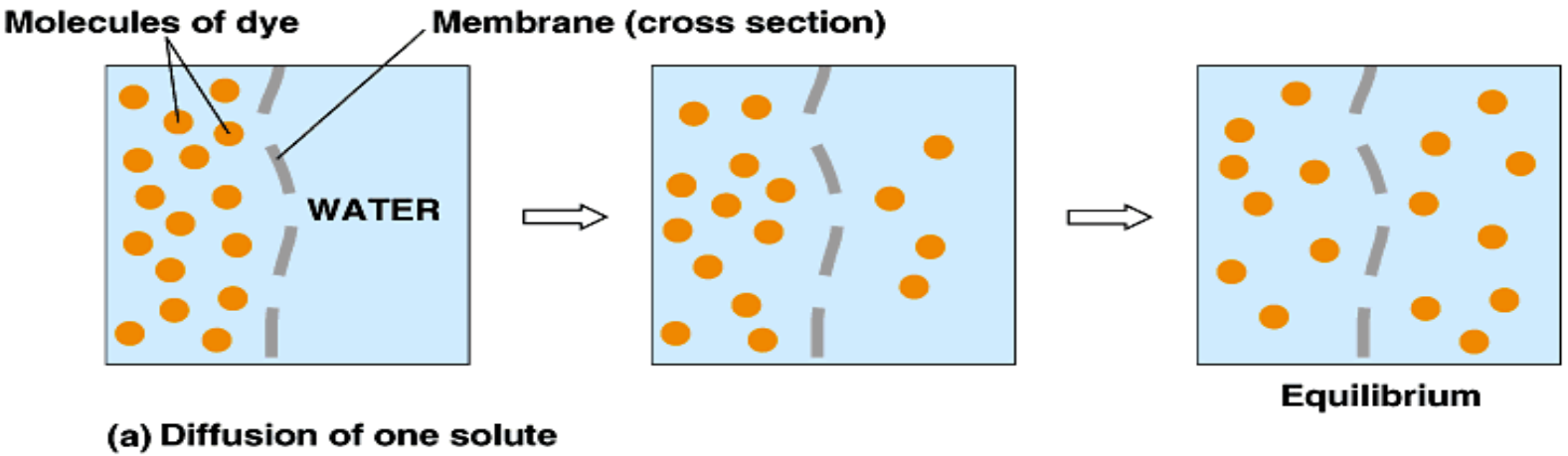
- CO2
- O2
- NO
- Steroid Hormones
- Monoglycerides

Diffusion through channels

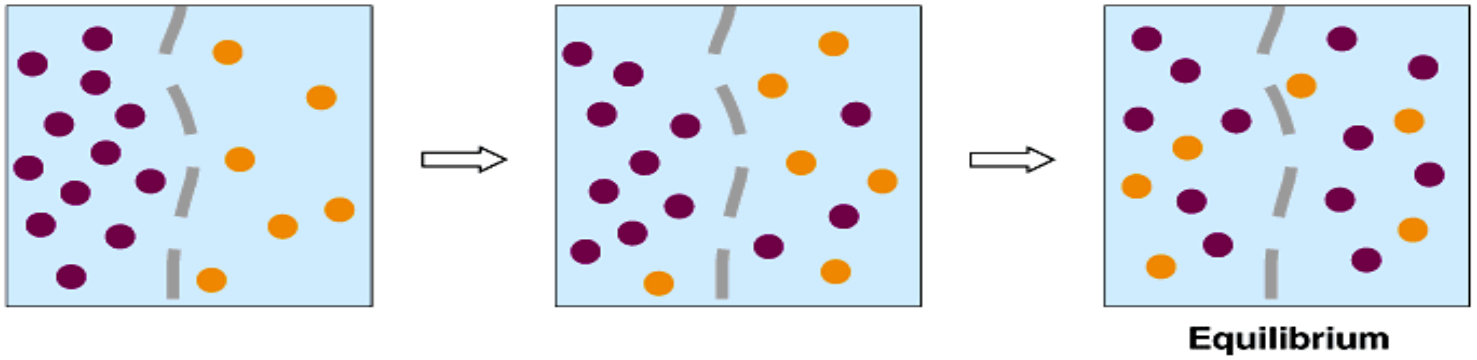
Channel proteins provide the openings through which small, dissolved particles, especially ions, diffuse by passive transport.



Simple Diffusion



(a) Diffusion of one solute



(b) Diffusion of two solutes

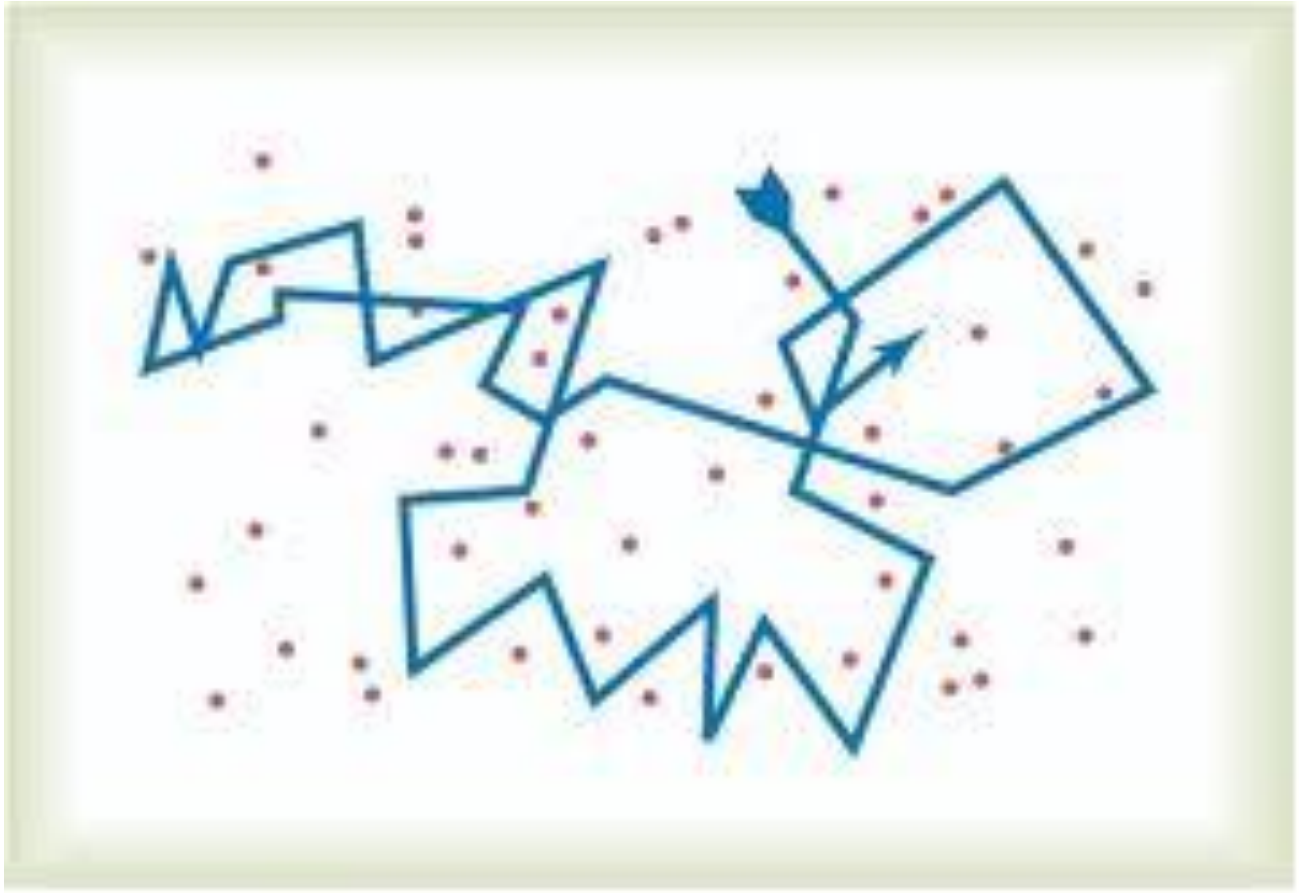
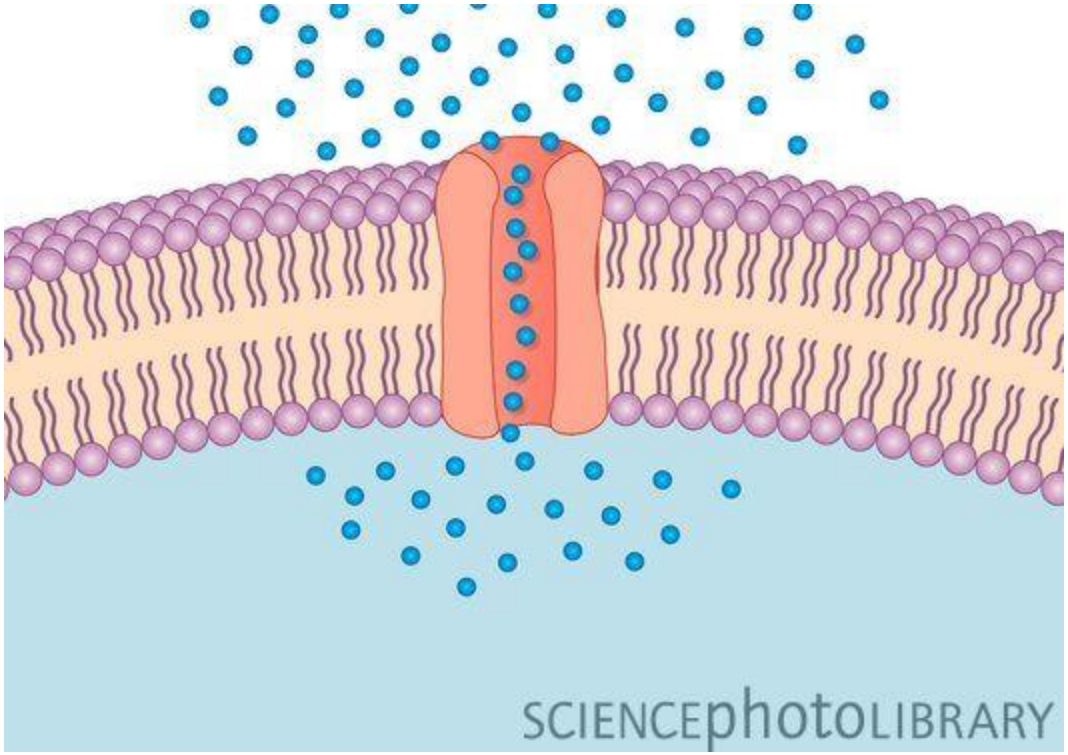


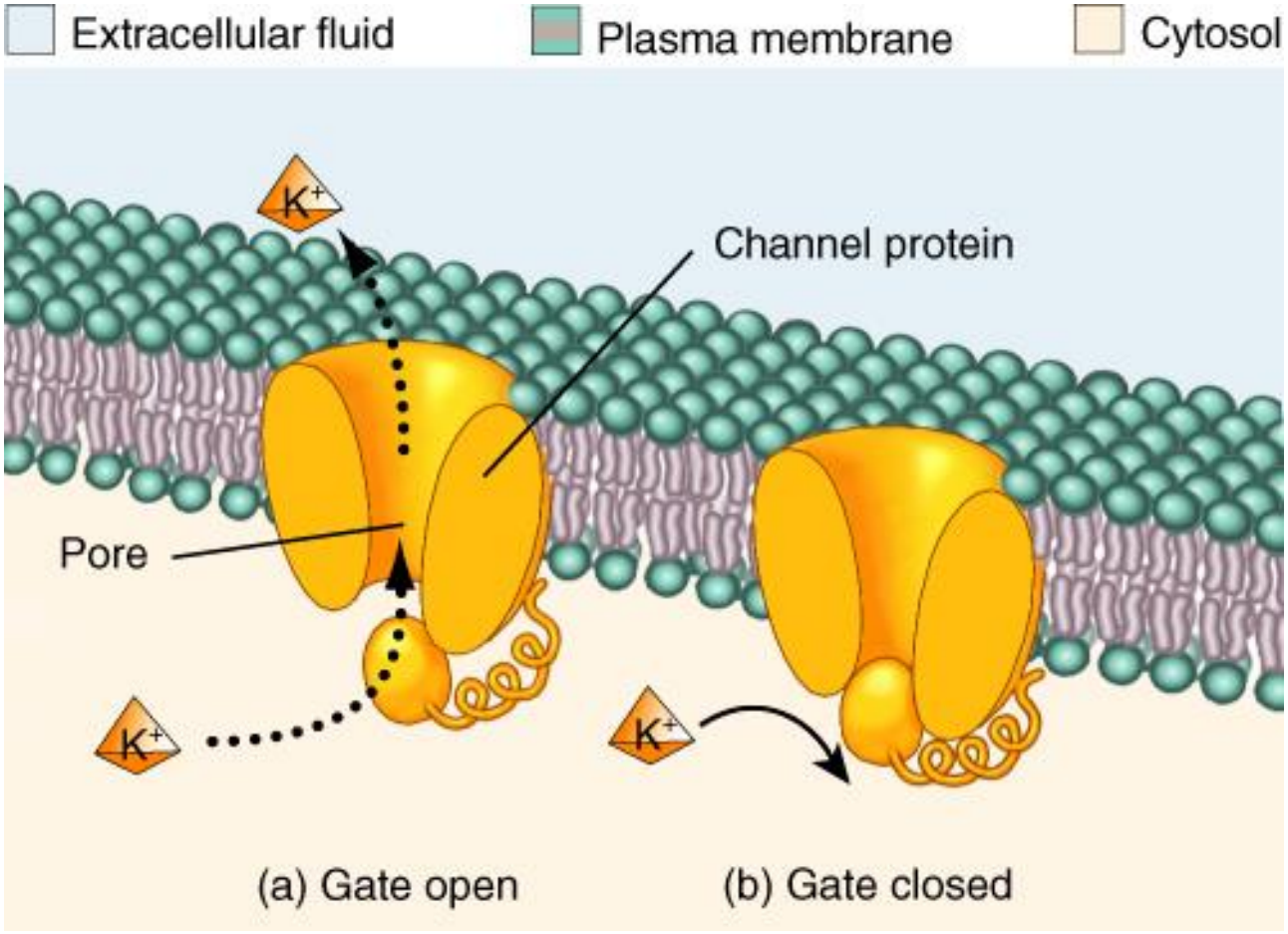
Figure 4–3

Diffusion of a fluid molecule during a thousandth of a second.

Simple Diffusion



Simple Diffusion



Fick's Law

- $J = P.\Delta C$
- $P = D.A/\Delta X$
- $J = D.A.\Delta C/\Delta X$

J = Flux (Rate of diffusion)

P = Permeability

D = Diffusion Coefficient

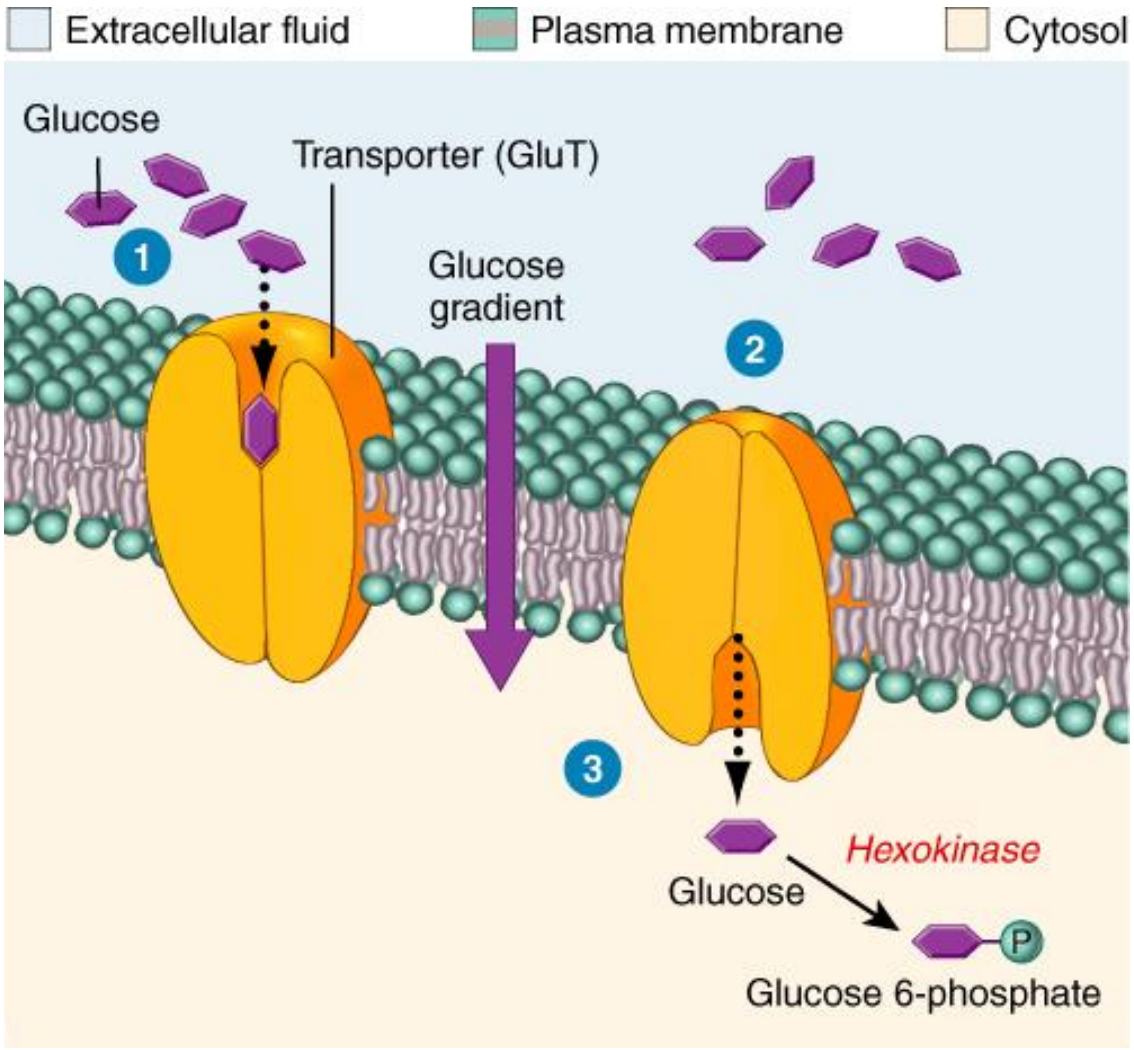
A = Surface area

C = Concentration

X = Membrane thickness

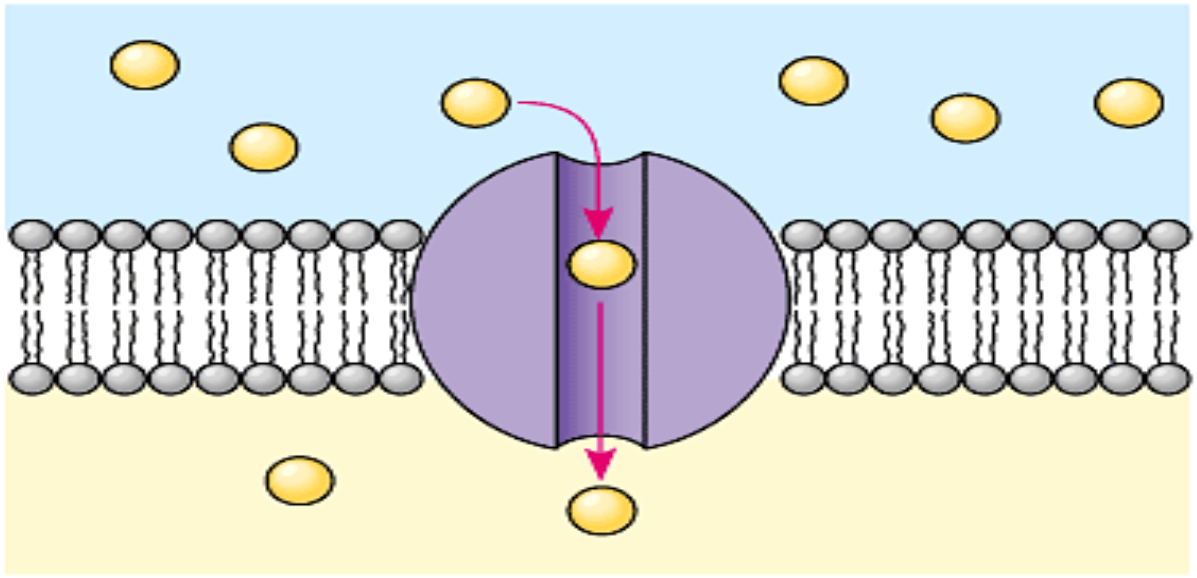
Facilitated Diffusion

Facilitated Diffusion

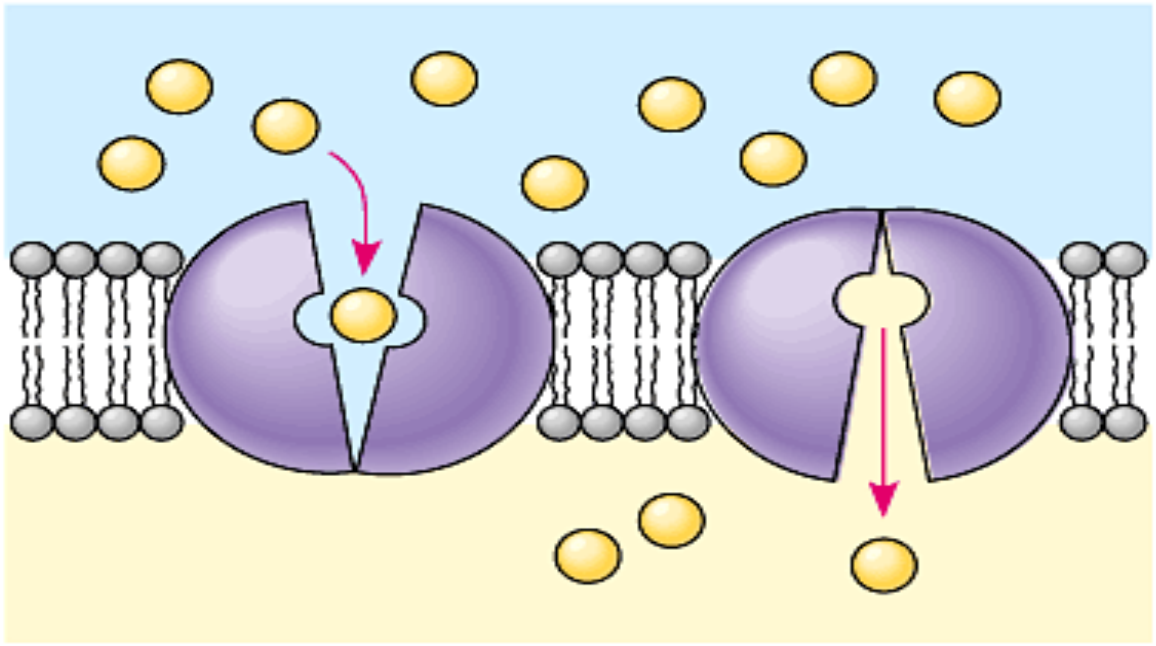


Facilitated Diffusion

- Aminoacids
- Glucose
- Galactose
- Fructose

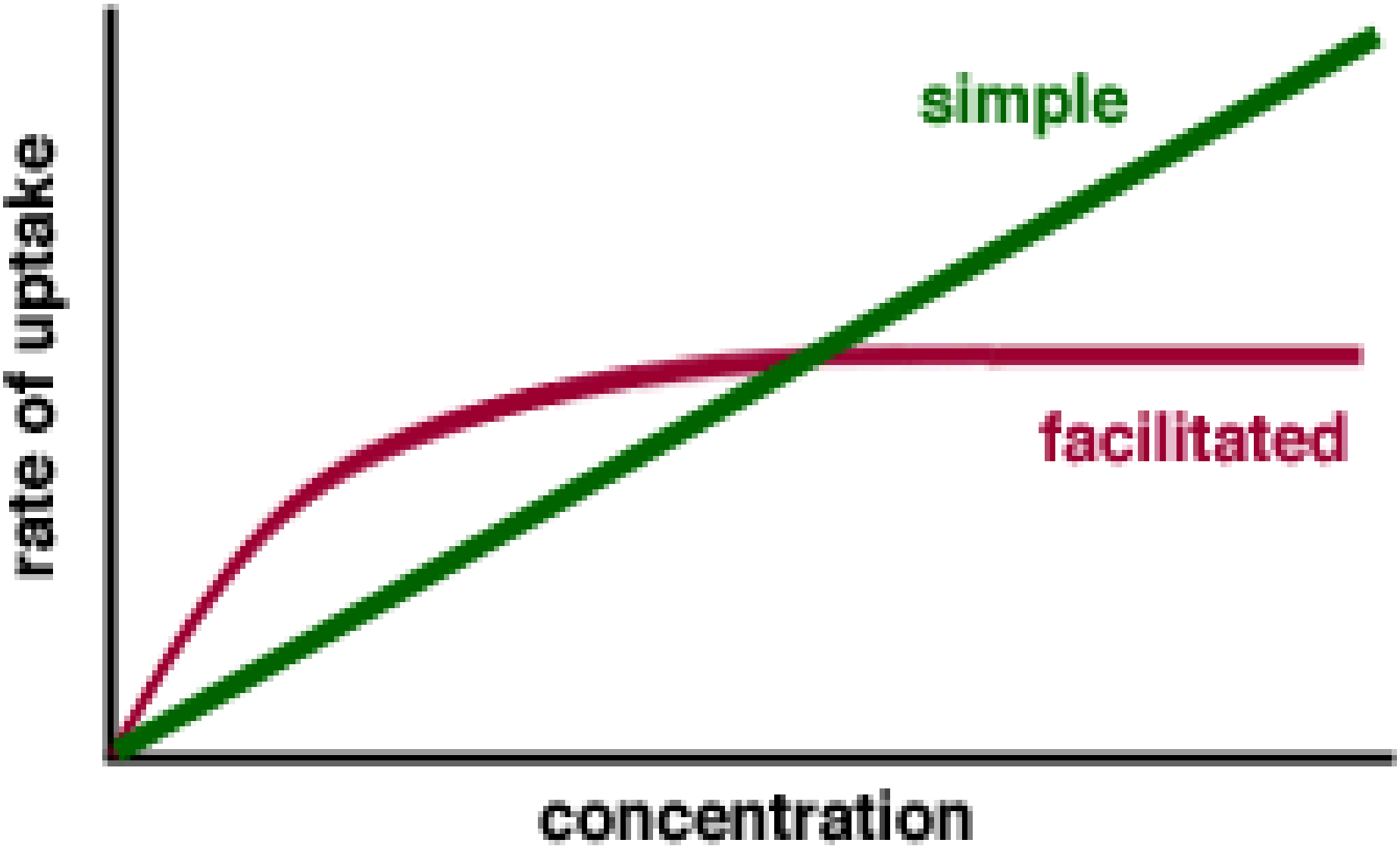


(a)



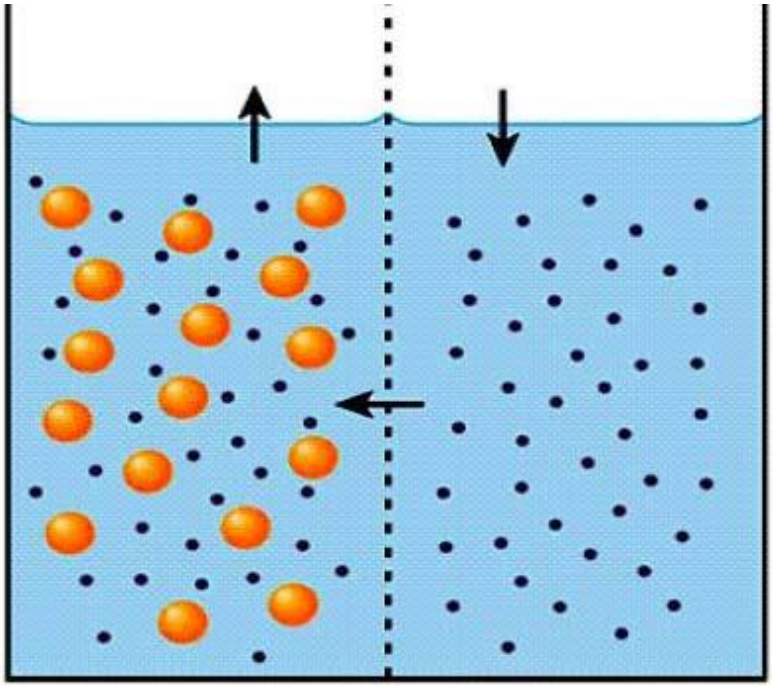
(b)

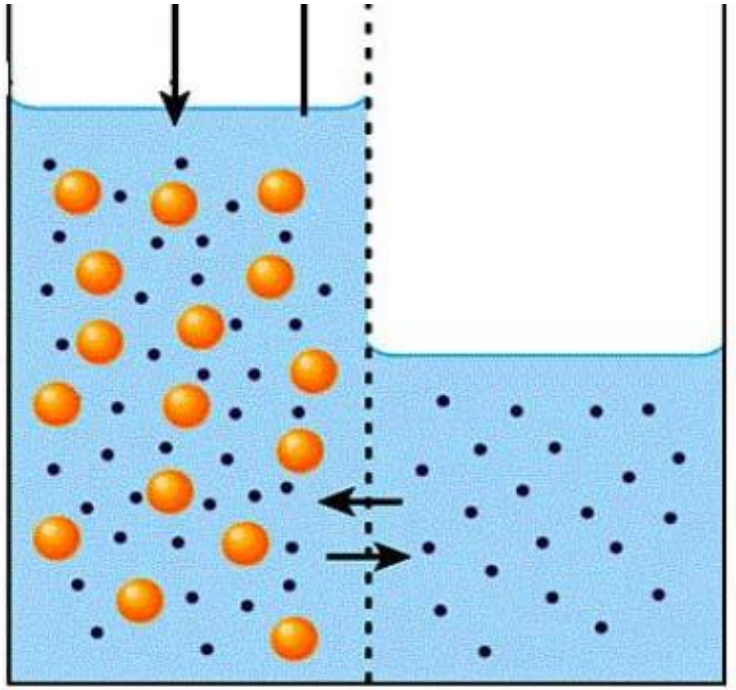
Diffusion

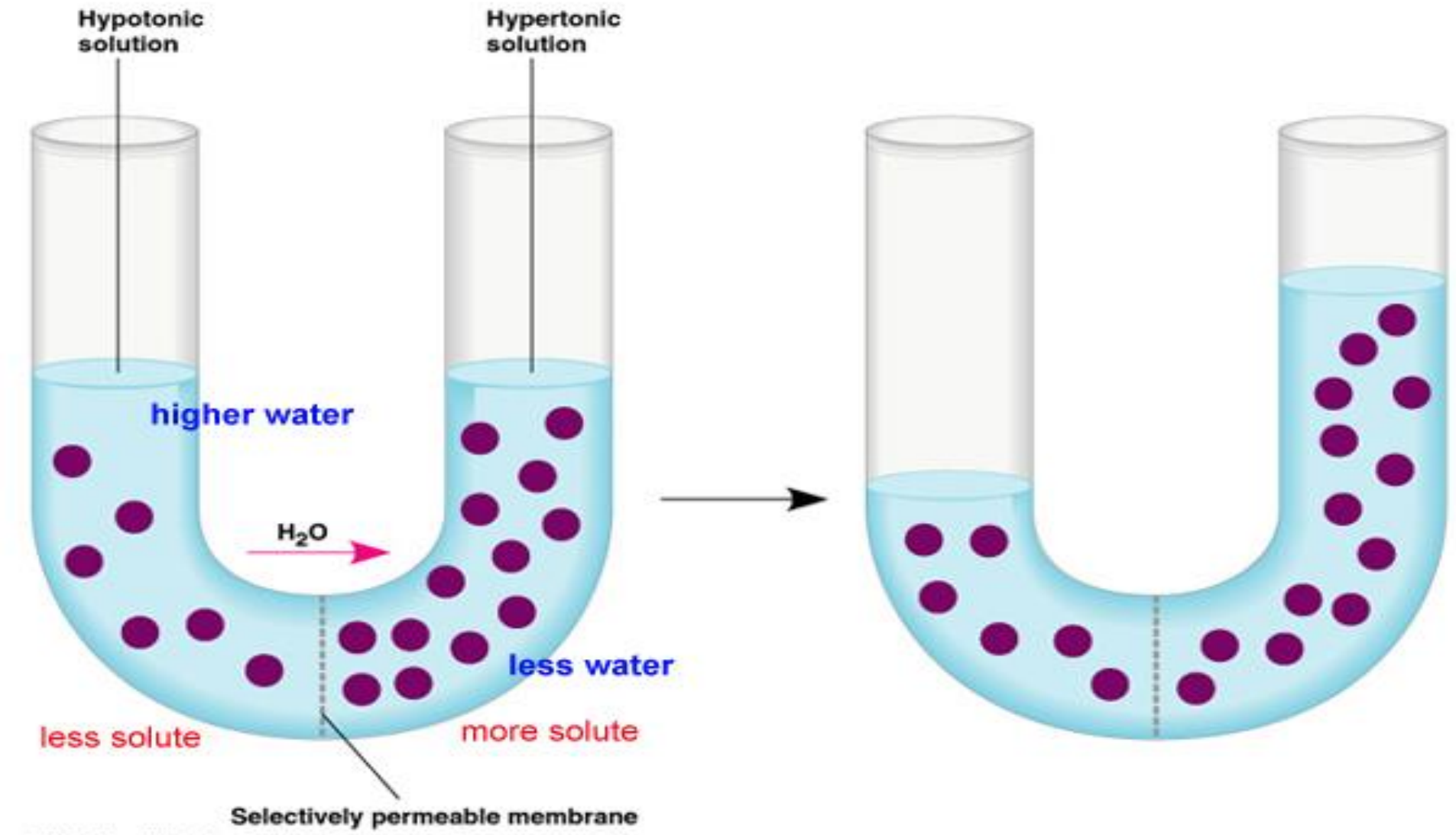


Osmosis

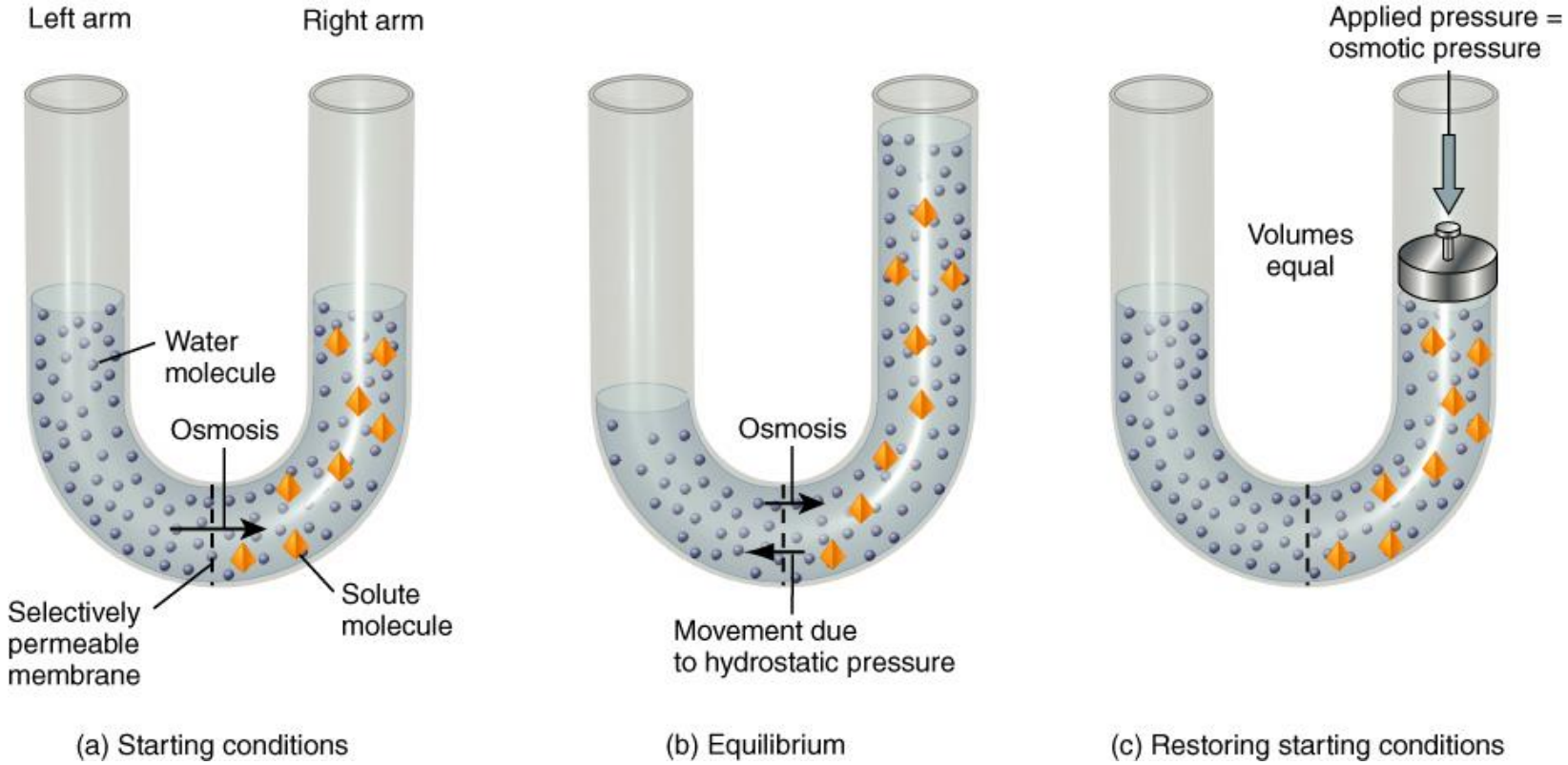
Osmosis







Osmotic pressure

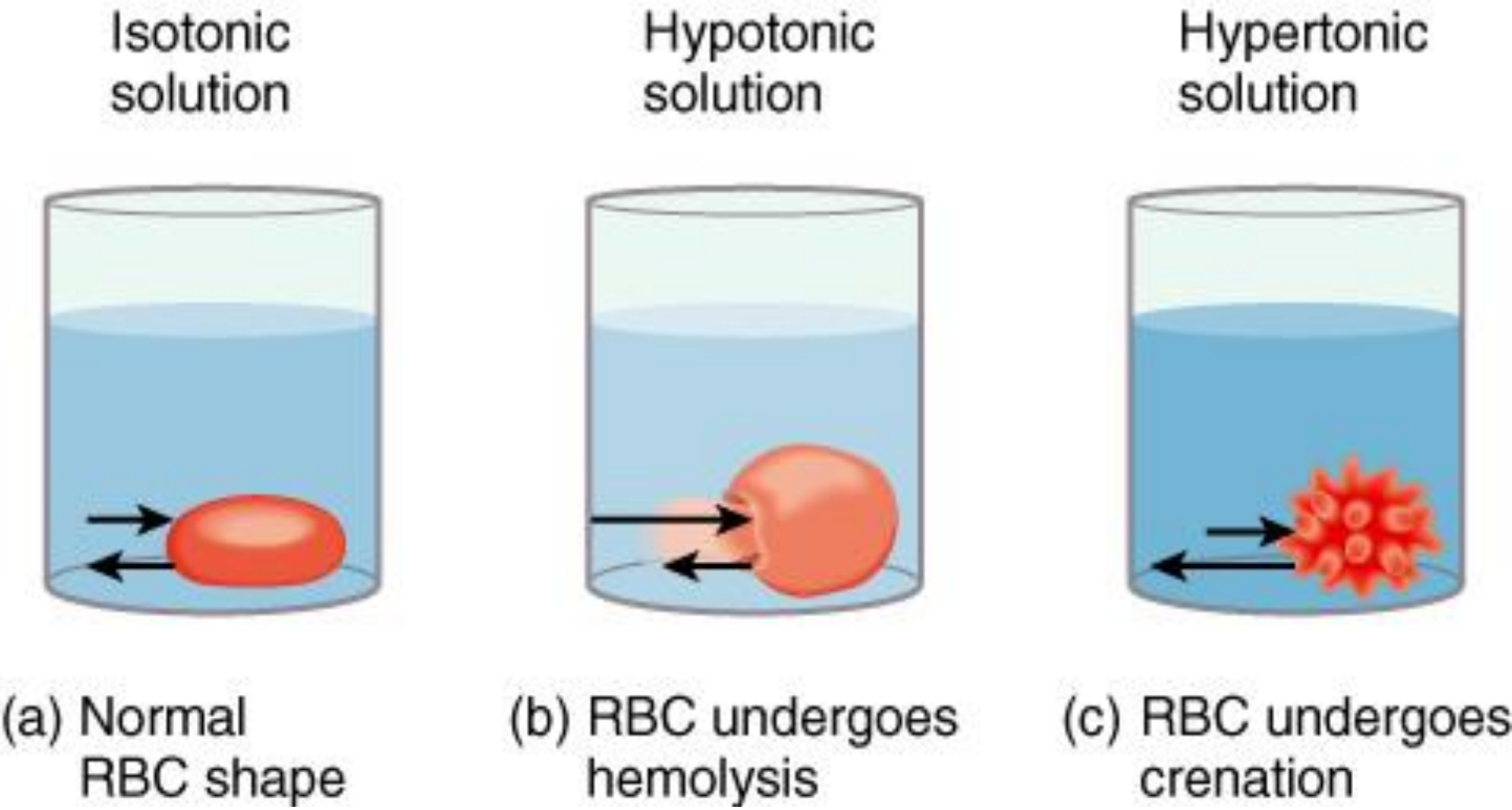


Van’t Hoff’s Law

$$\pi = RTC$$

π : osmotic Pressure
R = Gas constant
T = Absolute Temprature
C = Concentration

Tonicity of solution



Hypotonic (cell swells`

Isotonic (no change)

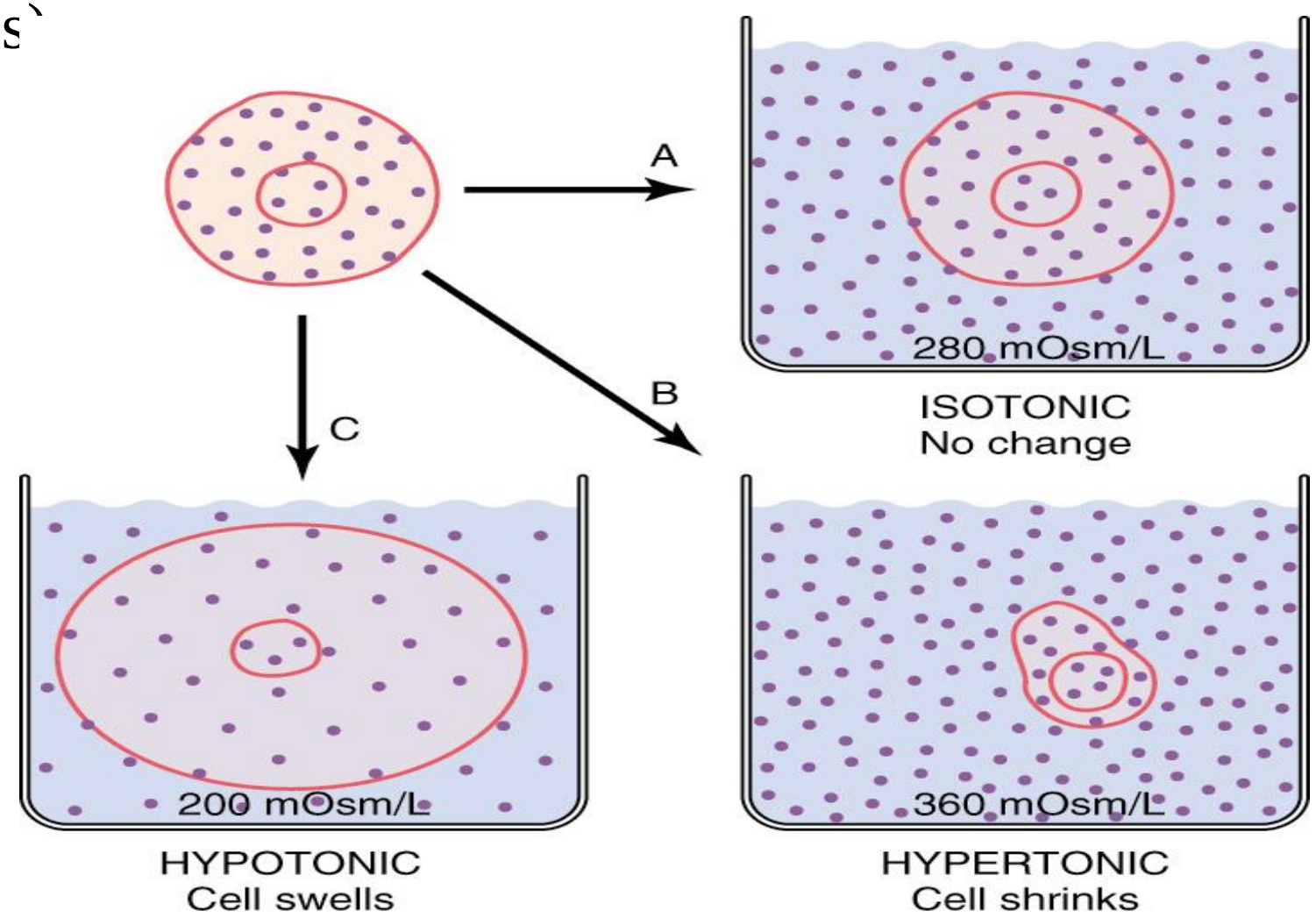
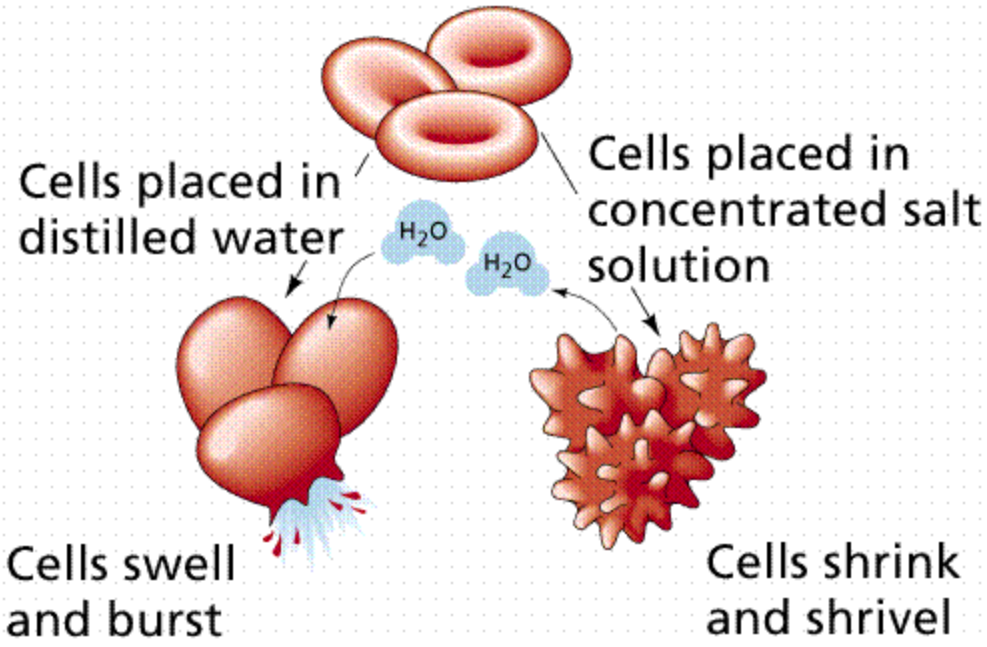
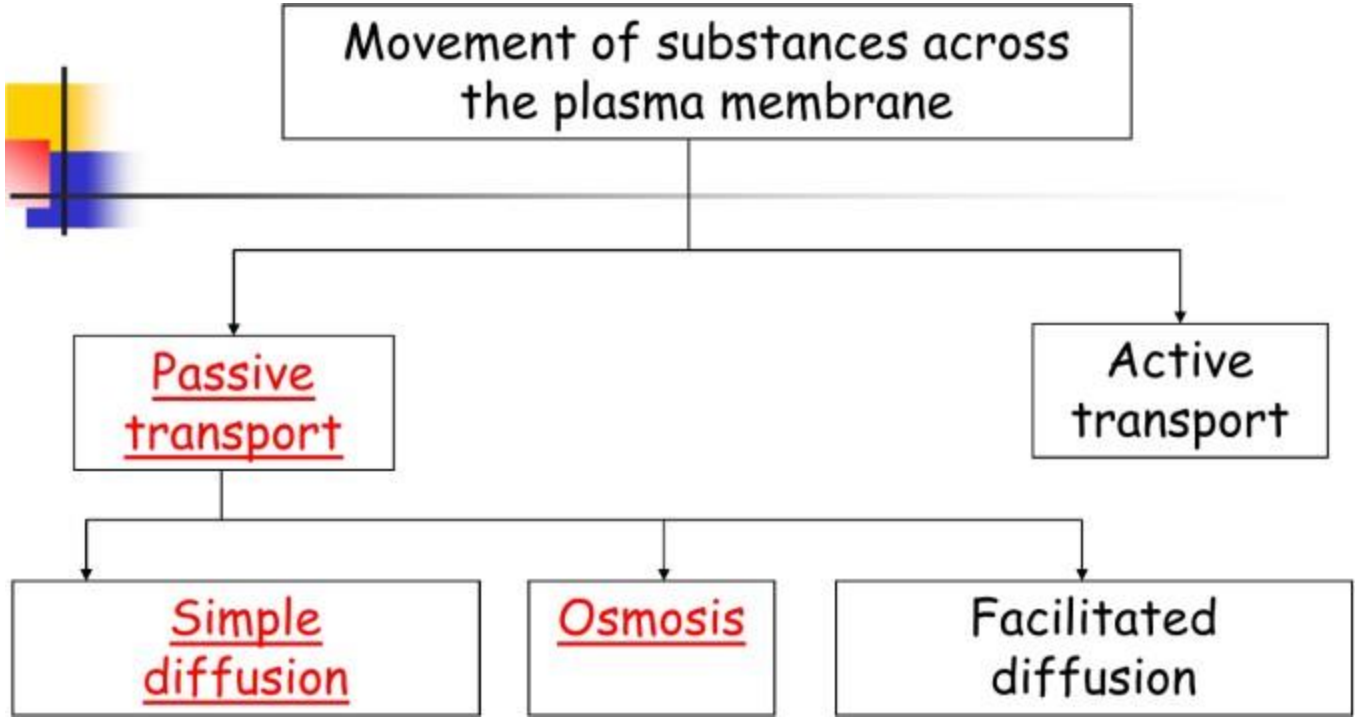


Figure 25-5; Guyton and Hall

Hypertonic (cell


Cells placed in distilled water
H_2O
H_2O
Cells placed in concentrated salt solution
Cells swell and burst
Cells shrink and shrivel

Transport across Plasma Membranes



Transport through plasma membranes

Passive transport modalities

-Simple diffusion: transport through lipid bilayer, transport through channels, Ficks law of diffusion.

-Facilitated diffusion: by carriers

Differences in diffusion Kinetics between the previous modalities

Equivalent Concentration of particles.

Transport through plasma membranes

Passive transport modalities

-**Osmosis**: concept of osmotic pressure (Van't Hoff's law), Oncotic (Colloid-osmotic) pressure. Osmolarity, Osmolality

Hydrostatic pressure and filtration

Transport through plasma membranes

Active transport modalities

- **Primary active transport** (ATP-ase carriers or Pumps) (functions of pumps: Na+/K+ pump, Ca++ pump, H+ pump, H+/K+ pump).
- **Secondary active transport** (Na+ dependent carriers) examples

Transport through plasma membranes

Active transport modalities

- **Vesicular transport**: endocytosis, phagocytosis, transcytosis, pinocytosis and exocytosis and its control in secretory cells.-

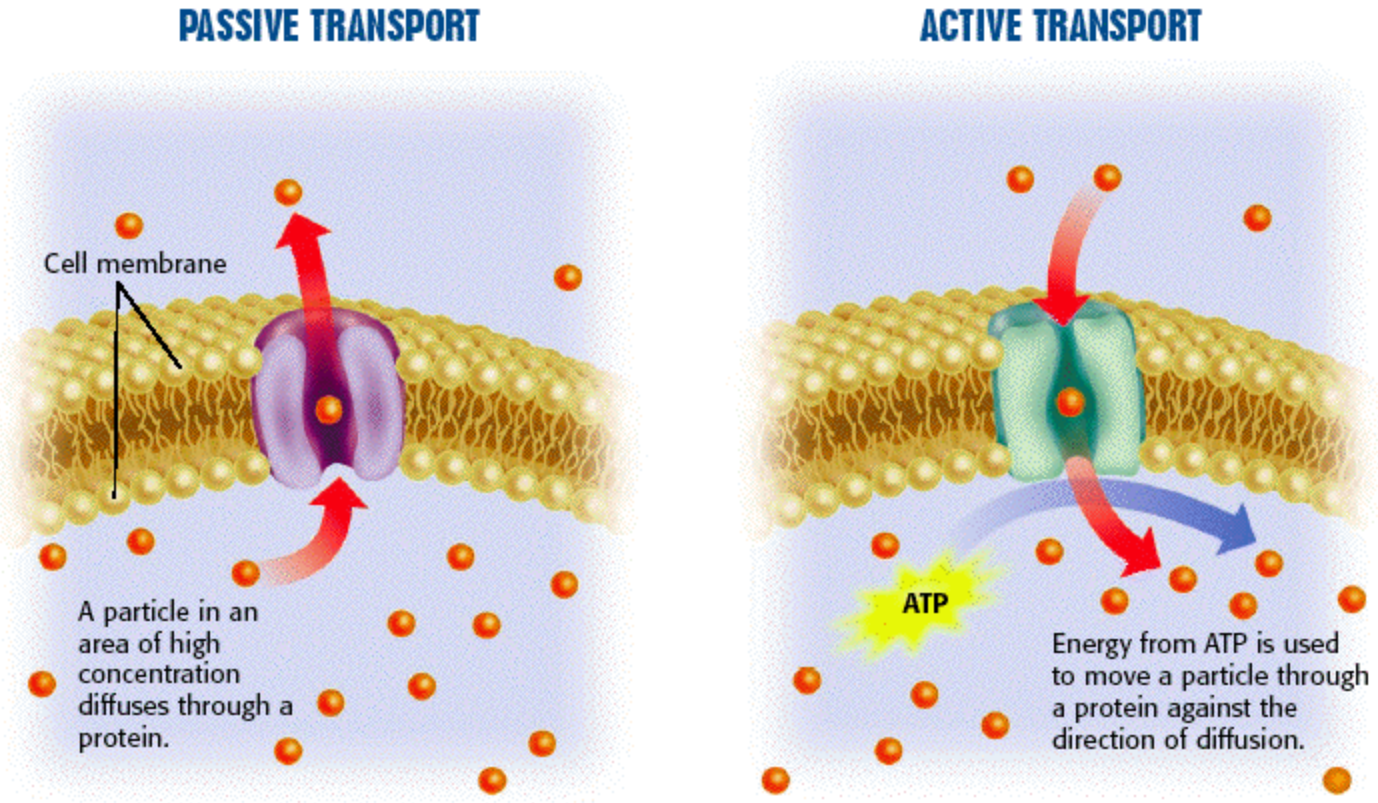
TABLE 3.1 Passive Membrane Transport Processes

PROCESS	ENERGY SOURCE	DESCRIPTION	EXAMPLES
DIFFUSION			
Simple diffusion	Kinetic energy	Net movement of particles (ions, molecules, etc.) from an area of their higher concentration to an area of their lower concentration, that is, along their concentration gradient	Movement of fats, oxygen, carbon dioxide through the lipid portion of the membrane
Facilitated diffusion	Kinetic energy	Same as simple diffusion, but the diffusing substance is attached to a lipid-soluble membrane carrier protein or moves through a membrane channel	Movement of glucose and some ions into cells
Osmosis	Kinetic energy	Simple diffusion of water through a selectively permeable membrane	Movement of water into and out of cells directly through the lipid phase of the membrane or via membrane pores (aquaporins)
FILTRATION			
	Hydrostatic pressure	Movement of water and solutes through a semipermeable membrane (either through the plasma membrane or between cells) from a region of higher hydrostatic pressure to a region of lower hydrostatic pressure, that is, along a pressure gradient	Movement of water, nutrients, and gases through a capillary wall; formation of kidney filtrate

Active Transport Mechanisms

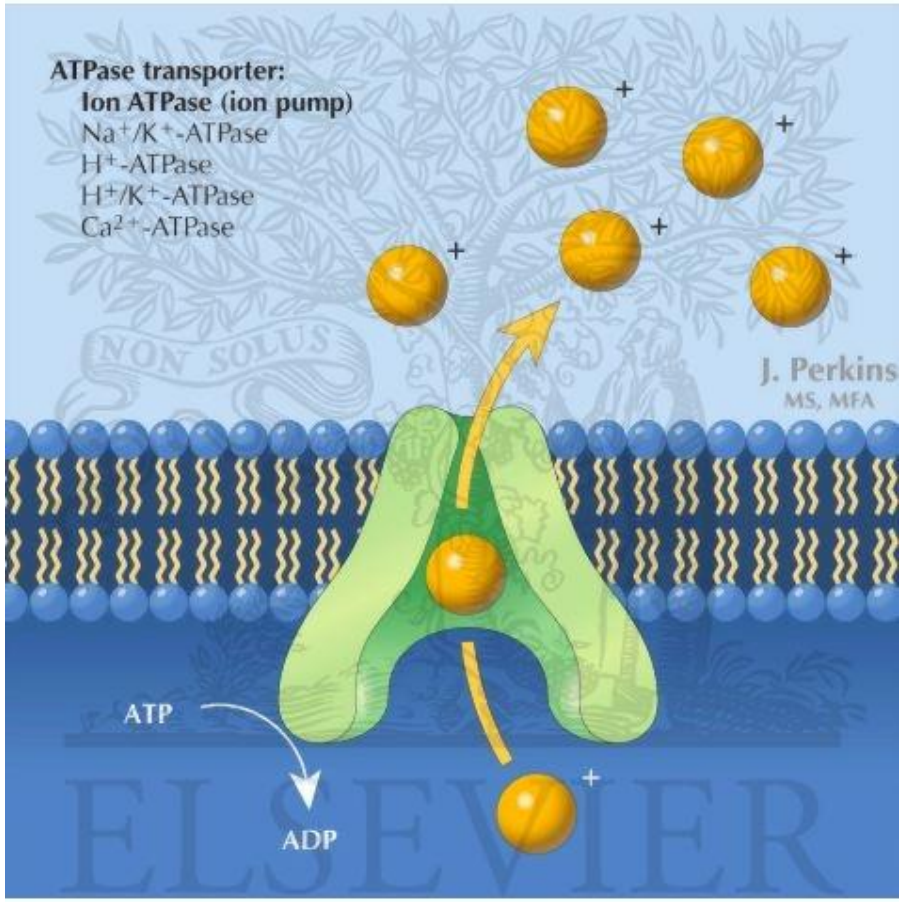
- Primary active transport
- Secondary active transport
- Vesicular transport

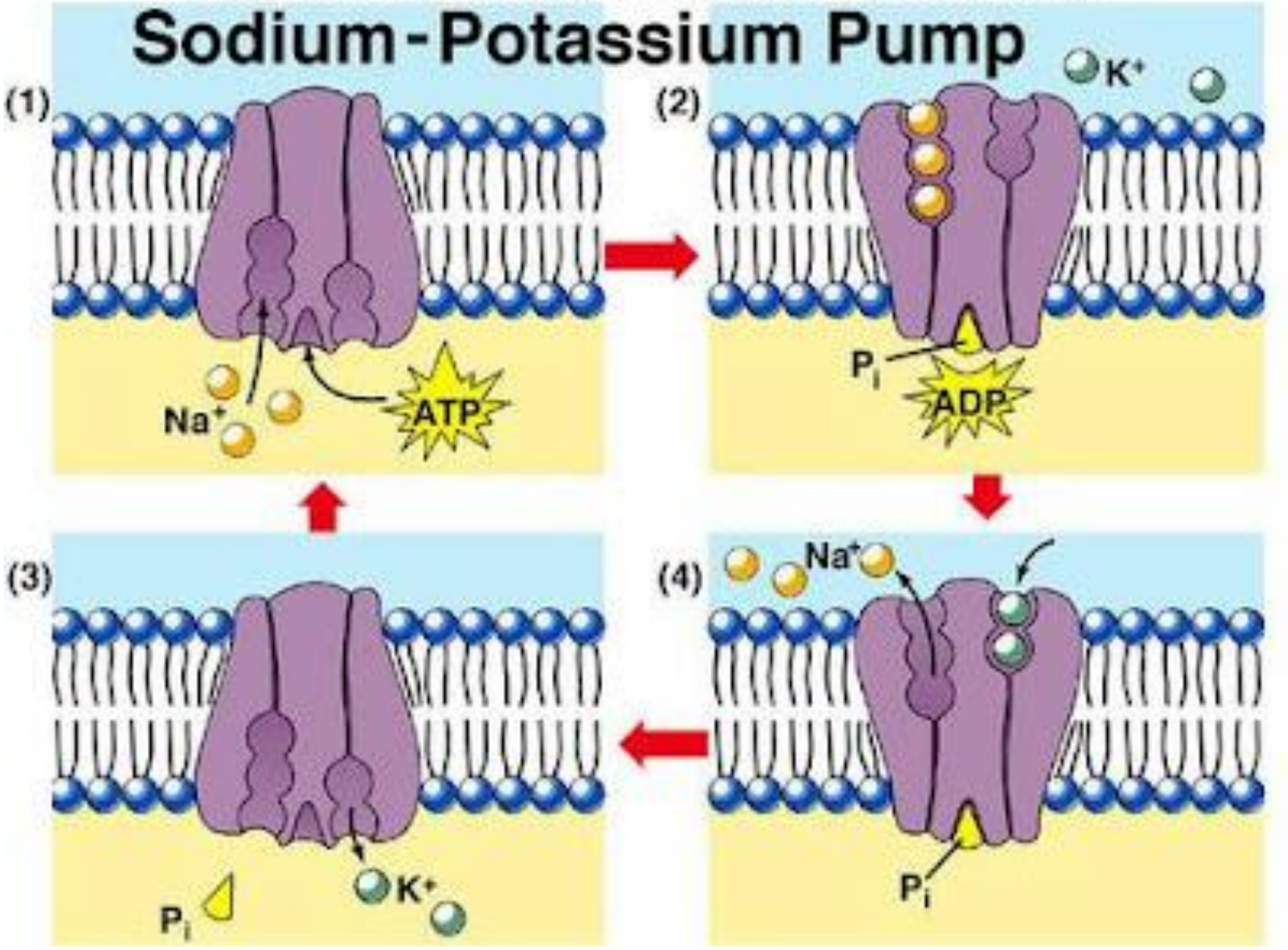
Passive and Active Transport



Types of Pumps

- Na+/K+ pump
- H+ pump
- H+/K+ pump
- Ca++ pump





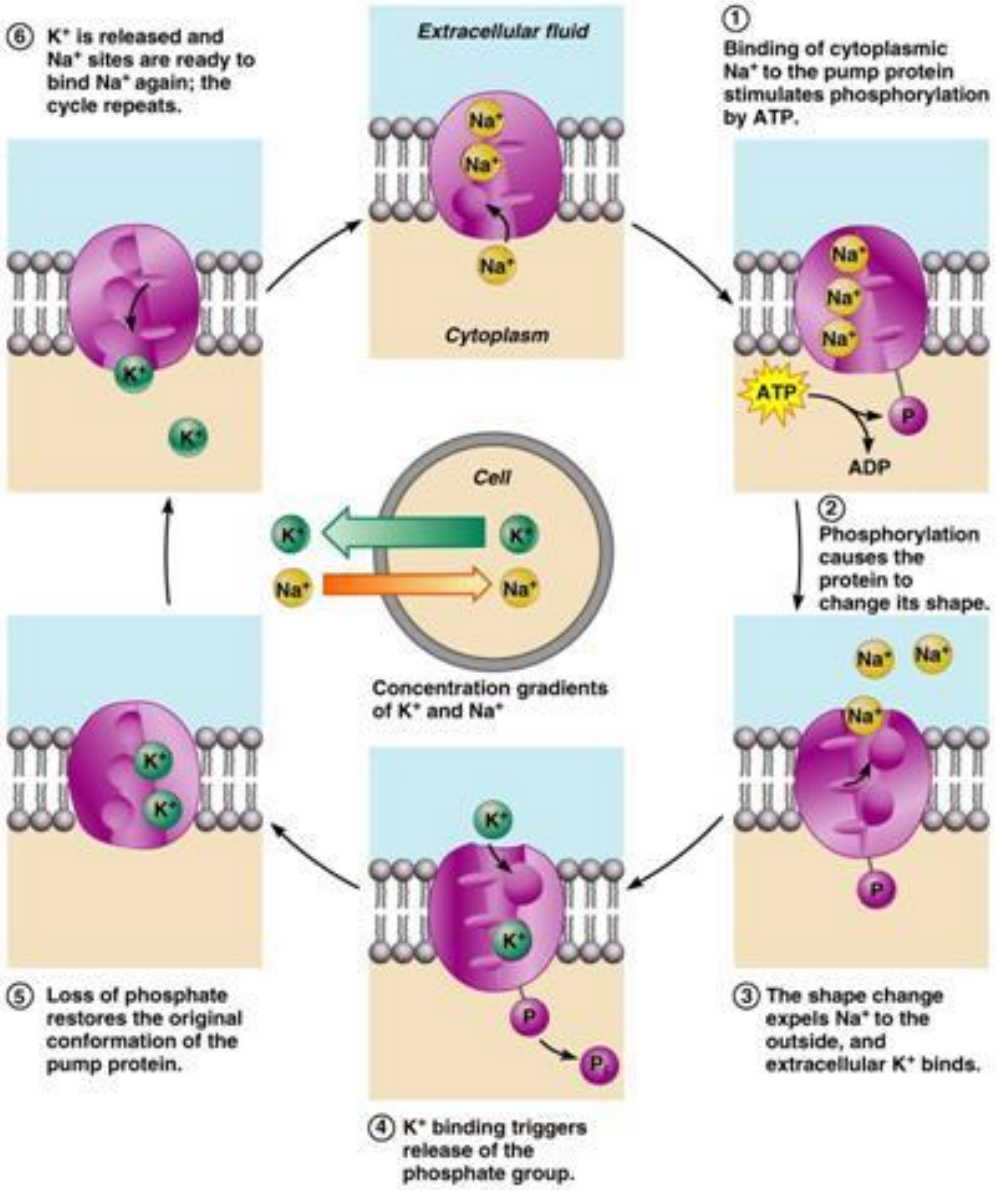
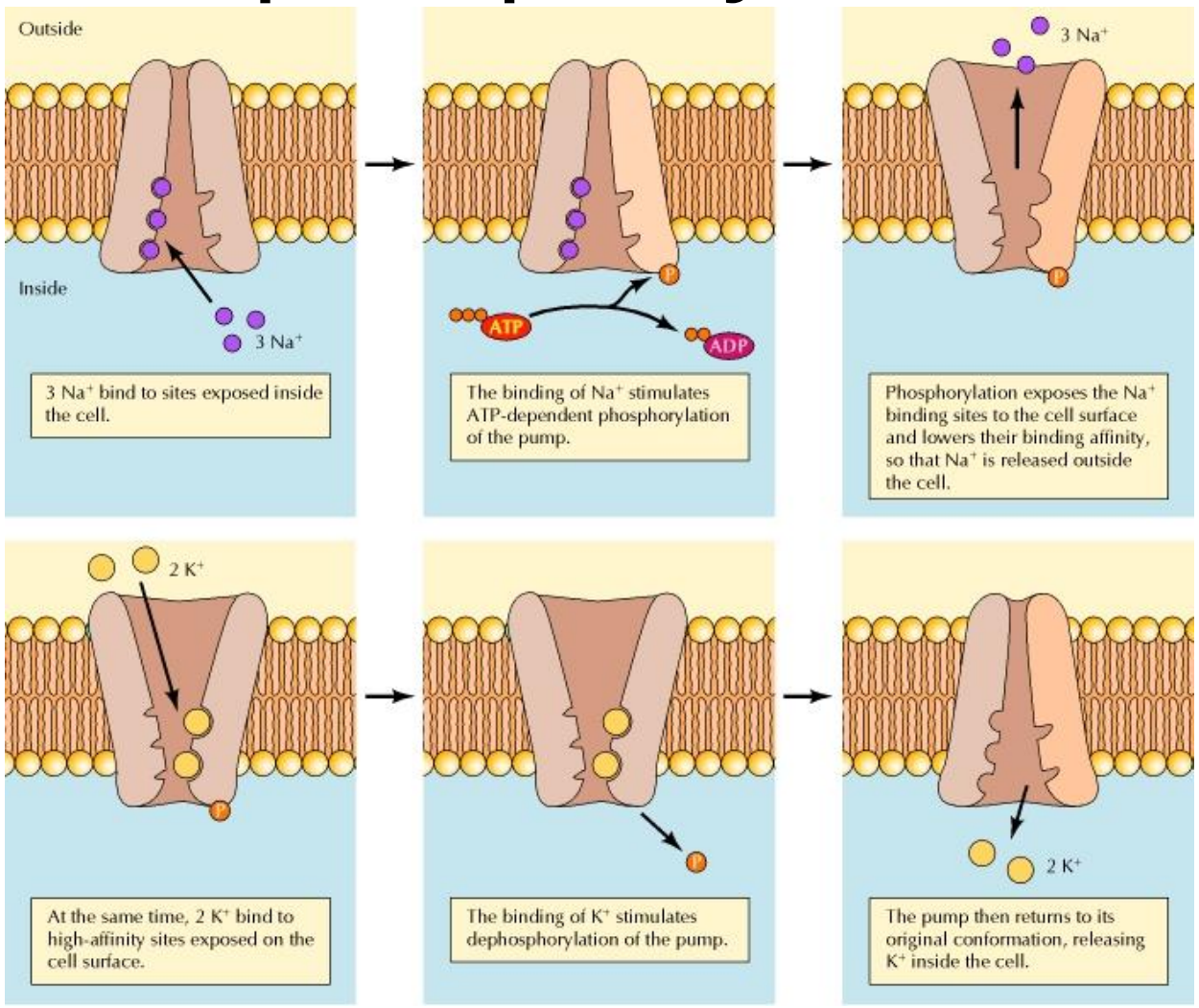
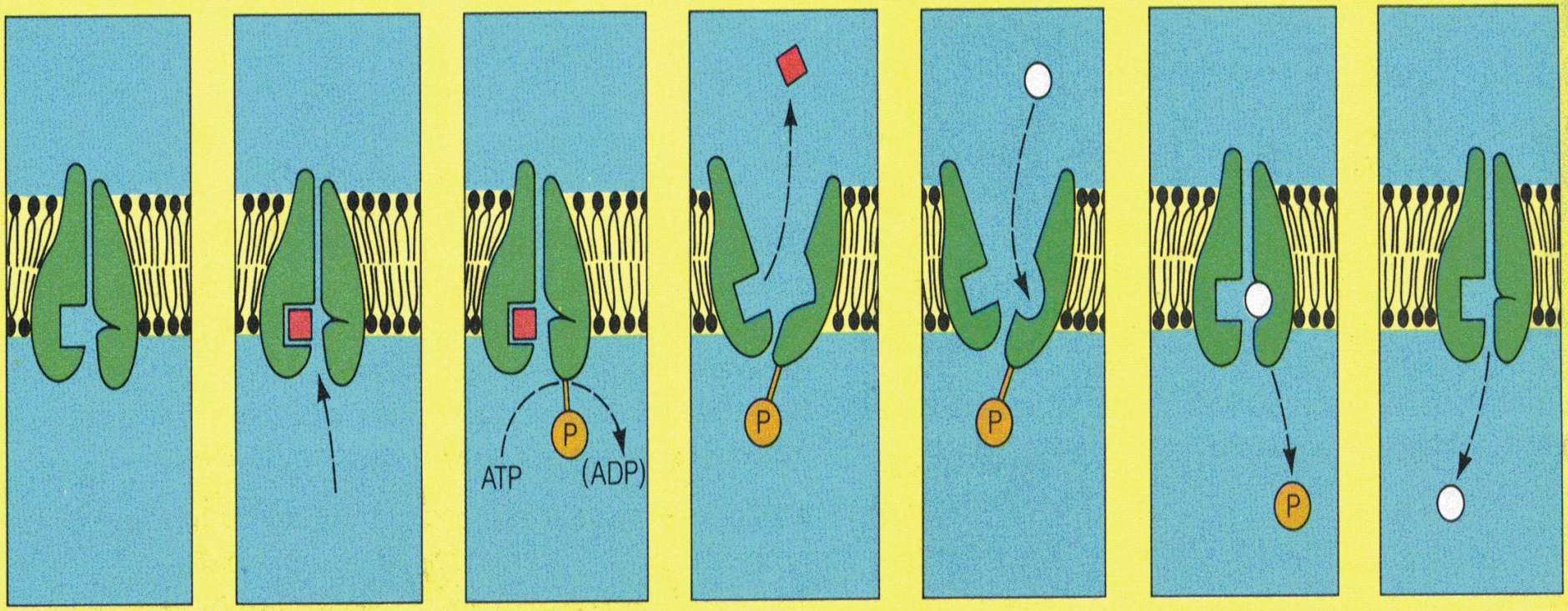


Figure 3.10

Phosphorylation & dephosphorylation





a Transport protein with two binding sites.

b Specific solute binds at one site.

c Phosphate group is transferred from ATP to protein.

d Protein changes shape, pumps the solute across membrane.

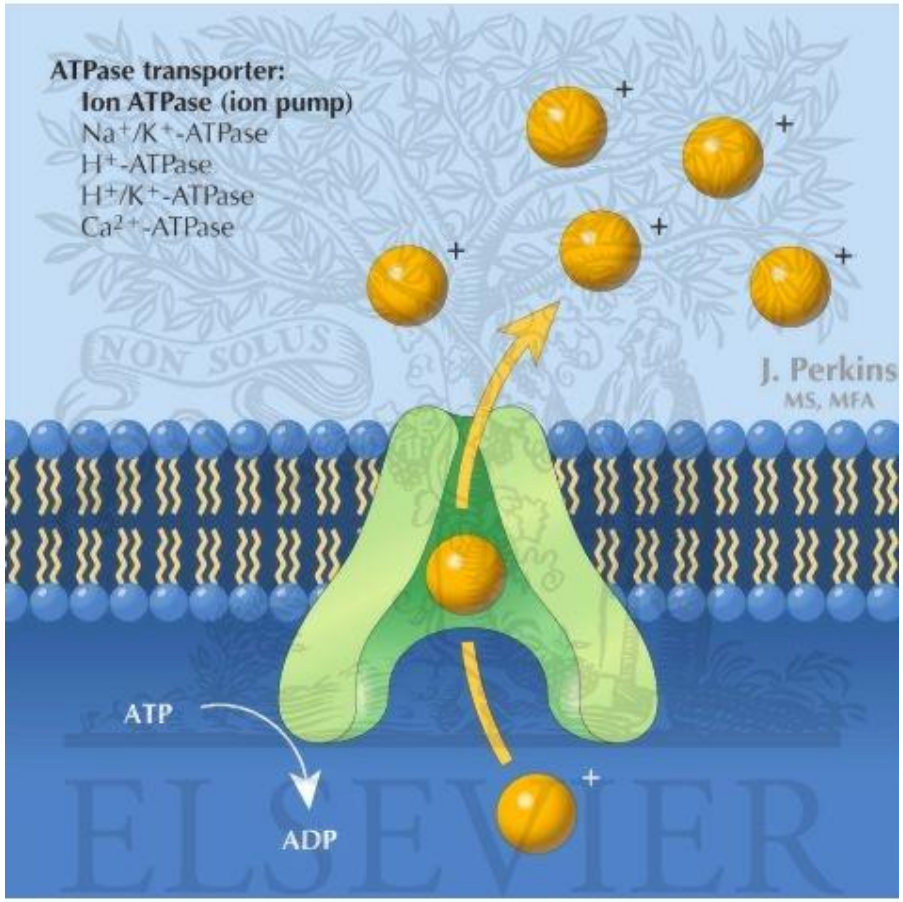
e The other binding site is now exposed, different solute binds to it.

f Phosphate group is released, protein returns to original shape.

g The shape change causes the solute to be released.

Types of Pumps

- Na+/K+ pump
- H+ pump
- H+/K+ pump
- Ca++ pump



The importance of pumps for cell functions

Secondary Active Transport

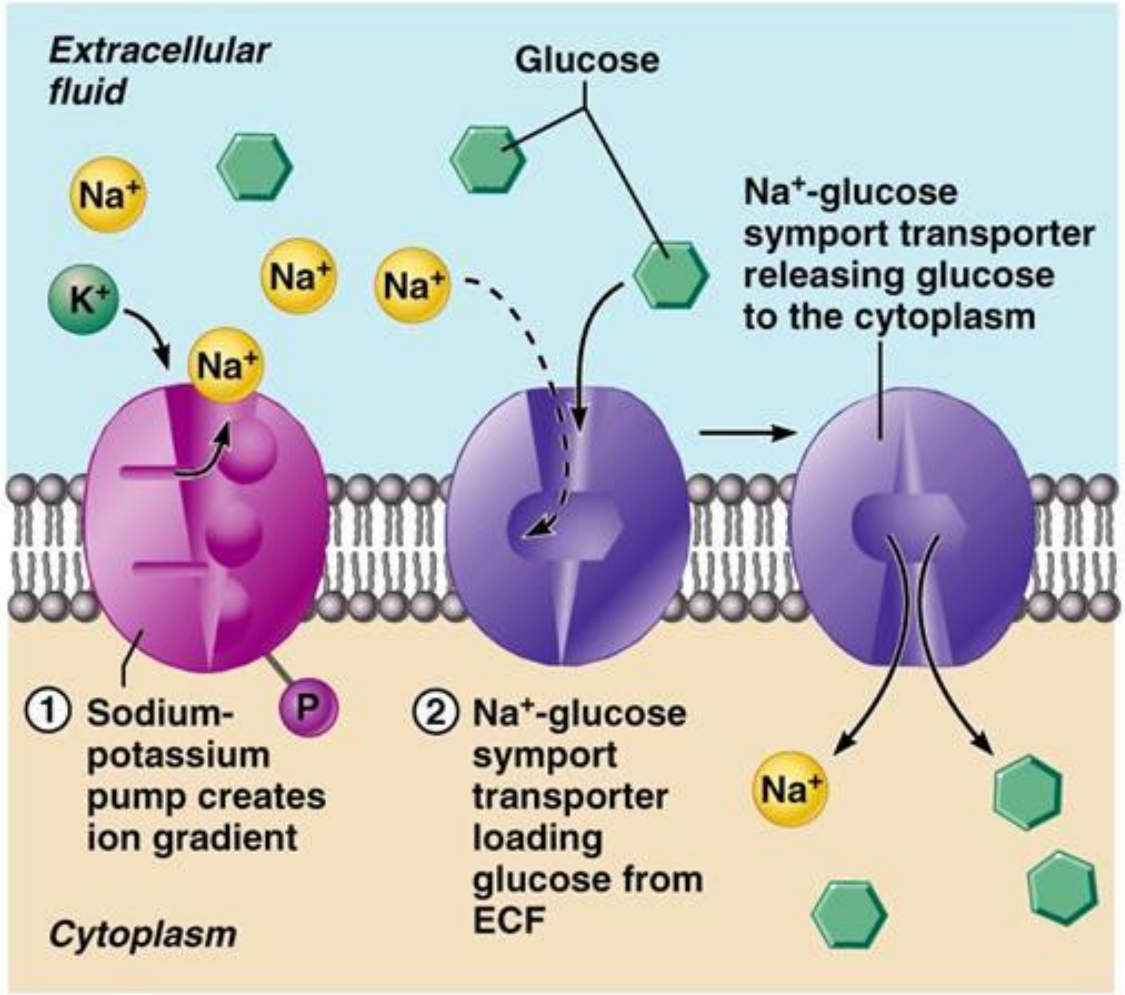
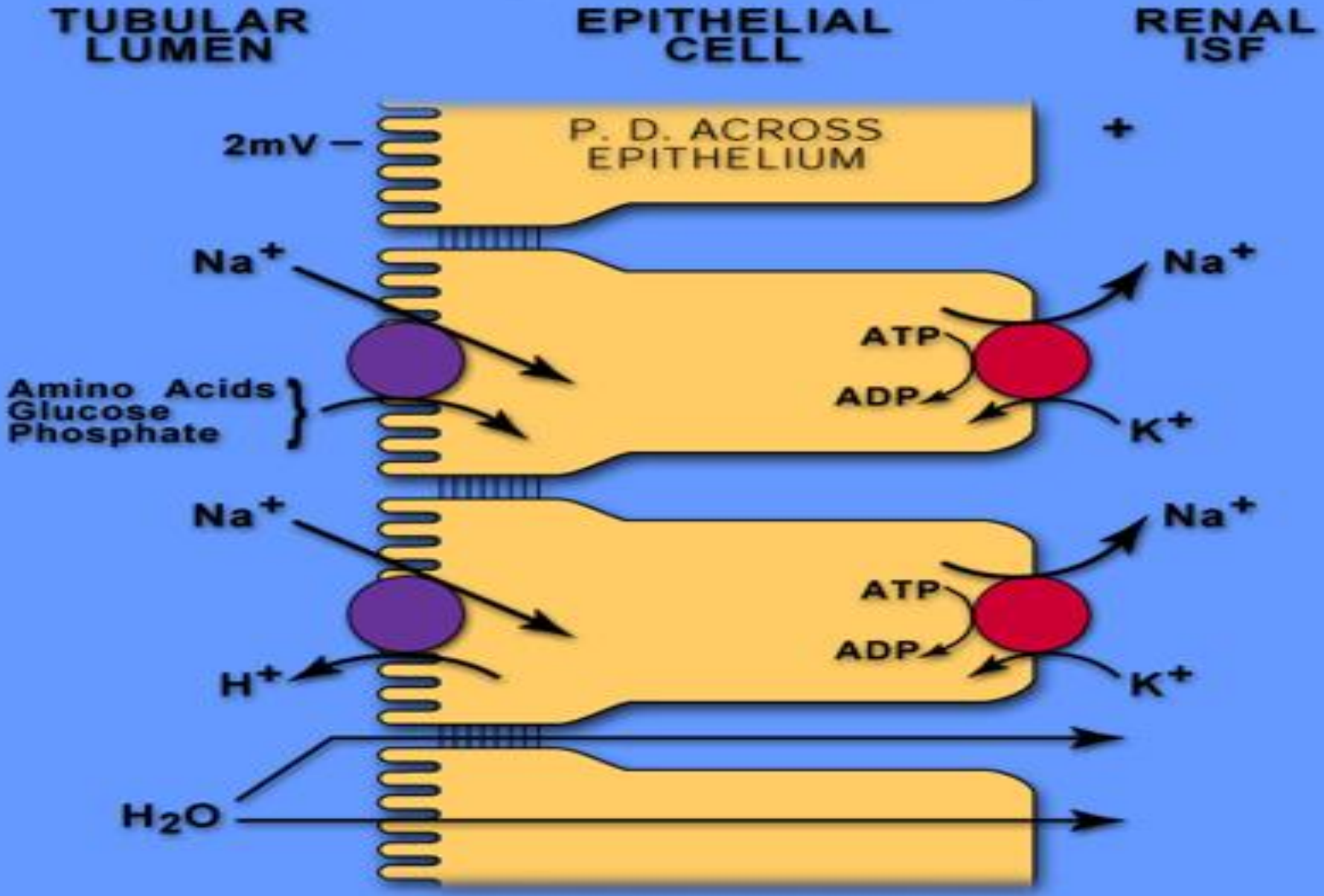


Figure 3.11

Na^+ ENTRY INTO PROXIMAL TUBULAR EPITHELIAL CELLS

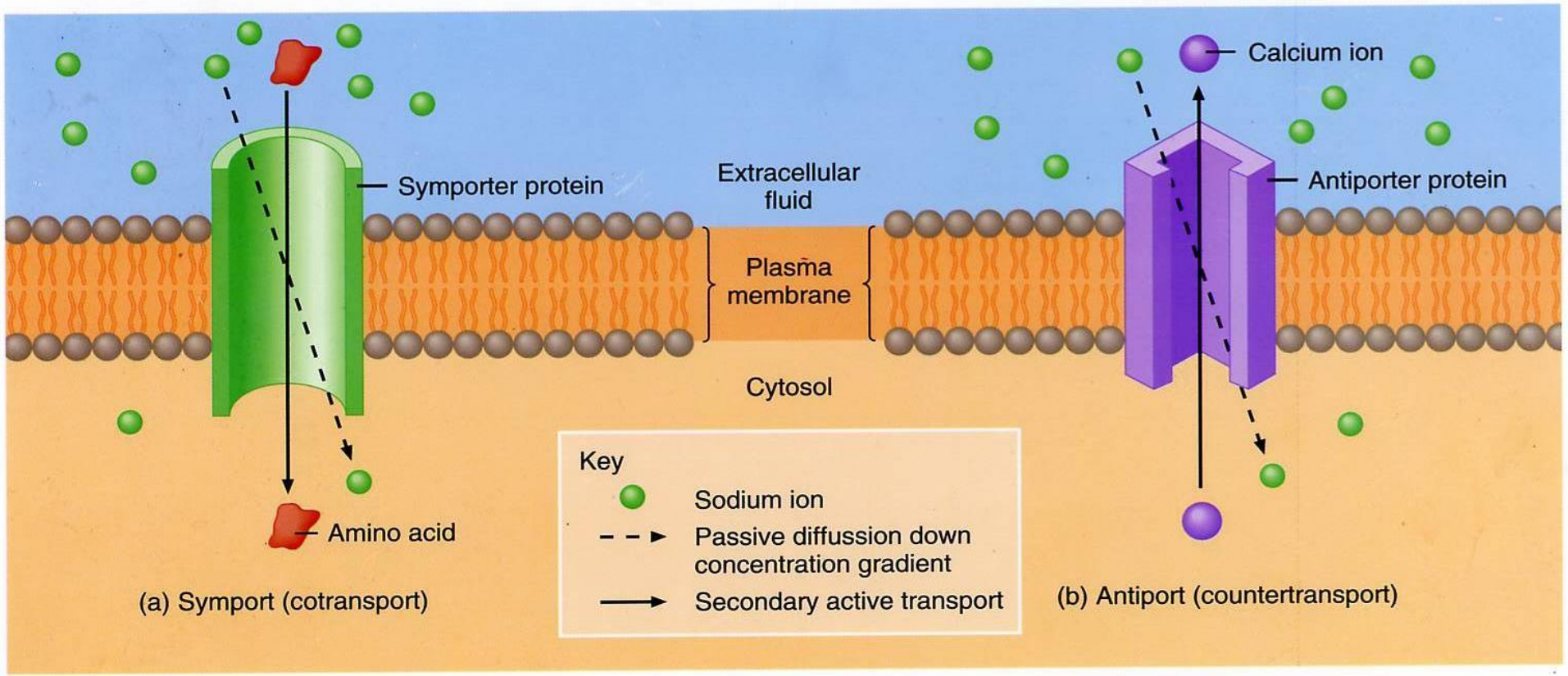
EARLY PROXIMAL



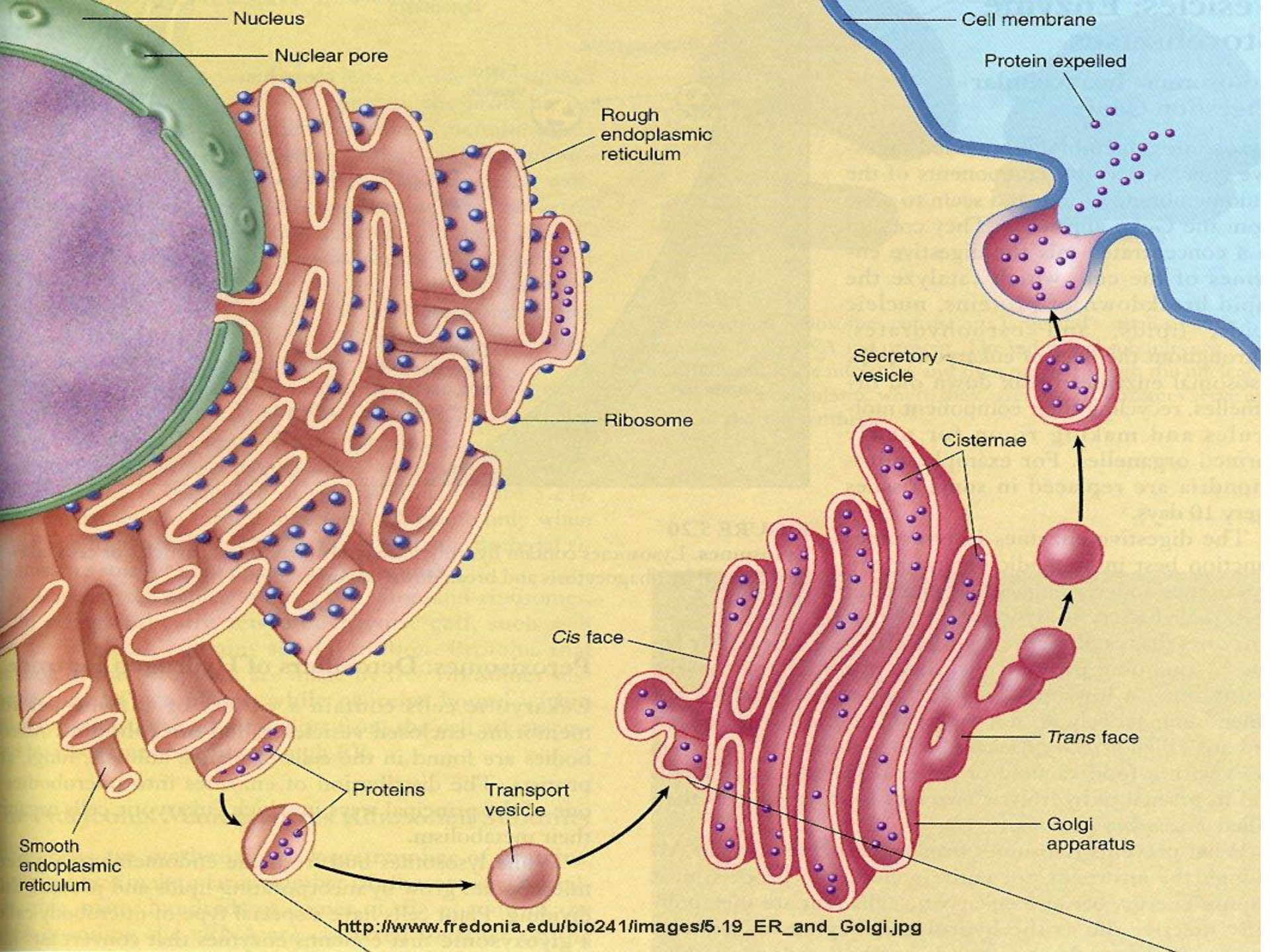
Secondary Active Transport

-Co-transport

-Counter transport

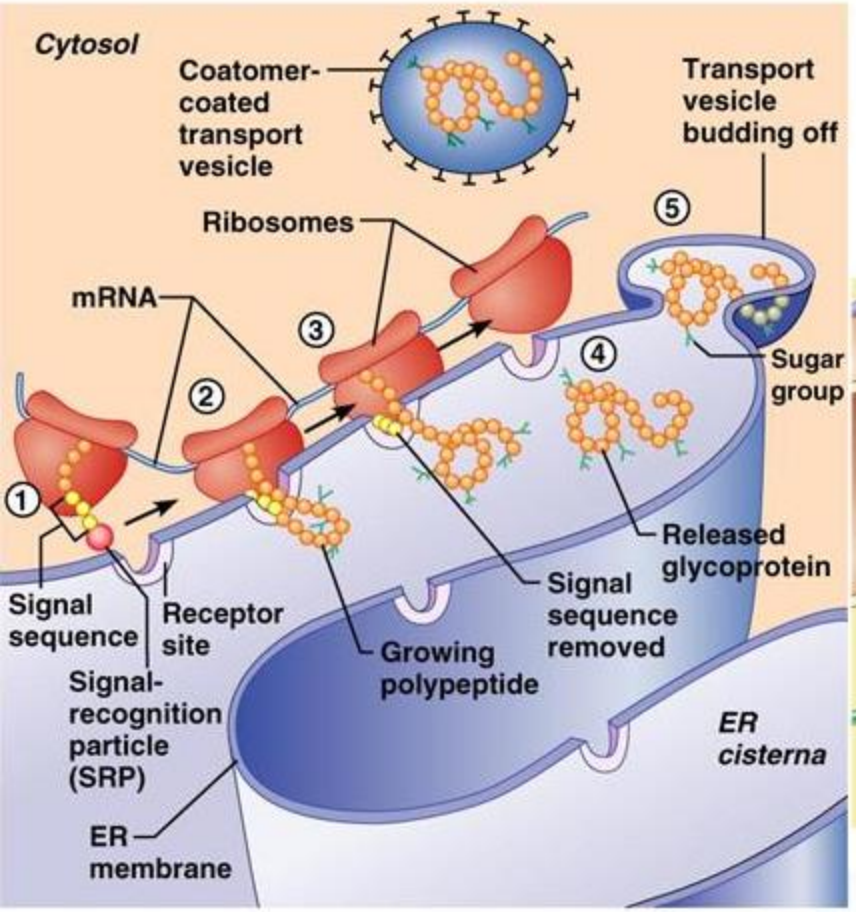


Vesicular Transport



http://www.fredonia.edu/bio241/images/5.19_ER_and_Golgi.jpg

Formation of vesicles at ER



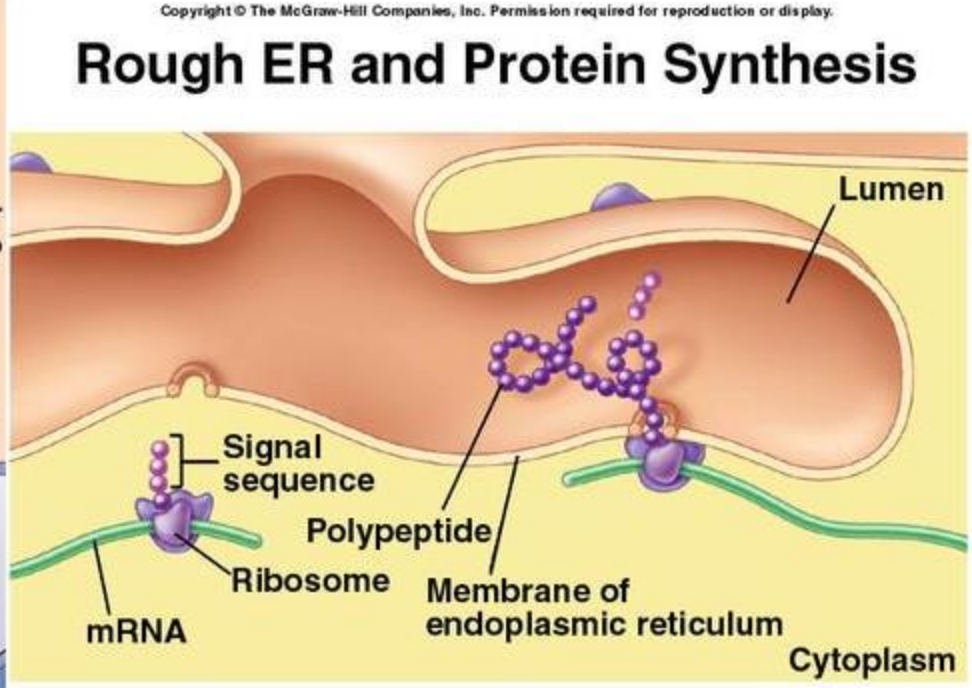
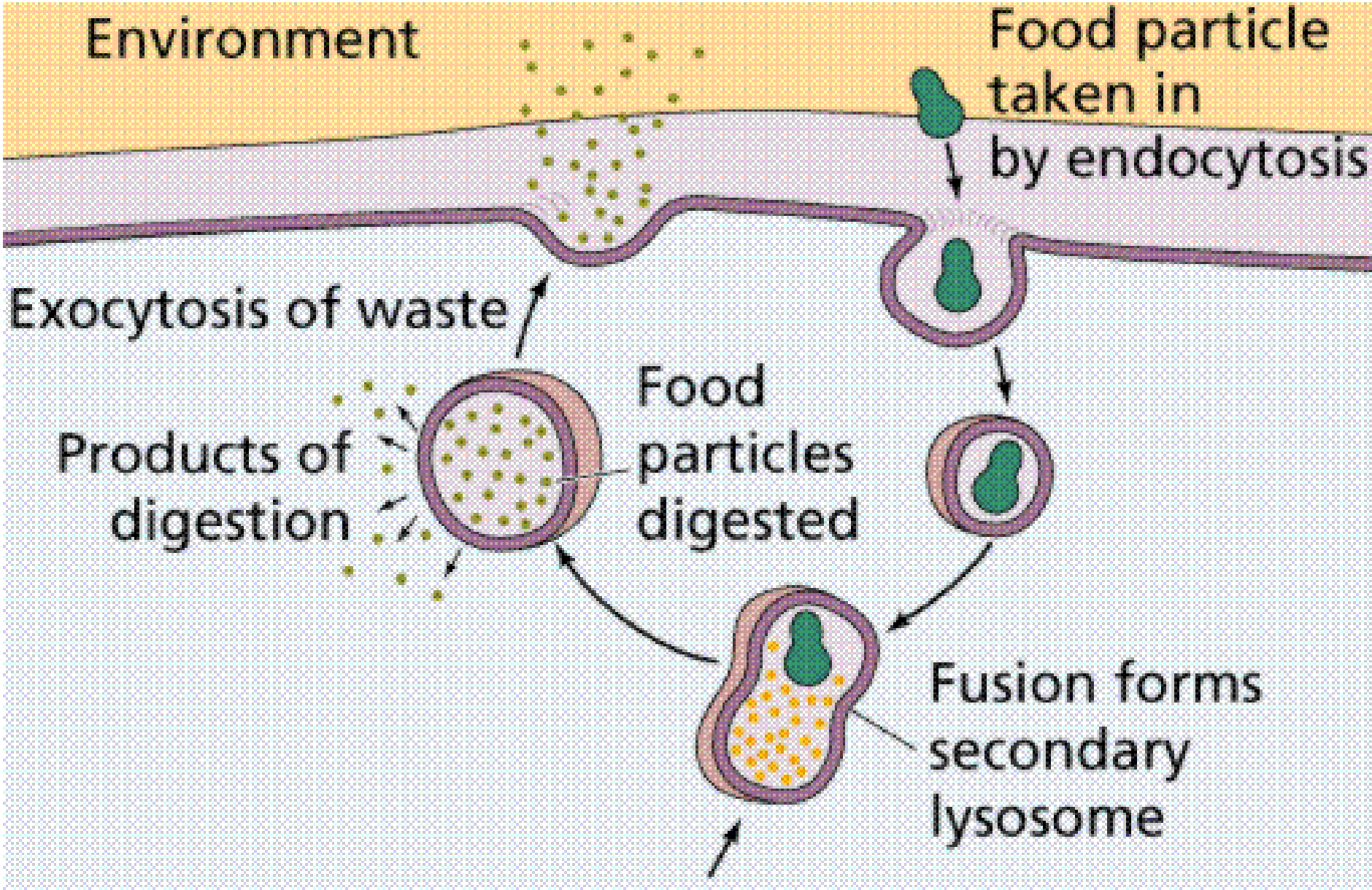
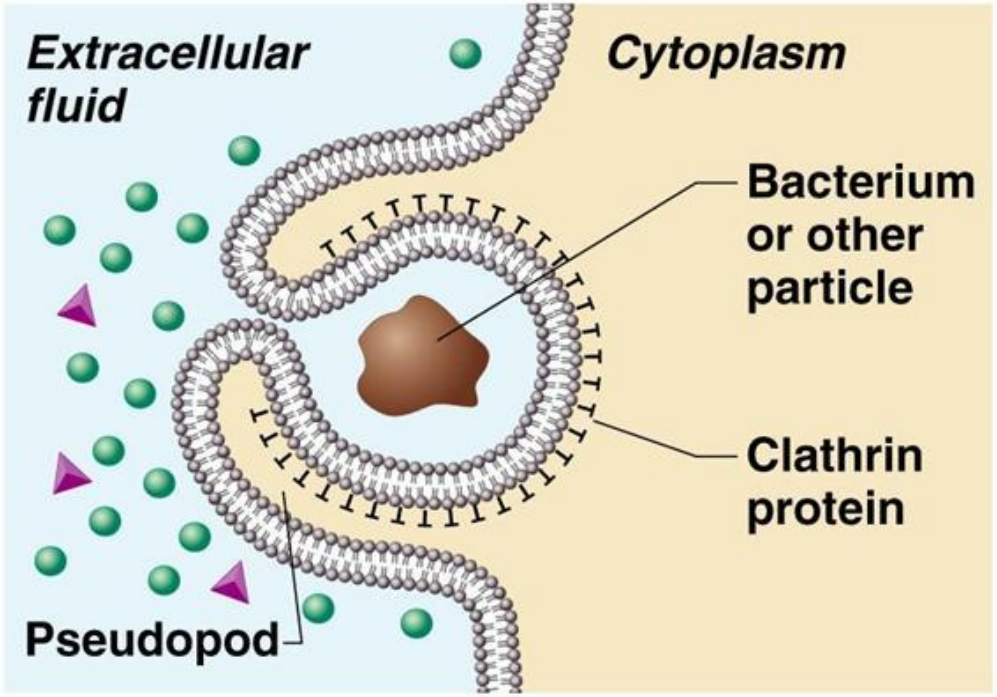


Figure 3.19

Endocytosis



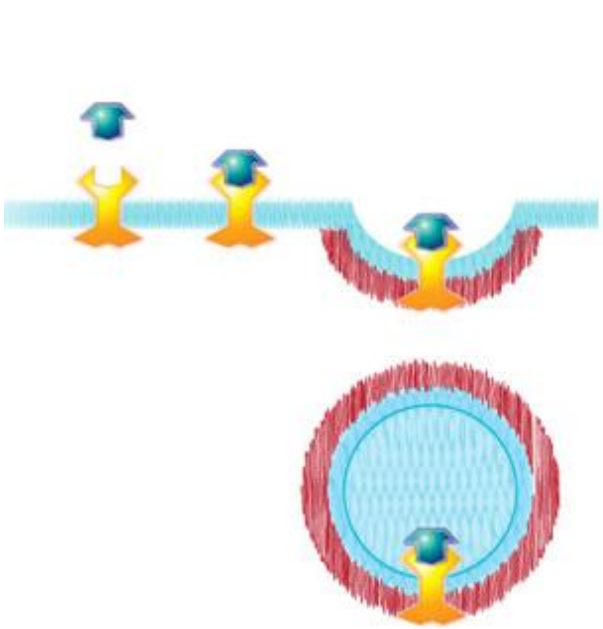
Phagocytosis

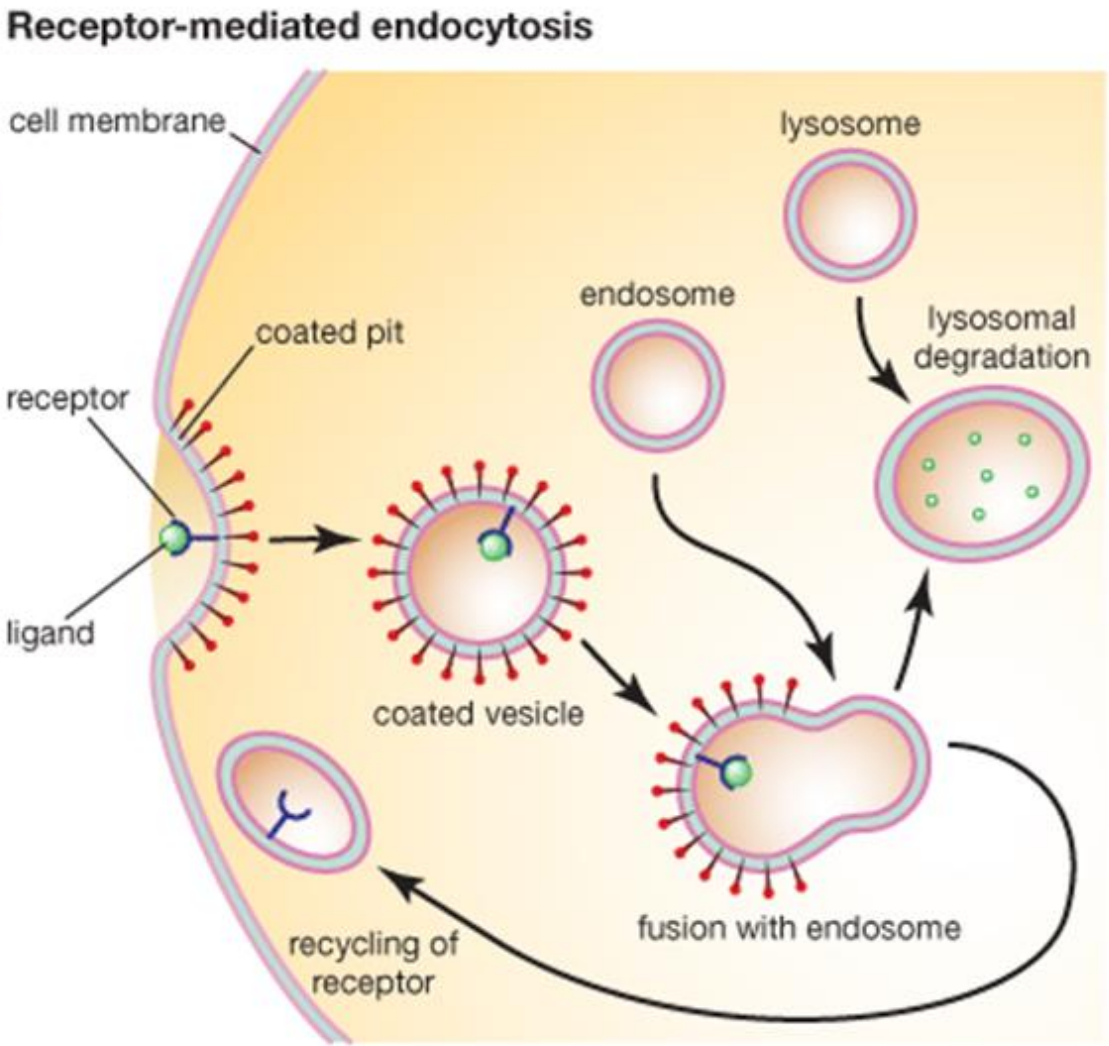


(b) Phagocytosis

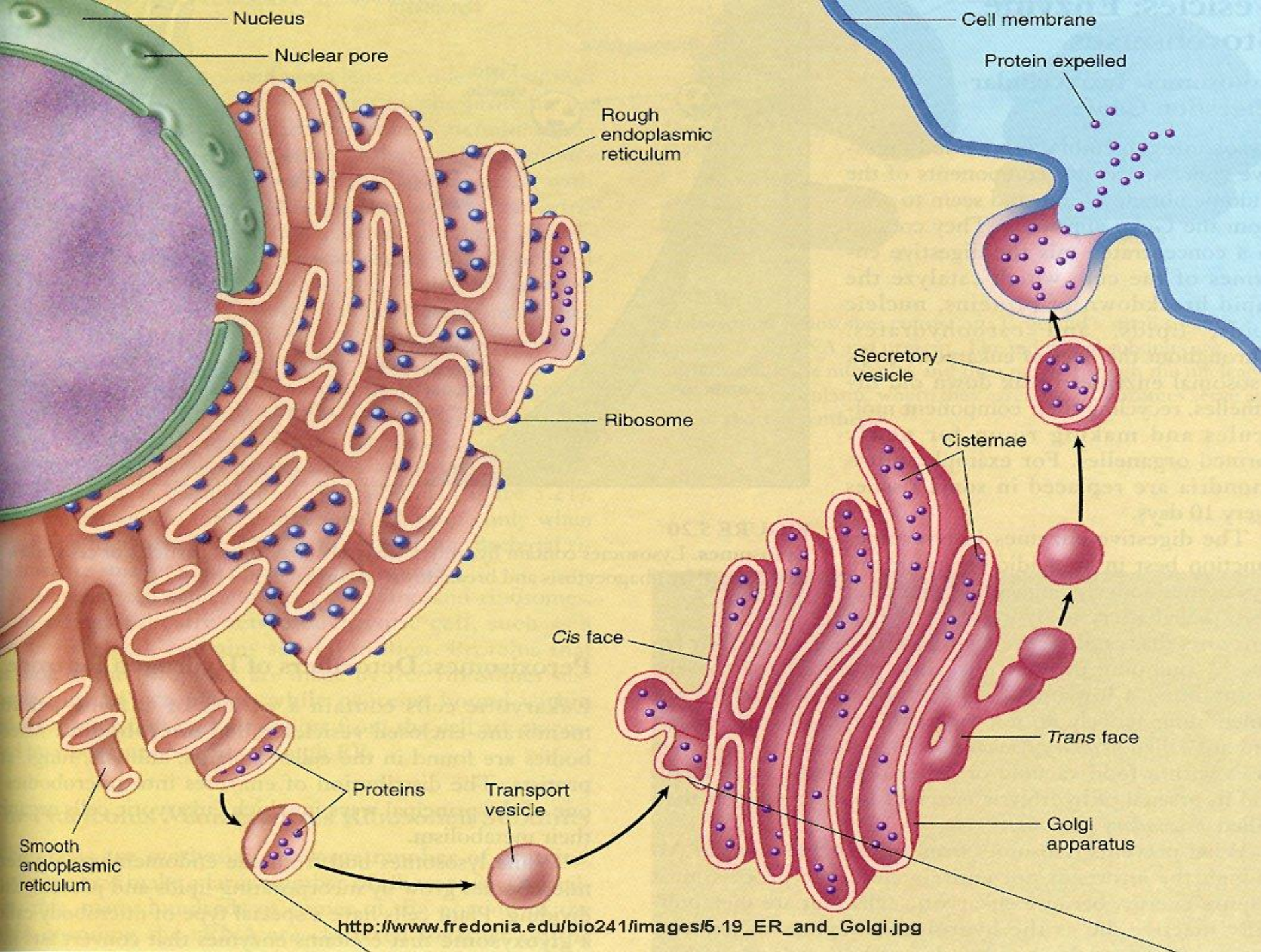
Figure 3.13b

Receptor mediated endocytosis



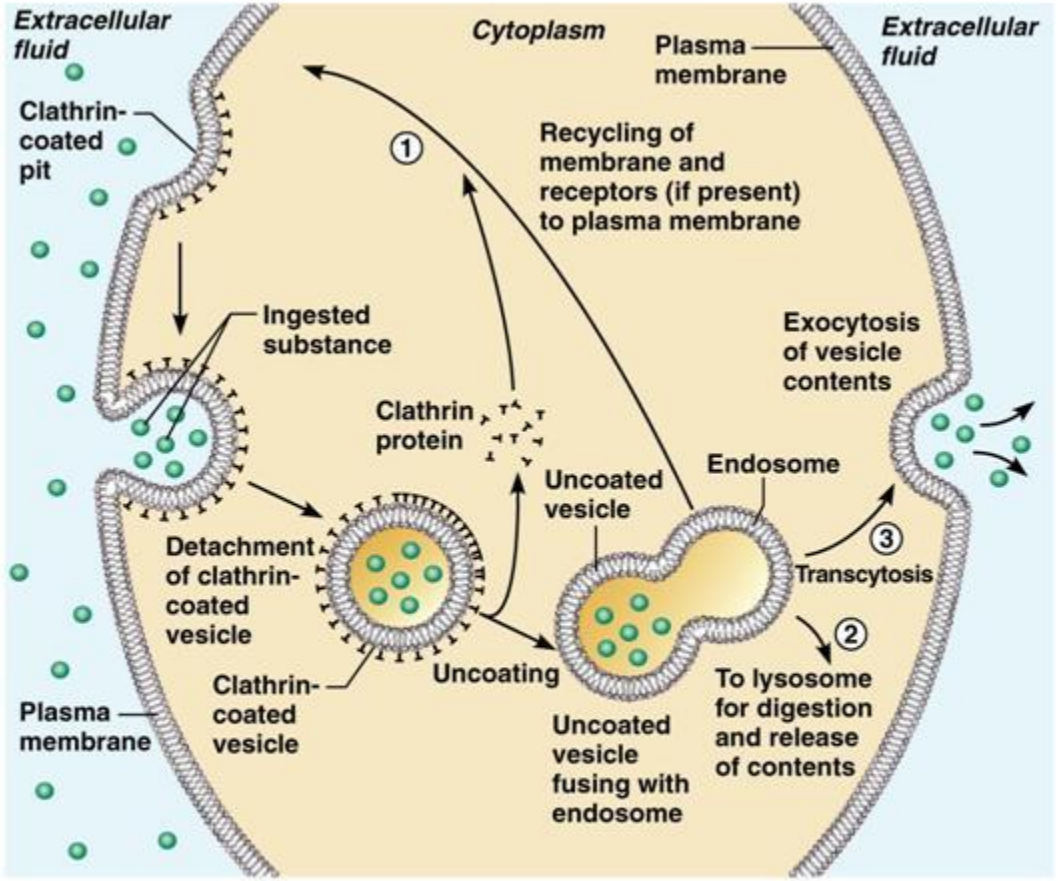


Exocytosis



http://www.fredonia.edu/bio241/images/5.19_ER_and_Golgi.jpg

Transcytosis



(a) Clathrin-mediated endocytosis

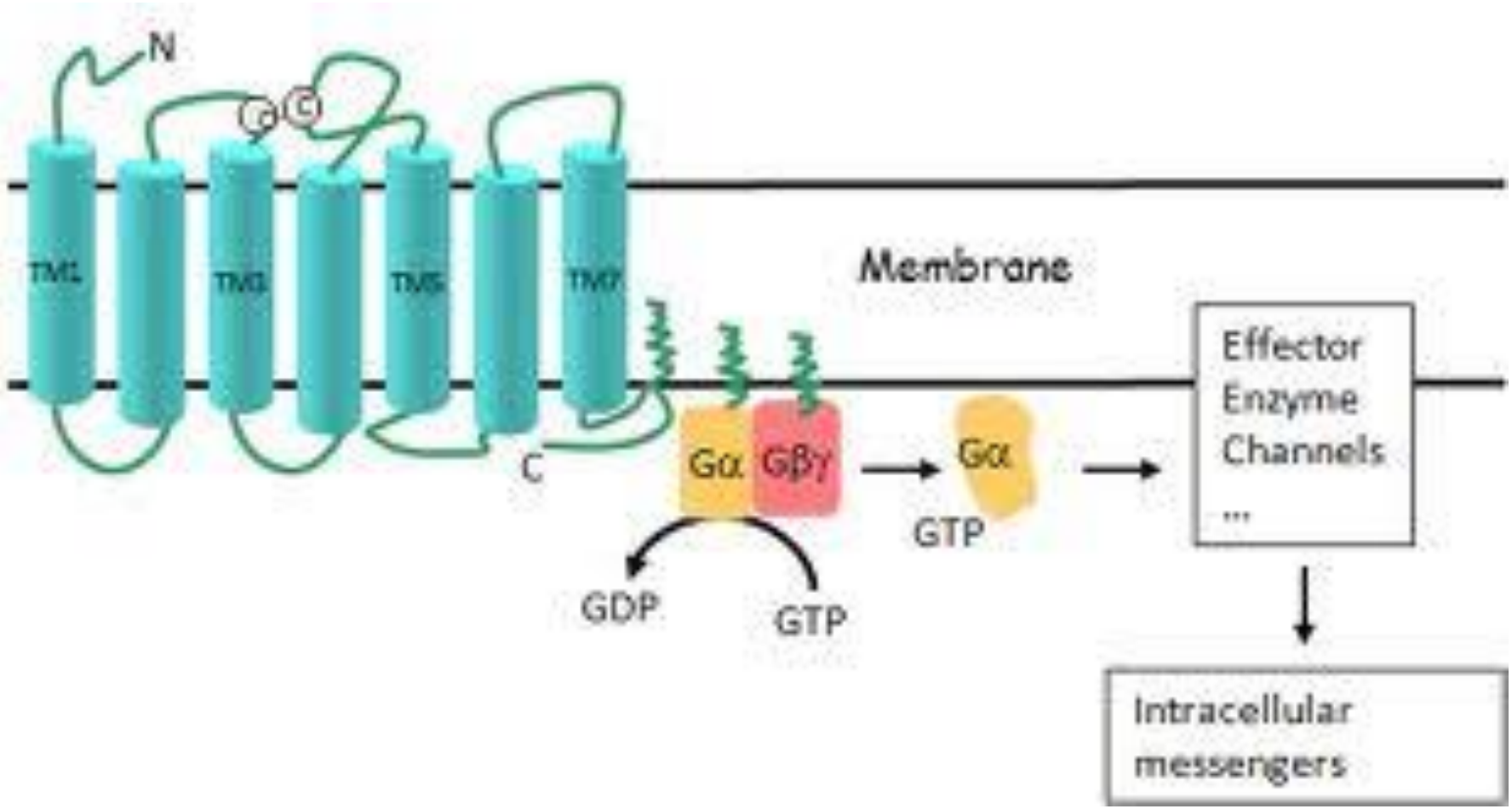
Figure 3.13a

Table 3.1 Transport of Materials Into and Out of Cells

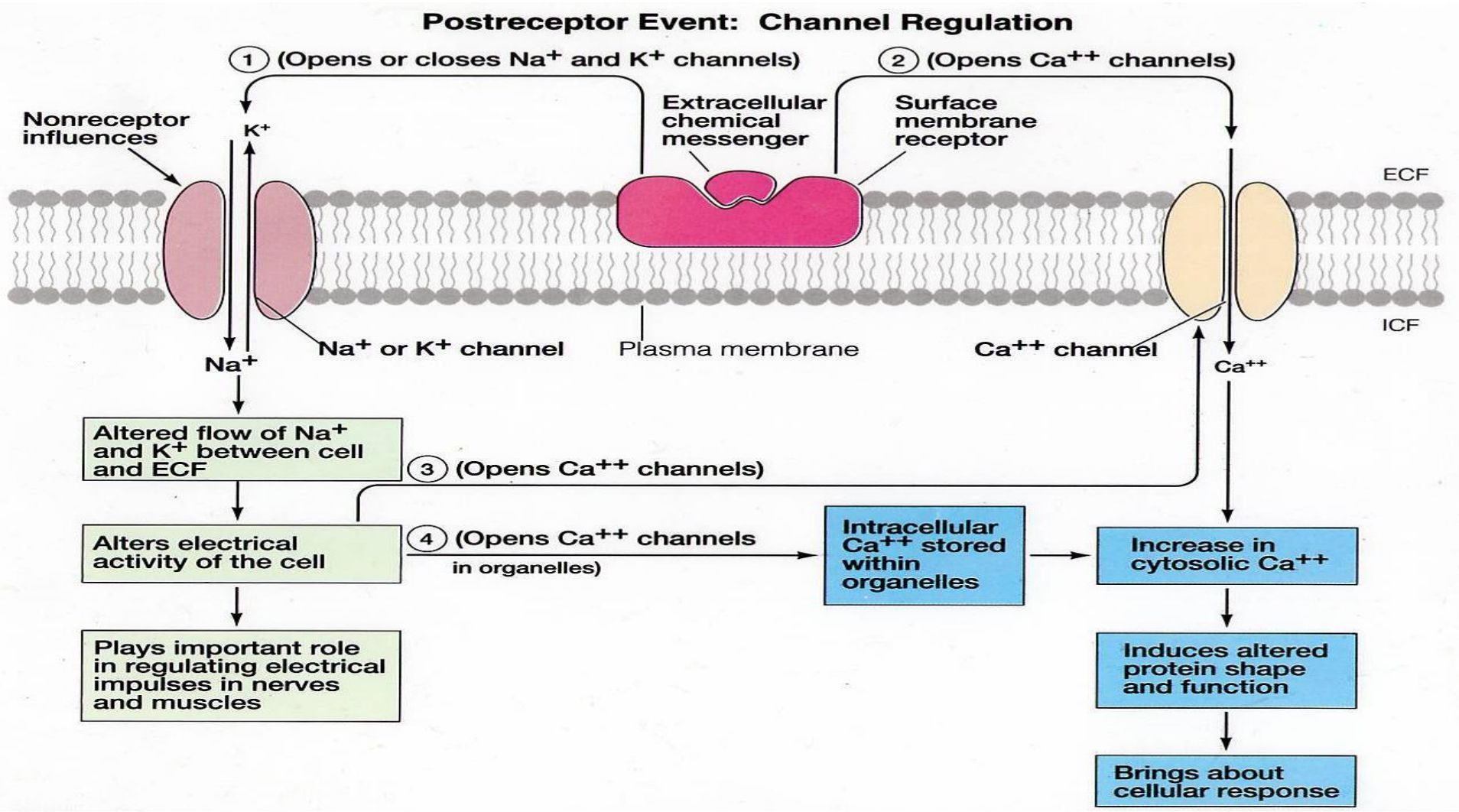
Transport Process	Description	Substances Transported
Osmosis	Movement of water molecules across a selectively permeable membrane from an area of higher water concentration to an area of lower water concentration.	Solvent: water in living systems.
Diffusion	Random mixing of molecules or ions due to their kinetic energy. A substance diffuses down a concentration gradient until it reaches equilibrium.	
Diffusion through the lipid bilayer	Passive diffusion of a substance through the lipid bilayer of the plasma membrane.	Nonpolar, hydrophobic solutes: oxygen, carbon dioxide, and nitrogen; fatty acids, steroids, and fat-soluble vitamins; glycerol, small alcohols; ammonia. Polar molecules: water and urea.
Diffusion through membrane channels	Passive diffusion of a substance down its electrochemical gradient through channels that span a lipid bilayer; some channels are gated.	Small inorganic solutes, mainly ions: K^+, Cl^-, Na^+, and Ca^{2+}. Water.
Facilitated Diffusion	Passive movement of a substance down its concentration gradient via transmembrane proteins that act as transporters; maximum diffusion rate is limited by number of available transporters.	Polar or charged solutes: glucose, fructose, galactose, and some vitamins.
Active Transport	Transport in which cell expends energy to move a substance across the membrane against its concentration gradient through transmembrane proteins that act as transporters; maximum transport rate is limited by number of available transporters.	Polar or charged solutes.
Primary active transport	Transport of a substance across the membrane against its concentration gradient by pumps; transmembrane proteins that use energy supplied by hydrolysis of ATP.	Na^+, K^+, Ca^{2+}, H^+, I^-, Cl^-, and other ions.
Secondary active transport	Coupled transport of two substances across the membrane using energy supplied by a Na^+ or H^+ concentration gradient maintained by primary active transport pumps. Antiporters move Na^+ (or H^+) and another substance in opposite directions across the membrane; symporters move Na^+ (or H^+) and another substance in the same direction across the membrane.	Antiport: Ca^{2+}, H^+ out of cells. Symport: glucose, amino acids into cells.
Transport In Vesicles	Movement of substances into or out of a cell in vesicles that bud from the plasma membrane; requires energy supplied by ATP.	
Endocytosis	Movement of substances into a cell in vesicles.	
Receptor-mediated endocytosis	Ligand-receptor complexes trigger infolding of a clathrin-coated pit that forms a vesicle containing ligands.	Ligands: transferrin, low-density lipoproteins (LDLs), some vitamins, certain hormones, and antibodies.
Phagocytosis	"Cell eating"; movement of a solid particle into a cell after pseudopods engulf it to form a phagosome.	Bacteria, viruses, and aged or dead cells.
Pinocytosis	"Cell drinking"; movement of extracellular fluid into a cell by infolding of plasma membrane to form a pinocytic vesicle.	Solutes in extracellular fluid.
Exocytosis	Movement of substances out of a cell in secretory vesicles that fuse with the plasma membrane and release their contents into the extracellular fluid.	Neurotransmitters, hormones, and digestive enzymes.

Control of Transport and activity of Enzymes

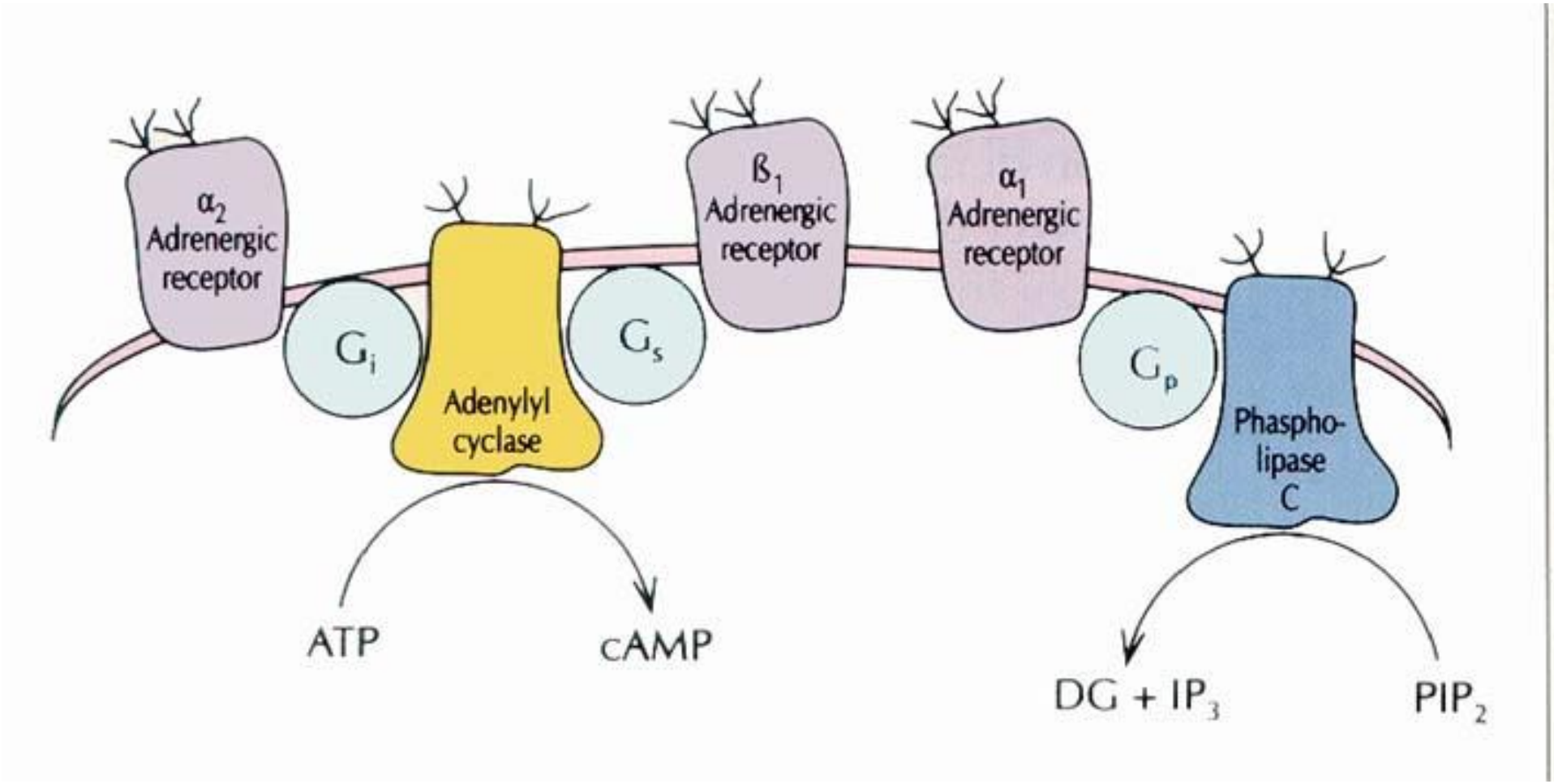
Receptors & Enzymes

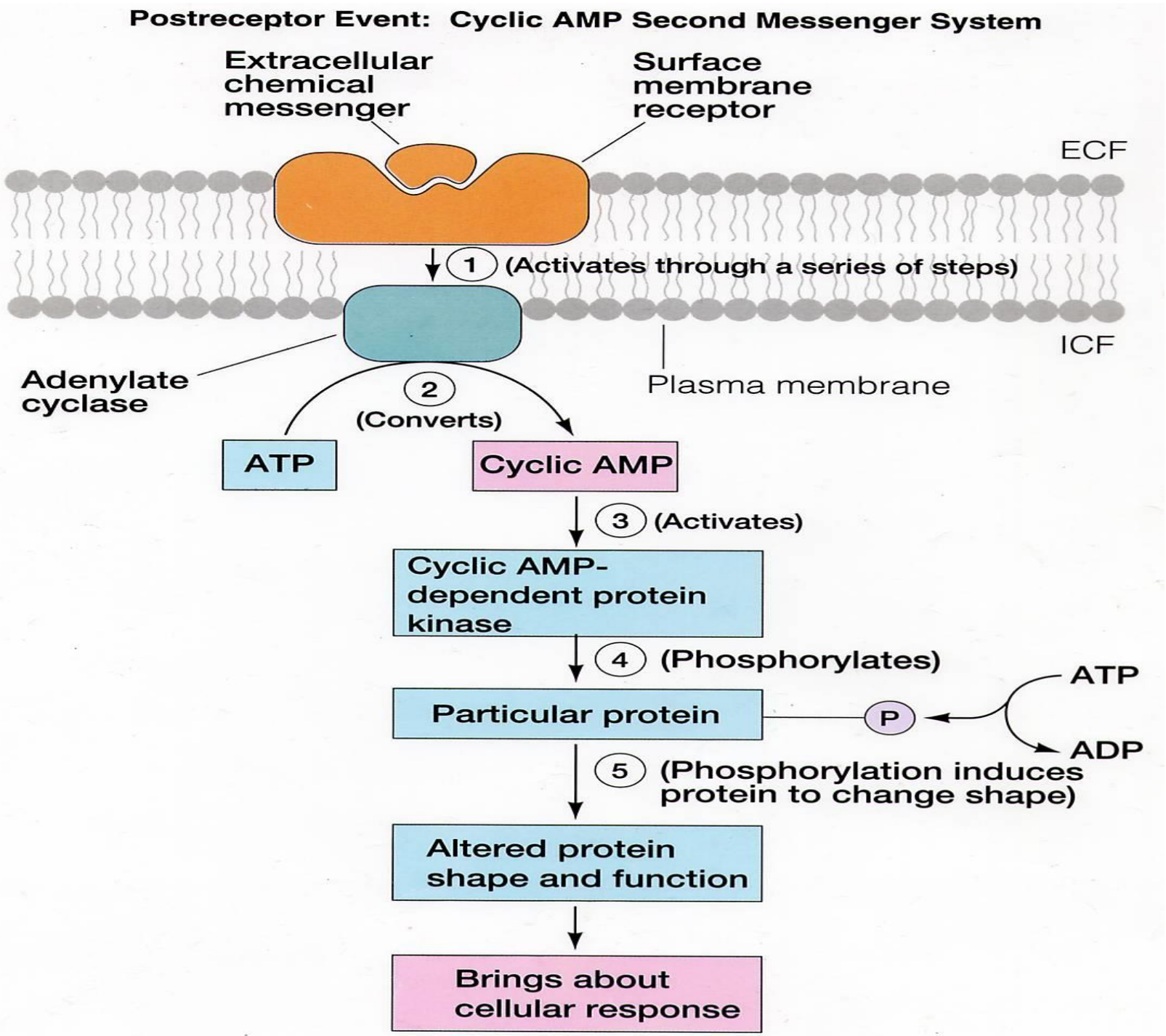


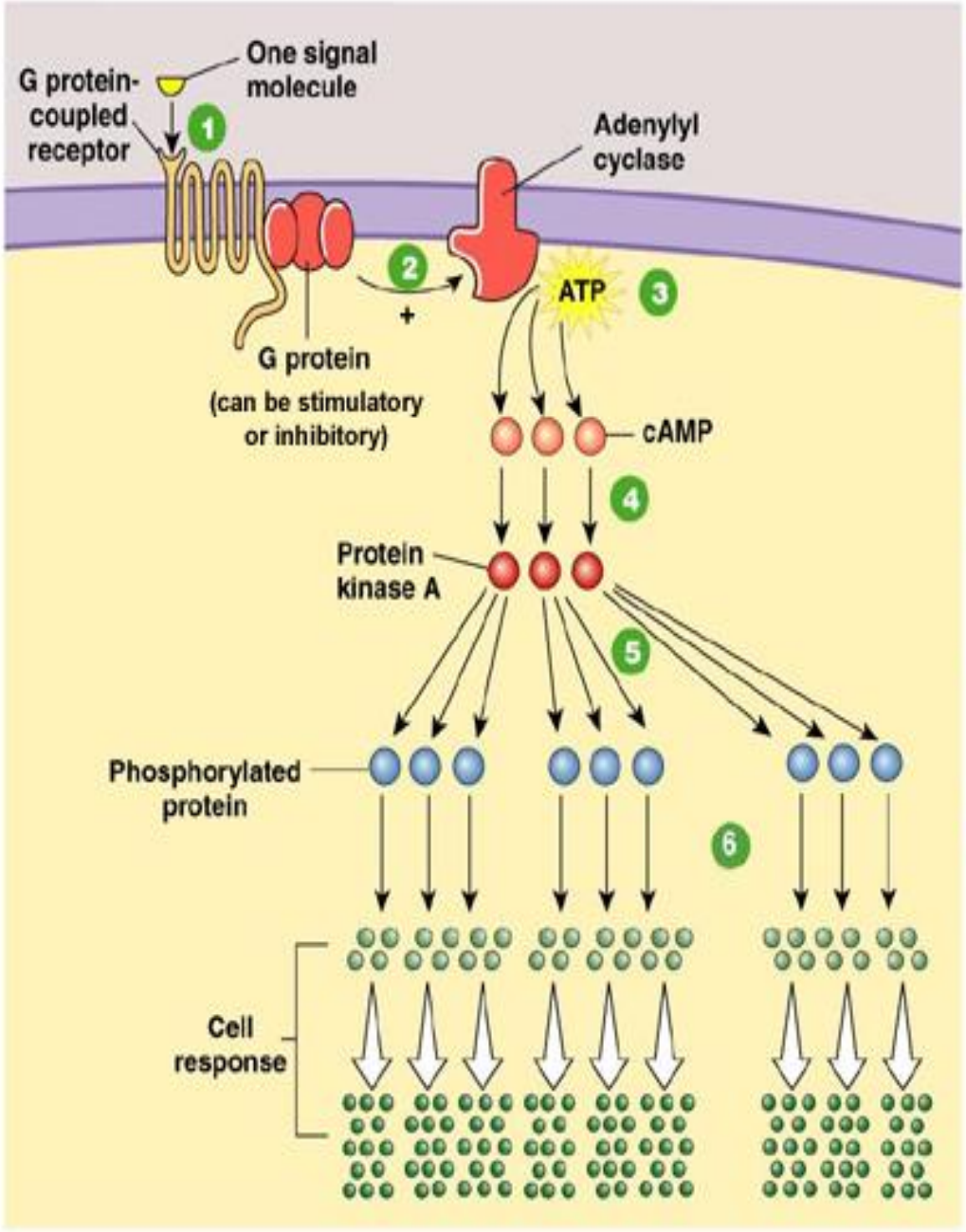
Receptors & Channels



Receptors & G proteins

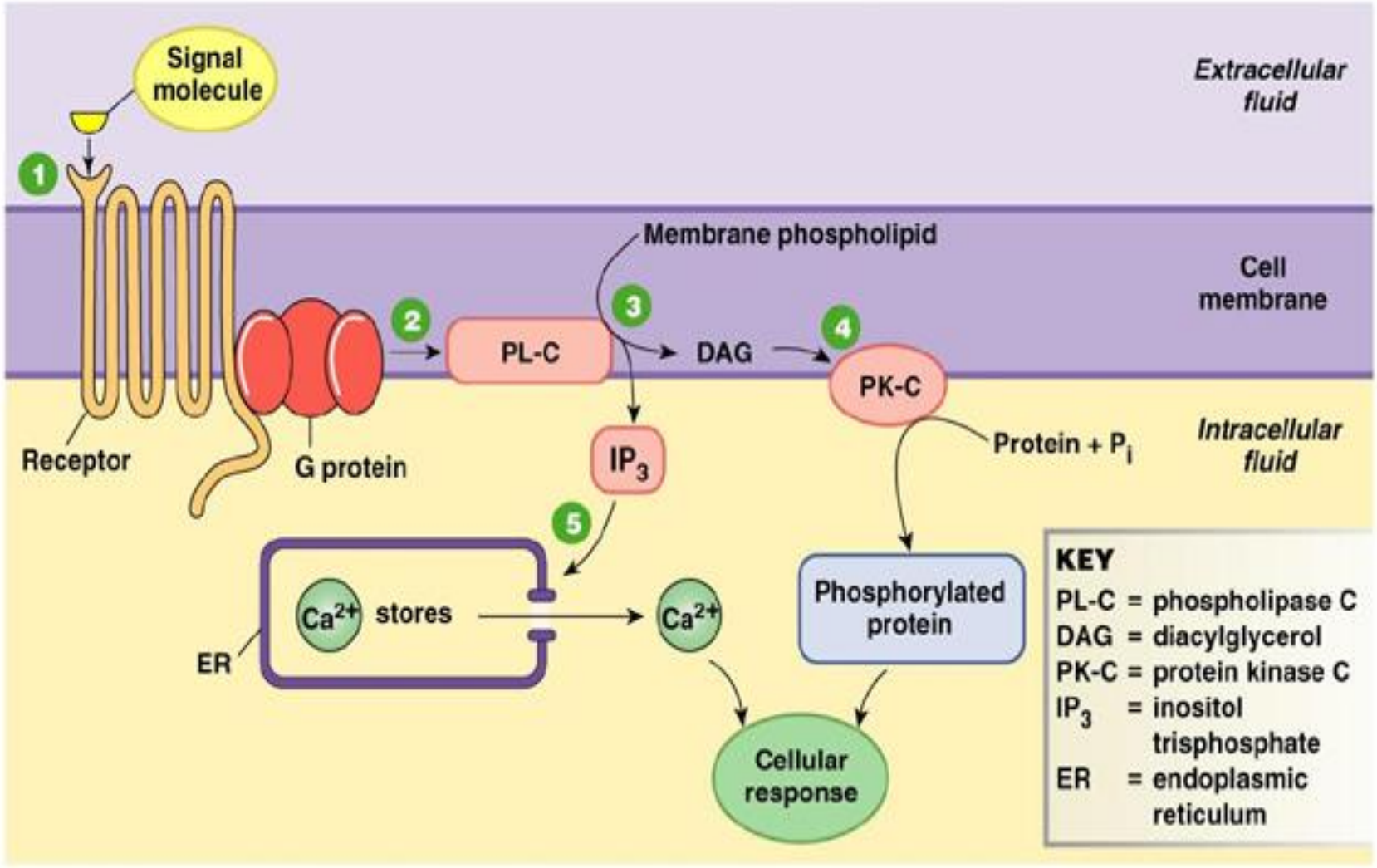



Postreceptor Event: Cyclic AMP Second Messenger System
Extracellular chemical messenger
Surface membrane receptor
ECF
1 (Activates through a series of steps)
ICF
Adenylate cyclase
Plasma membrane
2 (Converts)
ATP
Cyclic AMP
3 (Activates)
Cyclic AMP-dependent protein kinase
4 (Phosphorylates)
Particular protein
P
ATP
ADP
5 (Phosphorylation induces protein to change shape)
Altered protein shape and function
Brings about cellular response



1. Signal molecule binds to G protein-linked receptor, which activates the G protein.
2. G protein turns on adenylyl cyclase, an amplifier enzyme.
3. Adenylyl cyclase converts ATP to cyclic AMP.
4. cAMP activates protein kinase A.
5. Protein kinase A phosphorylates other proteins, leading ultimately to a cellular response.
6. Note how the initial signal is amplified.

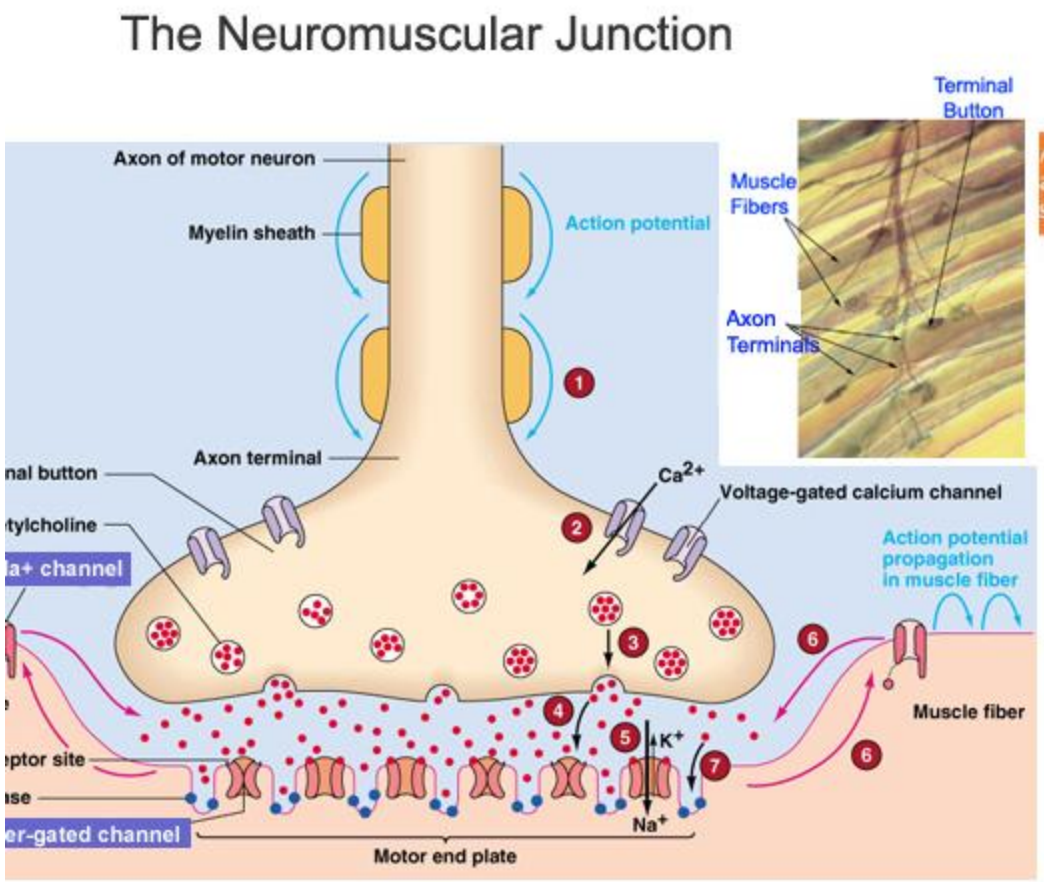
Fig. 6-11

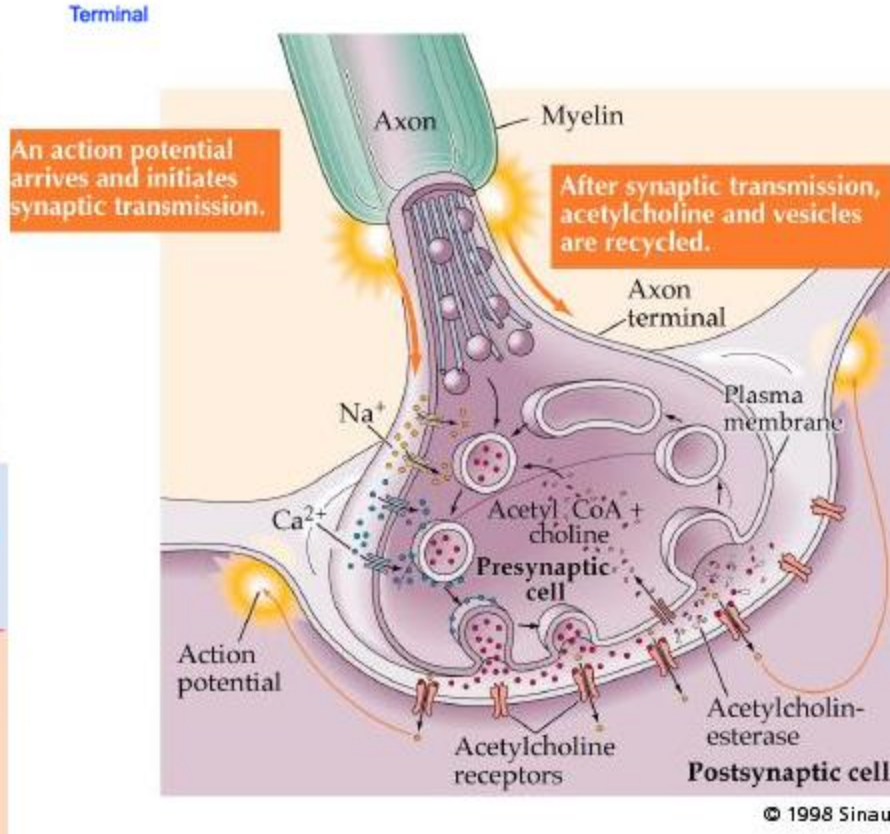


1. Signal molecule activates receptor and associated G protein.
2. G protein activates phospholipase C (PL-C), an amplifier enzyme.
3. PL-C converts membrane phospholipids into diacylglycerol (DAG), which remains in the membrane, and IP_3, which diffuses into the cytoplasm.
4. DAG activates protein kinase C (PK-C), which phosphorylates proteins.
5. IP_3 causes release of Ca^{2+} from organelles, creating a Ca^{2+} signal.

Fig. 6-12

Control of Exocytosis





Summary of Lectures

-Homeostasis

-Control of body functions by feed-back mechanisms to keep homeostasis

-Functions of Cell organells (ER, Golgi complex, Mitochondria, Lisosomes)

-Cytoskeletal structures and Functions:

Plasma membrane

- **Membrane structure and function of lipids of plasma membrane** including phospholipids, cholesterol and PIP2)

-**Functions of Protein structures of plasma membranes** (Channels, Carriers, Receptors, Pumps, enzymes, cell markers, G proteins, adhesion molecules)

-**Activation of chemical gated** channels

Transport through plasma membranes

Passive transport modalities

-Simple diffusion: transport through lipid bilayer, transport through channels, Ficks law of diffusion.

-Facilitated diffusion: by carriers

Differences in diffusion Kinetics between the previous modalities

Equivalent Concentration of particles.

Transport through plasma membranes

Passive transport modalities

-**Osmosis**: concept of osmotic pressure (Van't Hoff's law), Oncotic (Colloid-osmotic) pressure.Osmolarity, osmolality

Hydrostatic pressure

Transport through plasma membranes

Active transport modalities

- **Primary active transport** (ATP-ase carriers or Pumps) (functions of pumps: Na+/K+ pump, Ca++ pump, H+ pump, H+/K+ pump).
- **Secondary active transport** (Na+ dependent carriers) examples

Transport through plasma membranes

Active transport modalities

- **Vesicular transport**: endocytosis, phagocytosis, transcytosis, pinocytosis and exocytosis and its control in secretory cells.-