STUDY MATERIAL

VIVEKANANDA COLLEGE THAKURPUKUR

NAAC ACCREDITED GRADE—'A'

Subject: Membrane biology and bioenergetics
Topic: Transport across biological membrane

Name of the Teacher: **Dr. Dibyendu Raj**

Types of cell membrane transport

- Factors affecting transport
  - Cell membrane
  - Chemical gradient
  - Electrical gradient
  - Rate of transport

- Passive transport
  - Diffusion
  - Osmosis
  - Facilitated diffusion

- Active transport
  - Pumps
  - phagocytosis
  - Endocytosis/exocytosis

The membrane is permeable to:

- H_2O
- Gases (O_2, CO_2, N_2)
- Lipids
- Small, neutral molecules (such as urea)

The membrane is impermeable to:

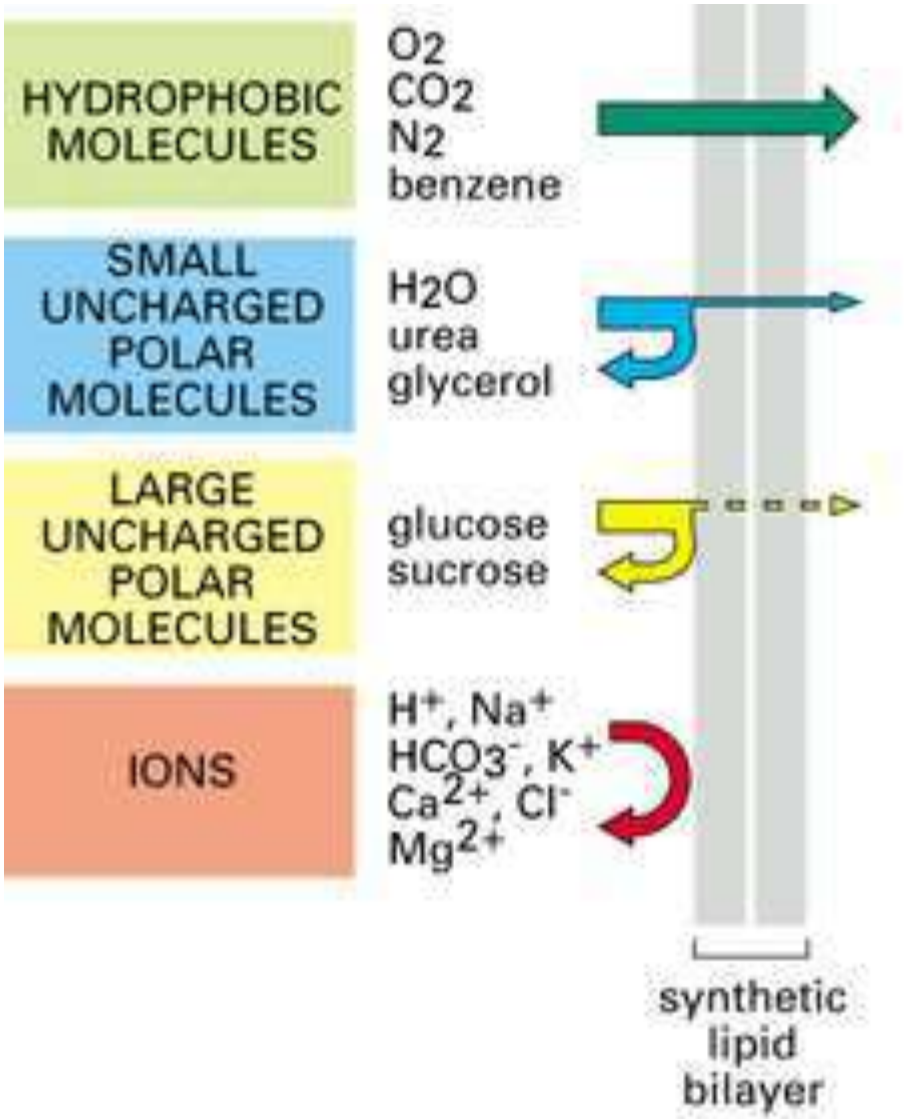
- Small, charged molecules
- "large molecules" such as amino acids, glucose and larger
- These compounds must go through channels present in the membrane in order to enter or exit the cell

Principles of membrane transport

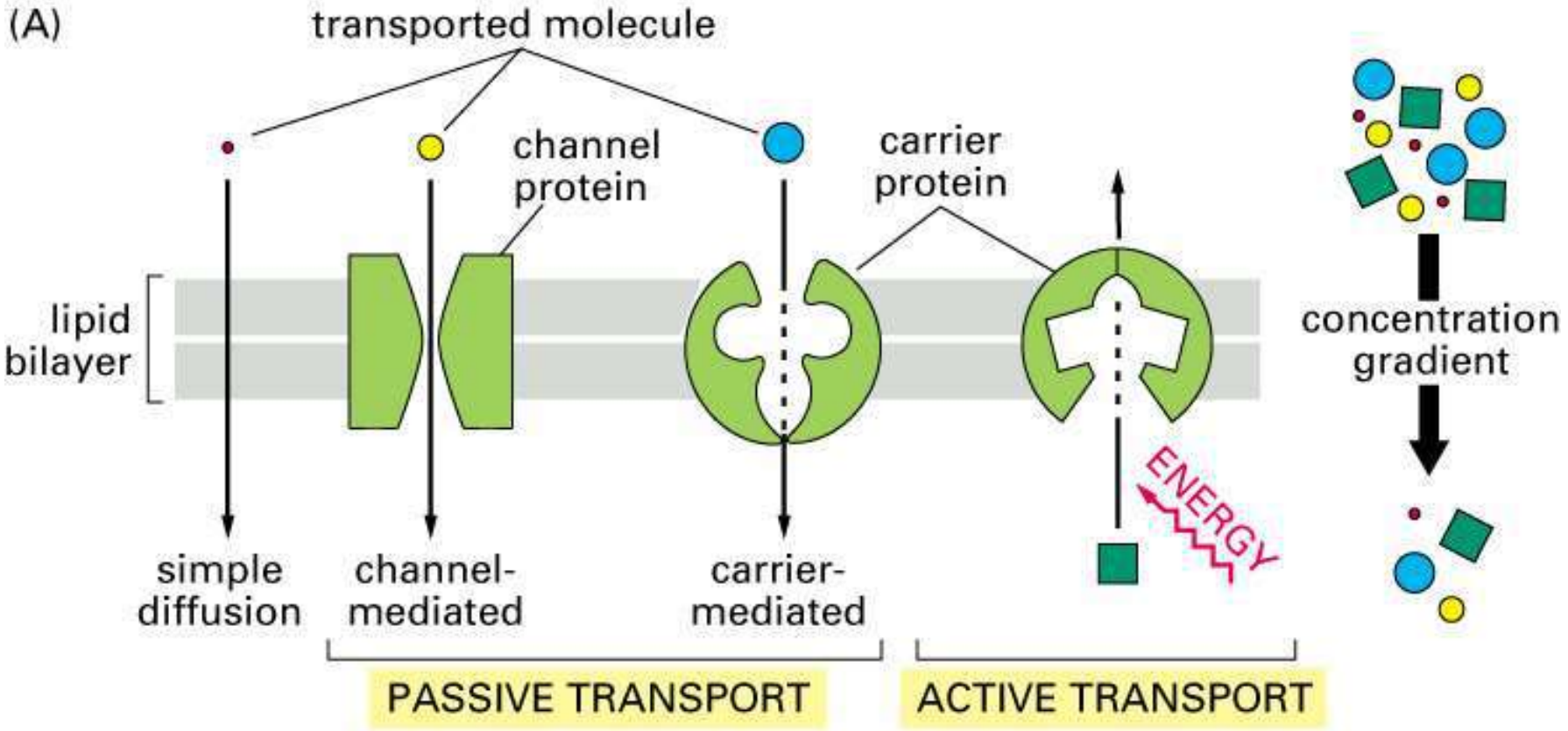
- Membranes are barriers to movement of water-soluble molecules.

- Two classes of transport
  -channels
  -carriers (=transporters, carriers, exchangers)

- Type of transport distinguished based upon how energy is used

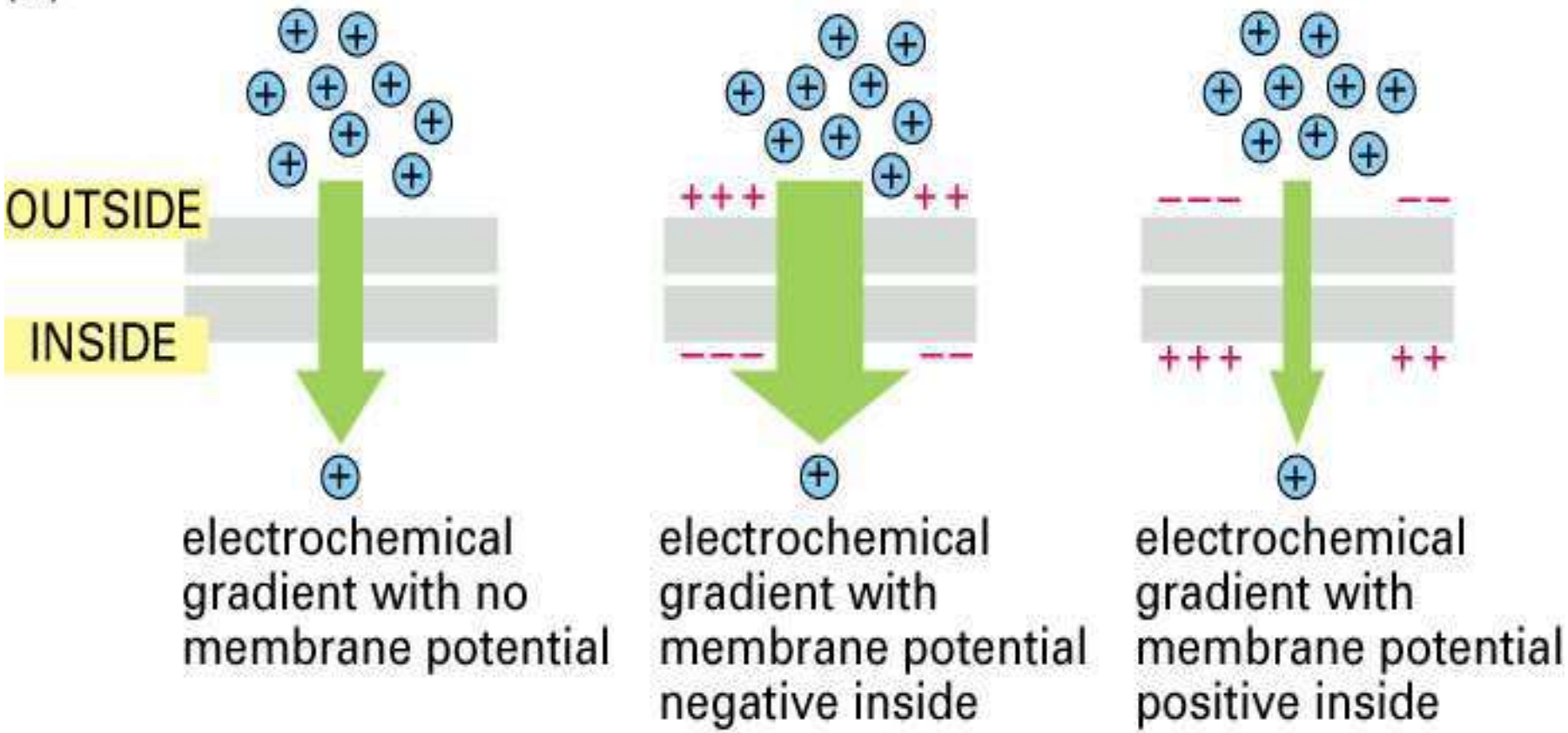


@ Molecular Biology of The Cell, 4th Edition



@ Molecular Biology of The Cell, 4th Edition

(B)

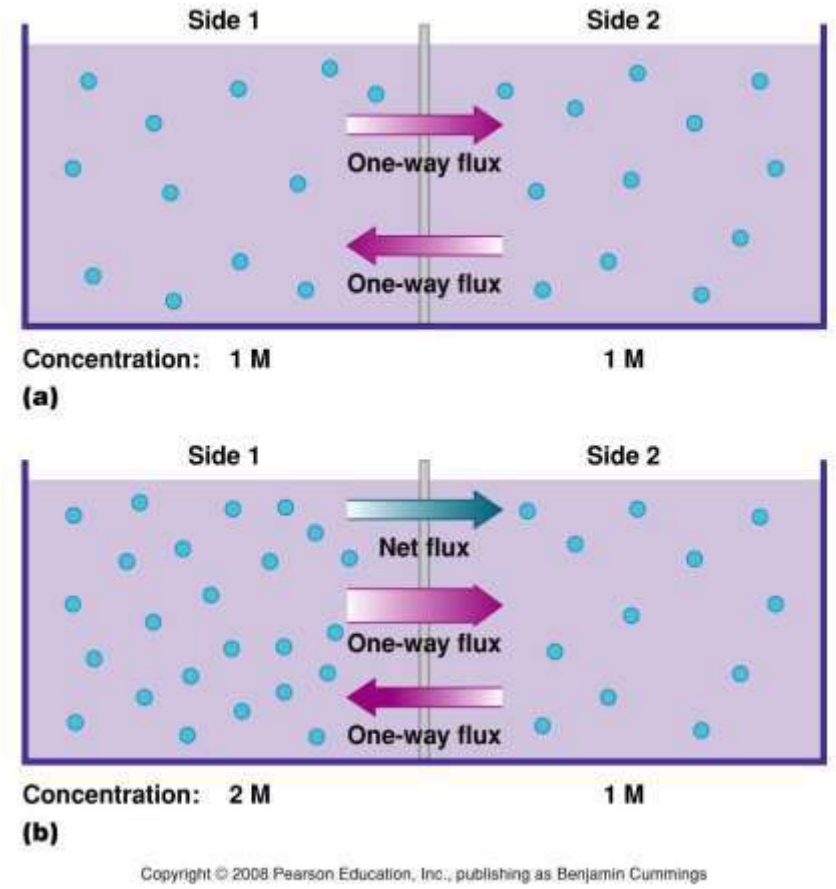


@ Molecular Biology of The Cell, 4th Edition

Factors affecting transport: **Chemical gradient**

- Compound moves from an area of high concentration to low concentration (or concentration gradient)

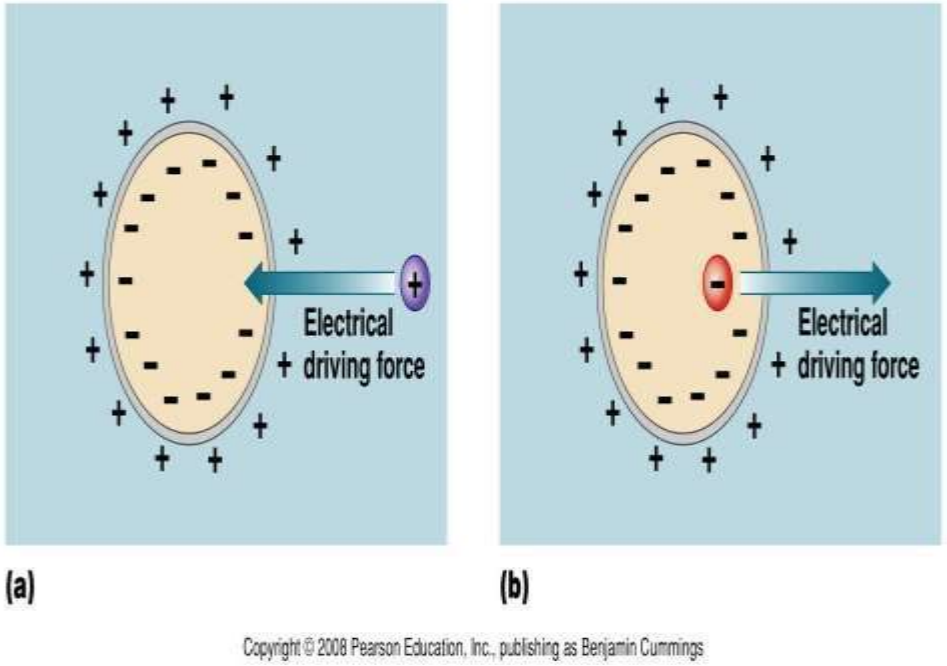
- All compounds permeable to the phospholipid bilayer will move this way



Factors affecting transport: **Electrical force**

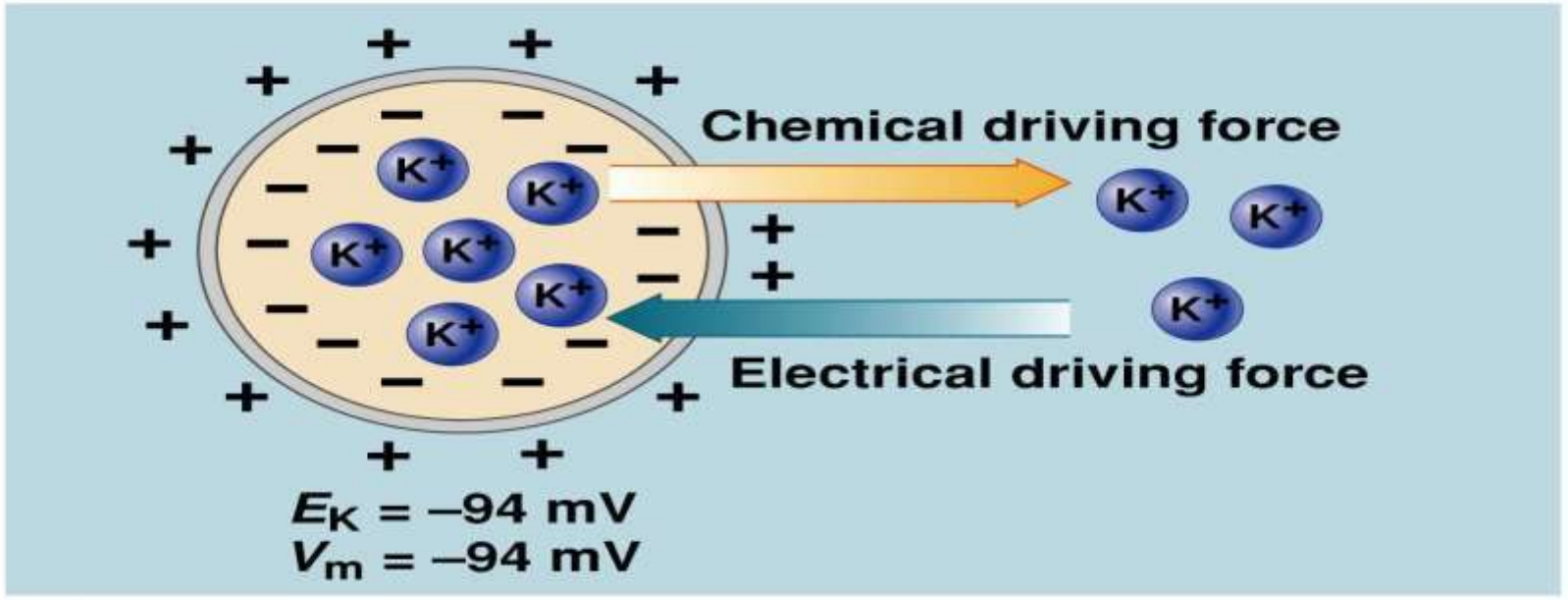
- Positive ions are attracted to negative ions and vice versa

- Ions are repelled by ions of the same charge (+ against + and – against -)



Movement across the cell membrane

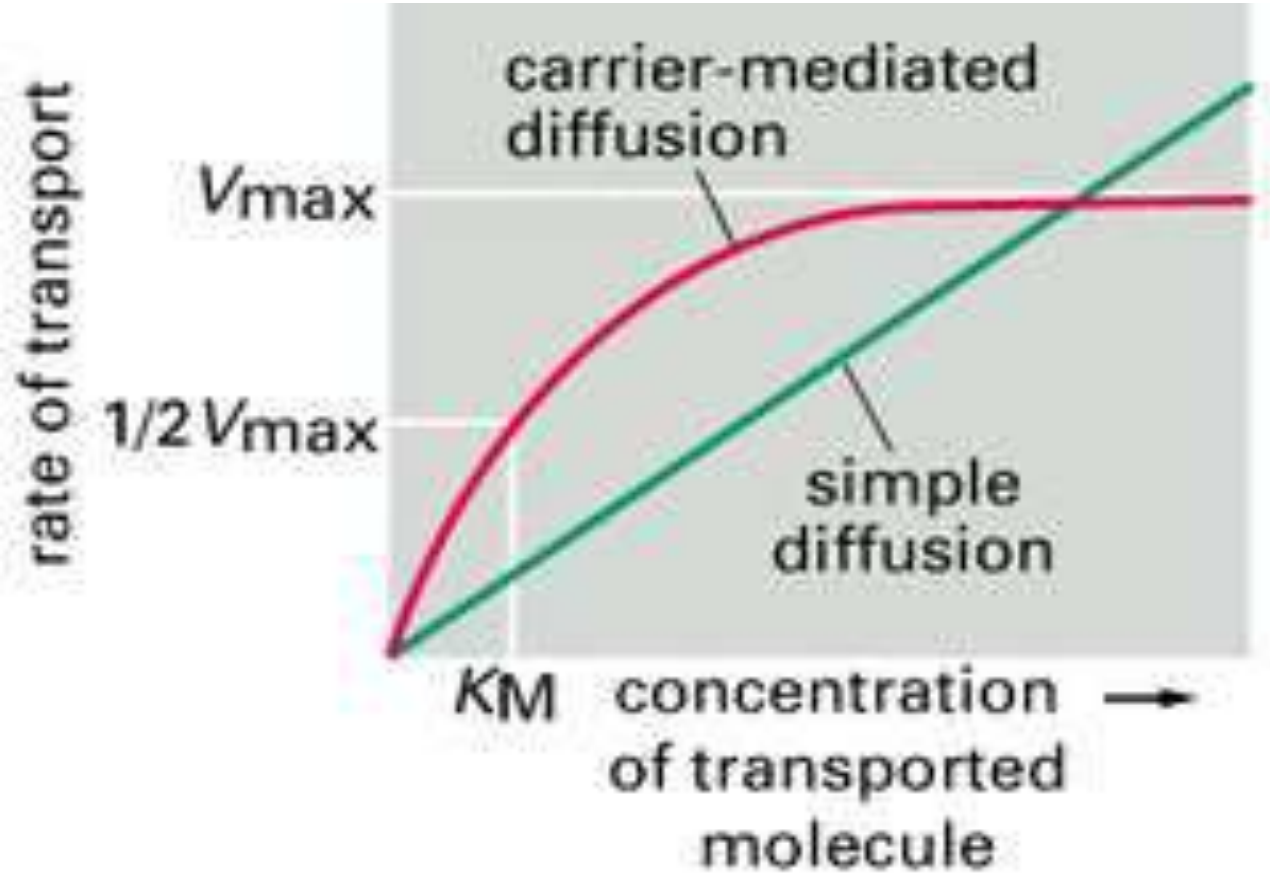
- Both chemical and electrical forces (electrochemical force) drive the movement of compounds across the cell membrane



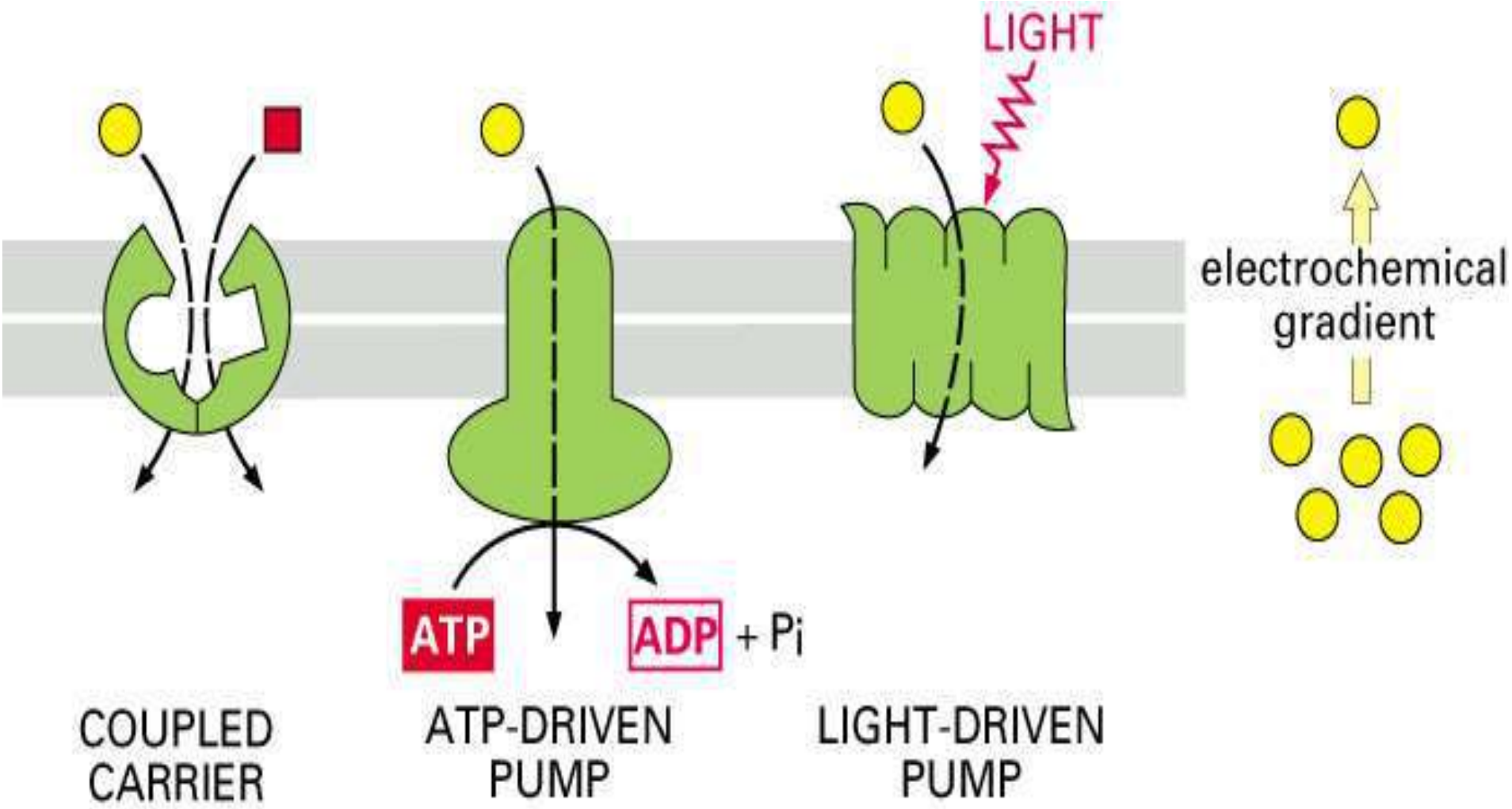
(a)

Principles of membrane transport

- (4) Kinetics (flux in relation to concentration)



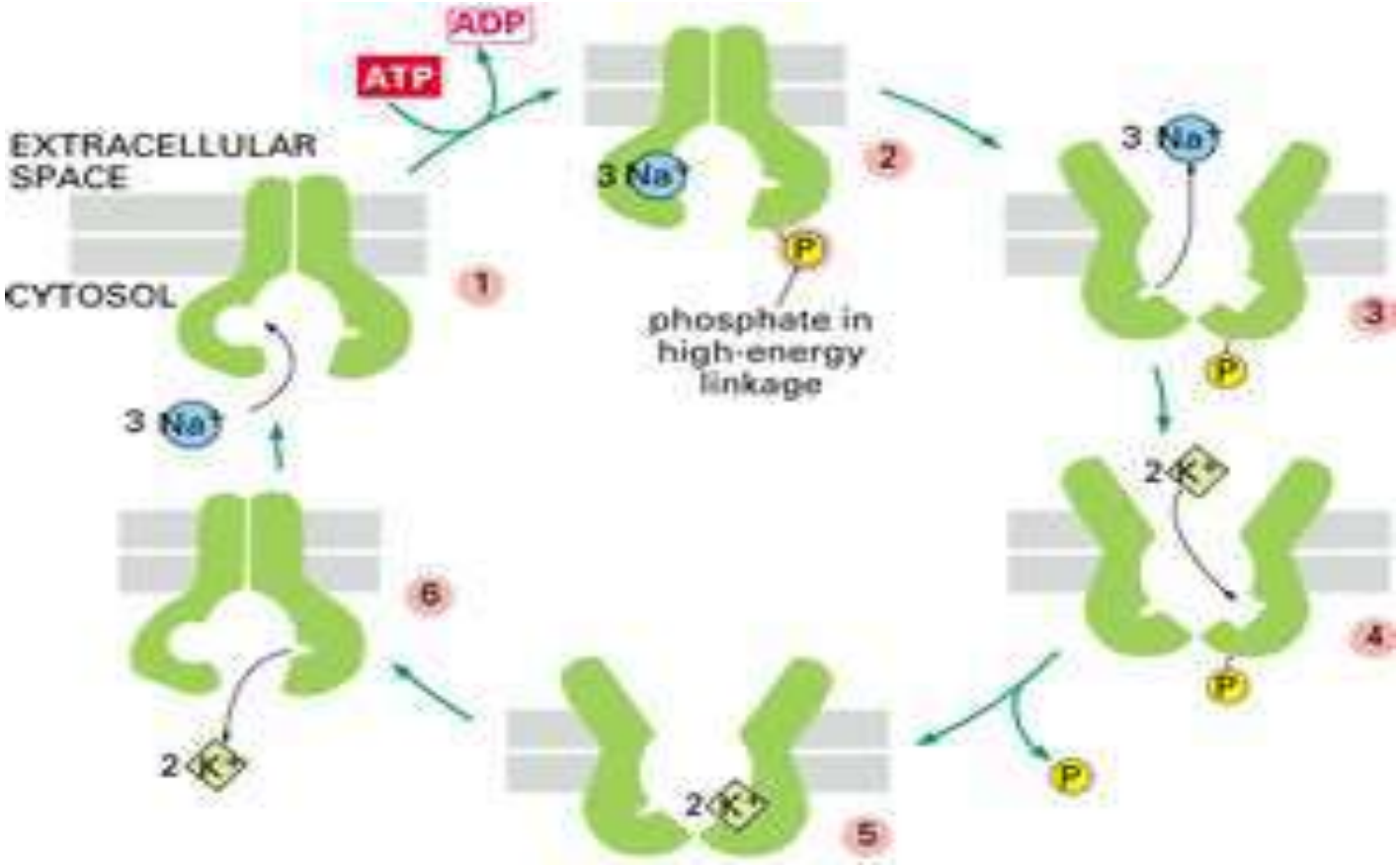
@ Molecular Biology of The Cell, 4th Edition



@ Molecular Biology of The Cell, 4th Edition

ATPases

- Many proteins use the energy of ATP hydrolysis to fuel transport.
- **(1) P-type ATPase** e.g. Na^+-K^+ATPase



@ Molecular Biology of The Cell, 4th Edition

ATPases

Many proteins use the energy of ATP hydrolysis to fuel transport.

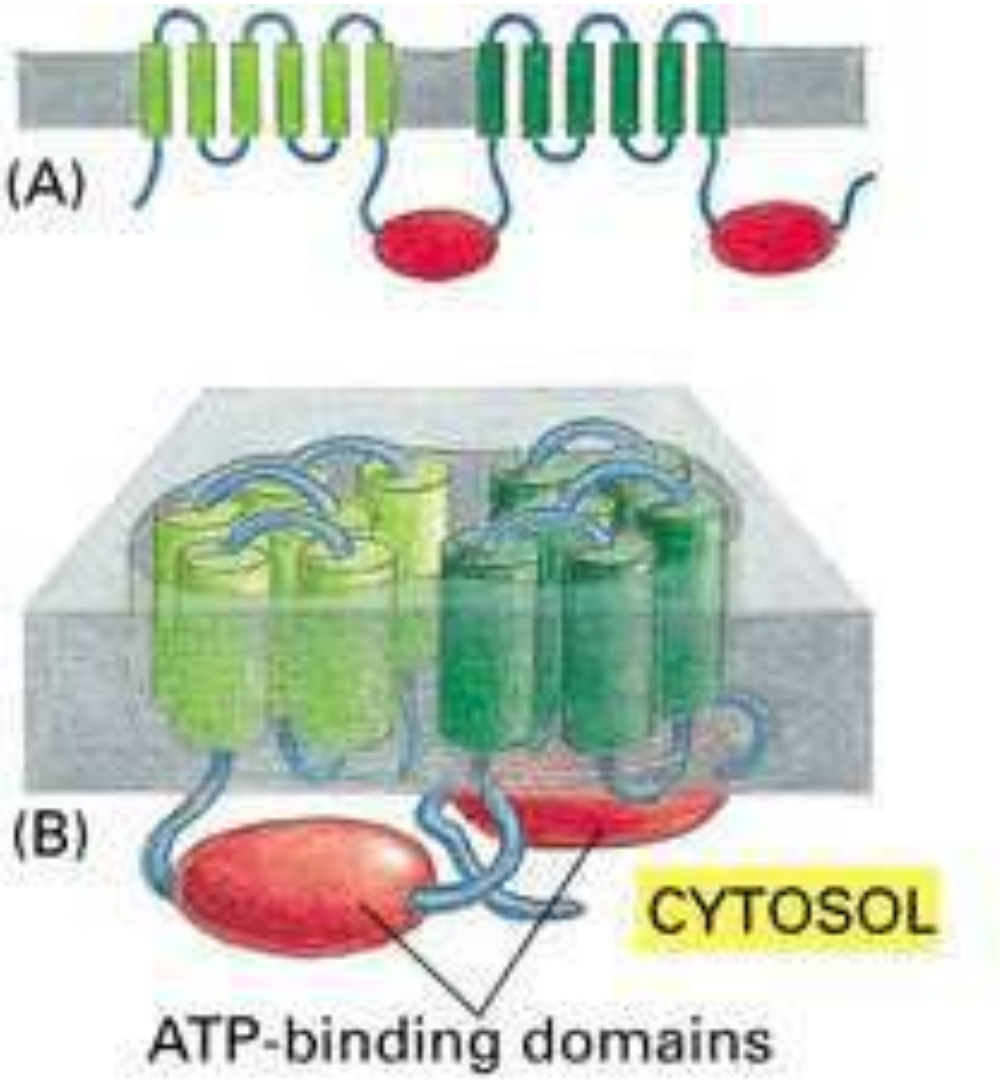
(2) V-type ATPase

Multimeric transporters often work in the reverse direction (ATP synthesis)

F_1Fo ATPase is the mitochondrial ATP synthase

H^+-ATPase of lysosomes acidify the organelle

ATPases



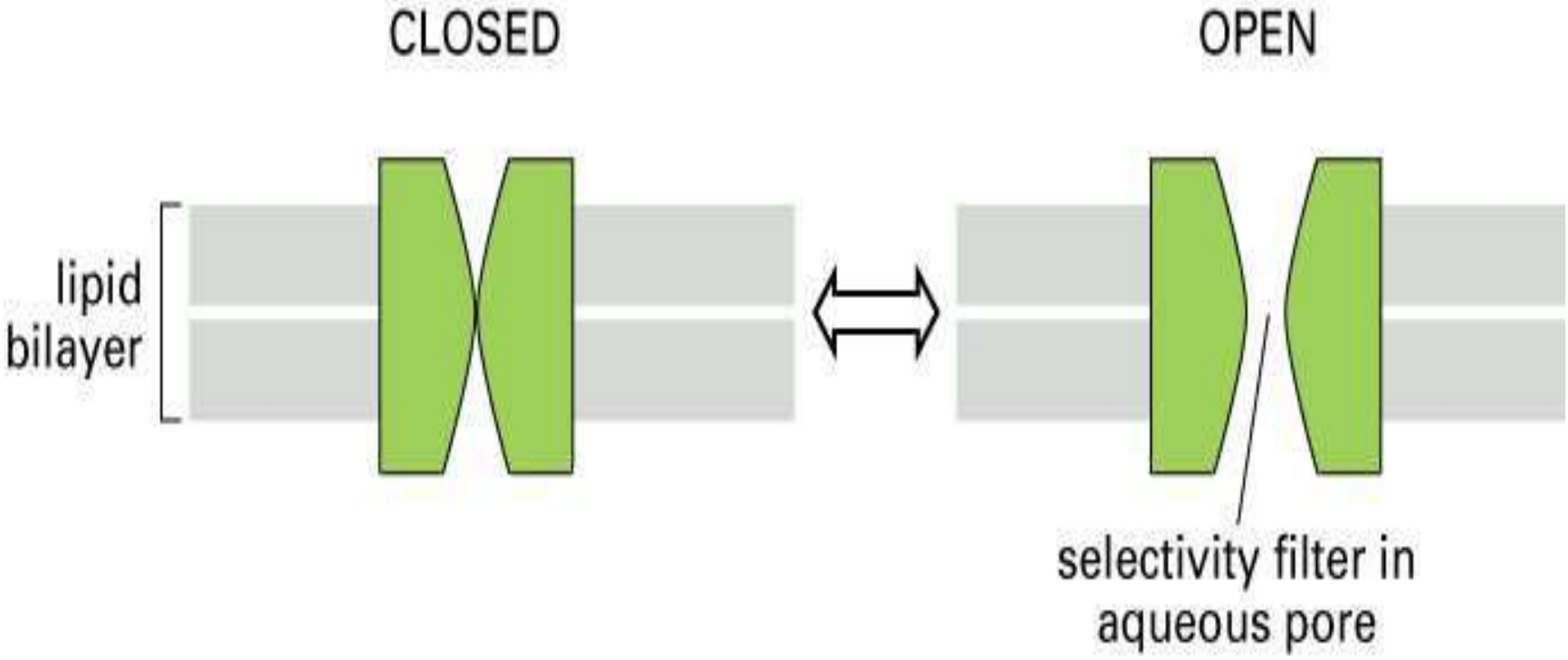
- **(3) ABC Transporters**
- Many proteins have an "ATP-Binding Cassette" and move large molecules across membranes

-Multi-drug resistant protein can pump drugs out of cells. Some cancers become resistant to cancer therapy by increasing expression of MDR, either by gene duplication or increased transcription

@ Molecular Biology of The Cell, 4th Edition

Ion channels

- Ion channels are pores that permit the movement of specific ions.
- When open, the channels allow ions to move down concentration gradients



@ Molecular Biology of The Cell, 4th Edition

Types of ion channels

- (1) Ligand-gated channels:
- Usually opened by intracellular or extracellular ligands.
- e.g. IP_3-sensitive Ca^{2+} channel opens in the presence of IP_3

(2) Voltage-gated channels:

Altering voltage beyond a threshold will cause the channel to open.

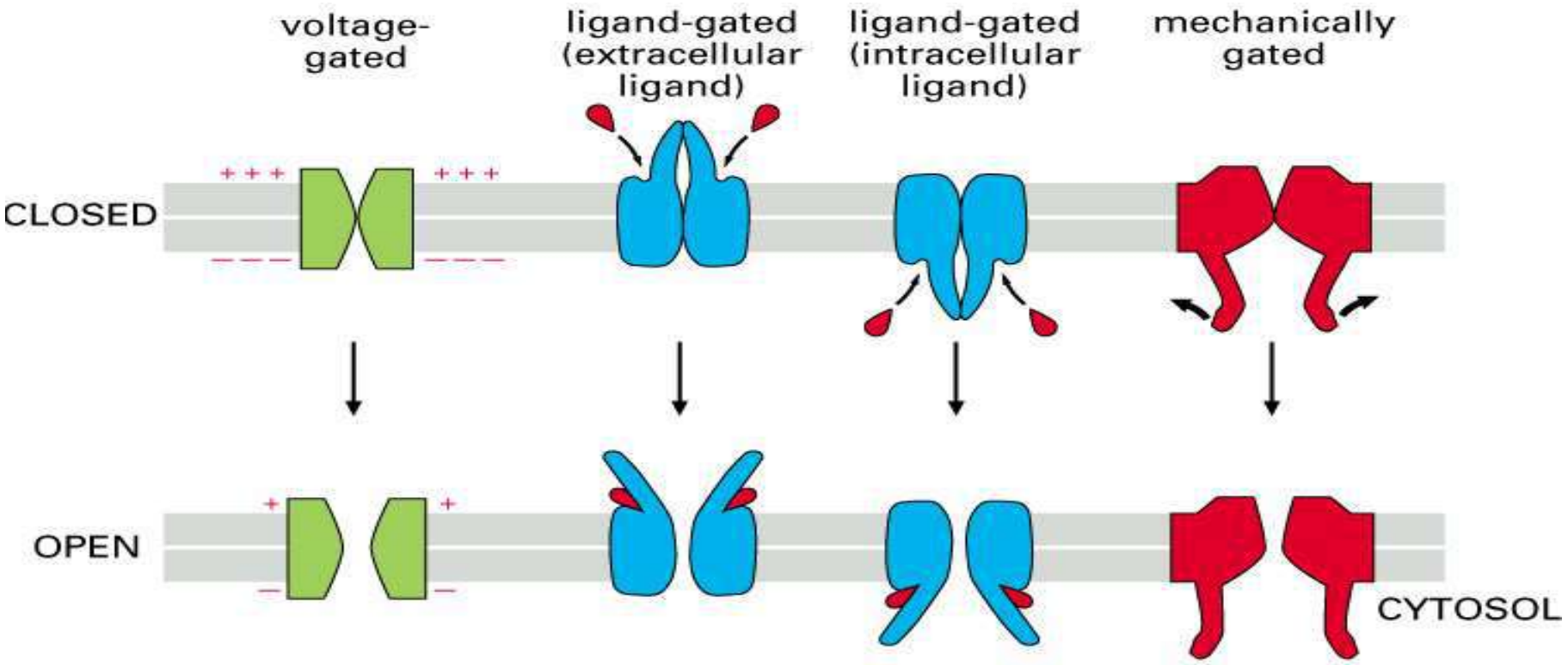
- (3) Mechanically-gated channels:

- e.g. “stretch-activated channels” open when cell shape is altered.
- Since channel is attached to the cytoskeleton, stretching causes a physical change in the protein

Movement is controlled by regulating “openness” –the proportion of time spent in the open configuration.

Ion channels can be regulated by specific conditions to be open or closed

If opened for a prolonged period, the channels can become desensitized



@ Molecular Biology of The Cell, 4th Edition

Probable questions

1 all membrane processes, such as pumping and channelling of molecules are carried out by.
a-lipid
b-carbohydrate
c-nucleic acid
d-protein
2 Which of the following statement about membrane transport protein is incorrect

a-carrier proteins are similar to enzymes in that they show saturation
b-carrier protein can facilitate both active and passive transport
c-channel protein can facilitate both active and passive transport
d-the Na^+ /Glucose transport protein carries out secondary active transport.

3 Diffusion across the plasma membrane is more rapid if a substance is
a-a protein
b-hydrophilic
c-high in its oil : water partition coefficient
d-larger and globular in shape

4 the difference between simple diffusion and facilitated transport is that facilitated transport.
a-is concentration dependent
b-occurs across plasma membrane
c-require membrane protein
d-utilize a substance moving with its concentration gradient

5. Erythrocyte glucose transporter specifically transports glucose down its concentration gradient and exhibit hyperbolic saturation kinetics .This is an example of

a-active mediated transport
b-passive mediated transport
c-non- mediated transport
d-group translocation

6. which one of the following is a correct statement for Na-K ATPase.

a-it gives out 3 Na-ions and takes in 2 K-ions
b- it gives out 2 Na-ions and takes in 3 K-ions
c- it gives out 3 Ca-ions and takes in 2 K-ions
d-it gives out 3 Na-ions and takes in 2 Ca-ions

7.which of the following effects of the steroid digitalis is observed after treatment of congestive heart failure.

a-decrease in cytosolic sodium levels
b-inhibition of Na-K ATPase
c-decrease in the force of heart muscle contraction
d-stimulation of the plasma membrane ion pump.

8.you wish to design a new drug which will act as an ionophore to deliver Ca^{2+} across the nerve cell membrane .This drug would most likely be

a-hydrophobic on the outside and hydrophilic on inside
b-insoluble in lipid
c-soluble in proteins
d-smaller than 0.001 nm in diameter

9. the process by which a cell secretes macro-molecule by fusing a vesicle to the plasma membrane is called

a-endocytosis
b-exocytosis
c-pinocytosis
d-phagocytosis

10. free fatty acids enter cell by

a-passive diffusion
b-active diffusion
c- through carrier protein
d – Active transport

11. Aquaporins transport-

a. Water only
b. water and small molecules.
c. Water and Glucose
d. Water and salt.

12. Which of the fallowing is responsible for PH Regulation-

a. Antiporters.
b. Symporters
c. Uniporters.
d. Co-porters.

13. V type – transporters are

a. ATPase dependent.
b. Symporters.
c. Carrier Proteins.
d. Receptor Proteins

14 . GLUT is an example of-

a. Antiporters.
b. Symporters
c. Uniporters.
d. Co-porters.

15. Presence of Ion channels are must on

a. Excitable tissue.
b. Non excitable tissue.
c. Renal tissue
d. Cardiac muscle.

16. Na- K ATPase transport Na-

a. Towards Concentration gradient.
b. Against Concentration gradient.
c. Towards electro chemical gradient.
d. Against electrochemical gradient.

17. Rennin secretion from JG cells is an example of-

a.) Exocytosis
b.) pincocytosis
c.) Vacular movement.
d.) Transcytosis.

18. PTH secretion fro parathyroid glands require-

a.) low intracellular Ca.
b.) high Intracellular Ca.
c.) Low intracellular K.
d.) high Intracellular K.

19. Transcytosis incudes-

a. Endocytosis and phagocytosis.
b. Endocytosis and pincocytosis.
c. Endocytosis and exocytosis.
d. Endocytosis only.

20. Transcytosis occurs at

a). Epethelial Cells.
b). Endocrine Cells.
c). Nerve cells.
d). None of the above.