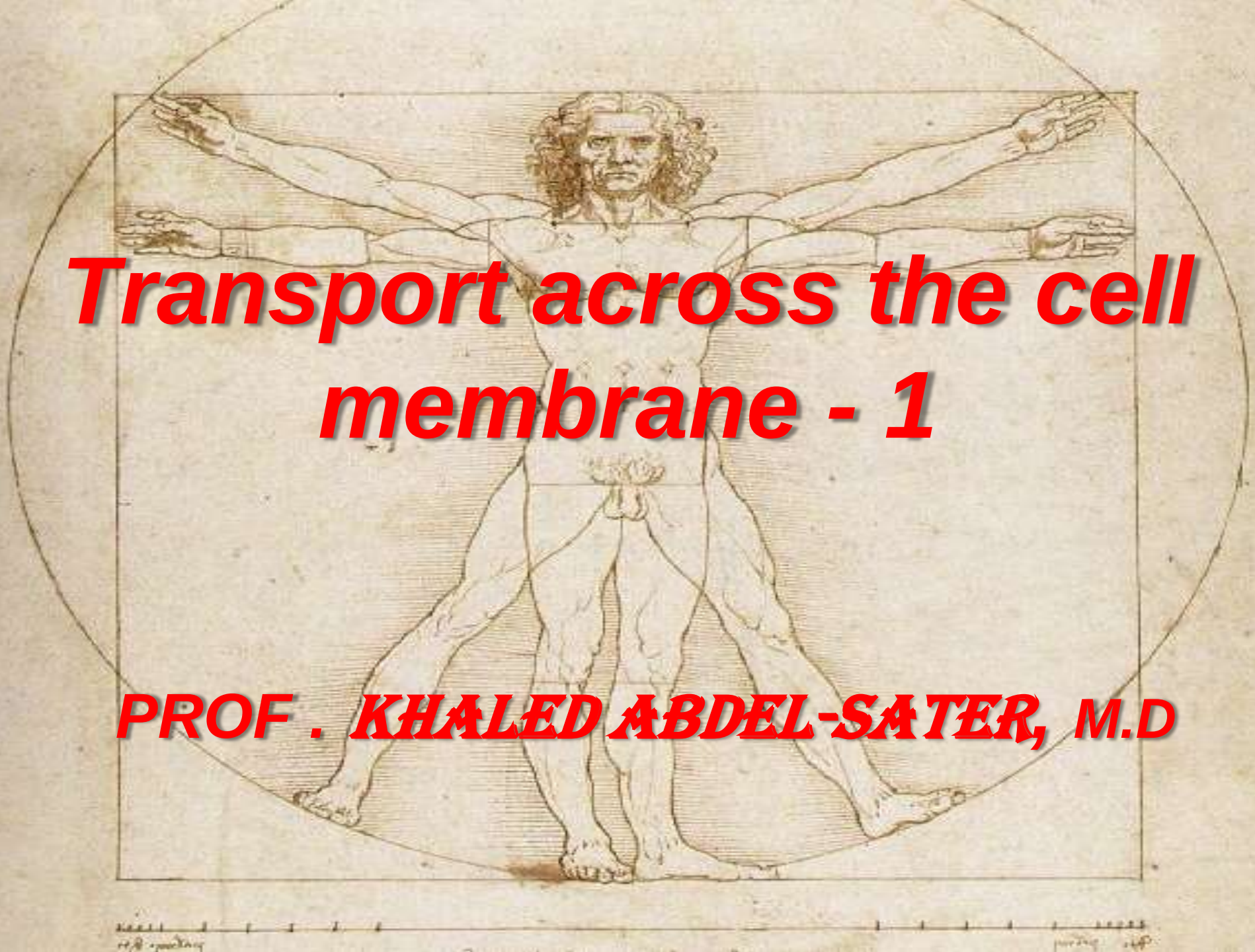


Transport across the cell membrane - 1

PROF . KHALED ABDEL-SATER, M.D

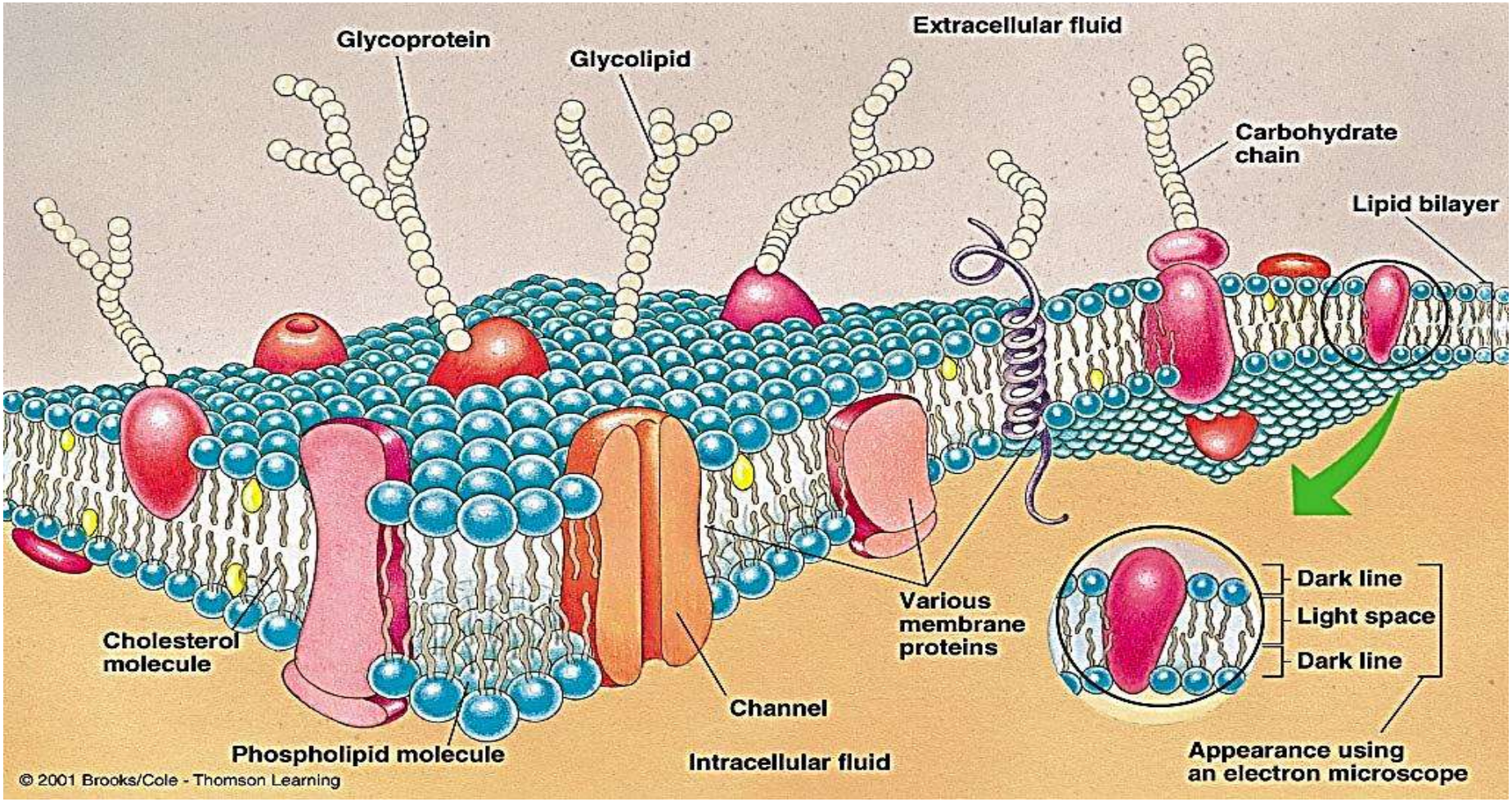
STUDY OBJECTIVES

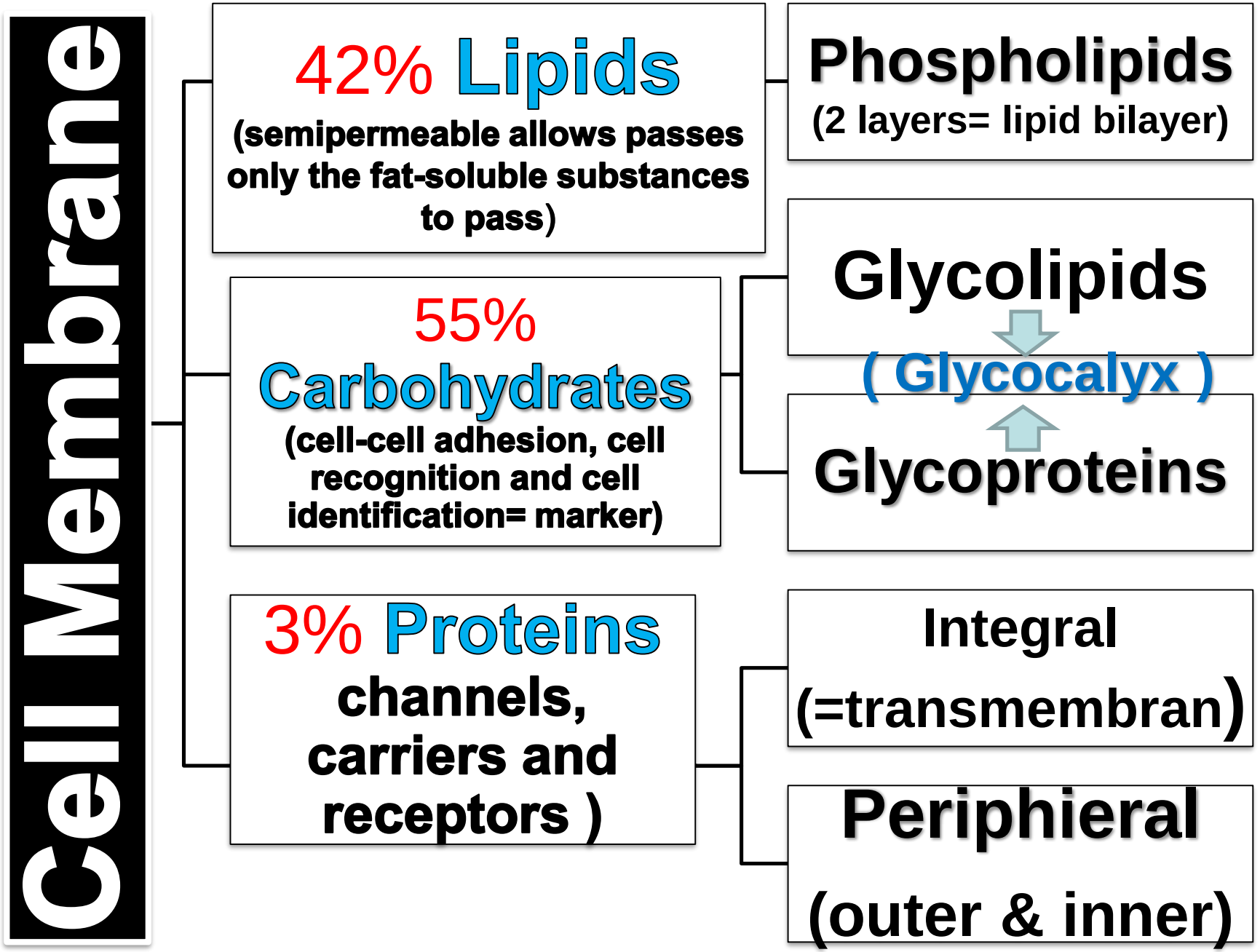
By the end of the lecture the student will able

- To understand the structure of the cell membrane
- To enumerate the types of transport through cell membrane
- To explain the difference between passive and active transport.
- To compare between simple and facilitated diffusion
- To understand osmosis and its clinical application.

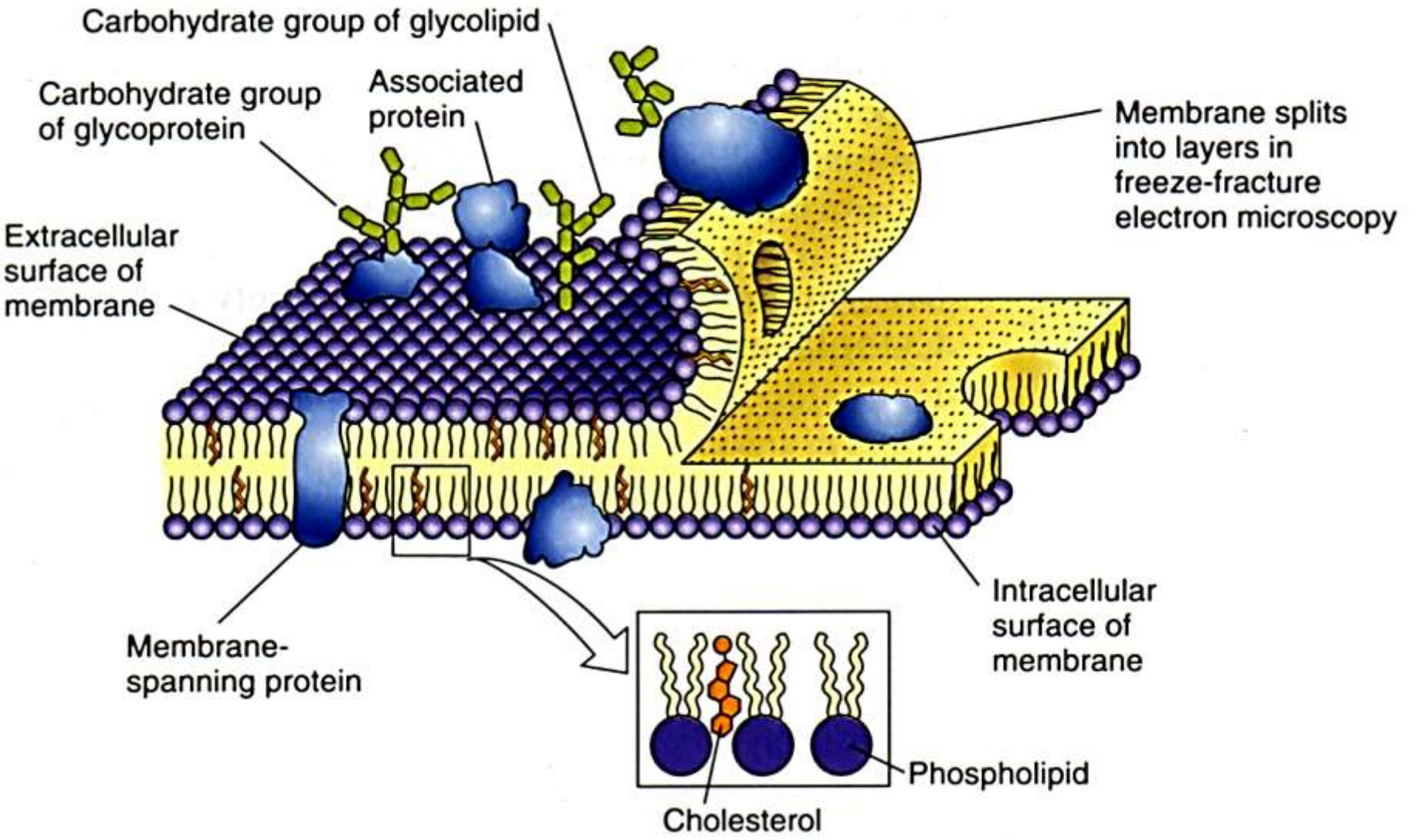
Cell Membrane

Lipid, Protein & Carbohydrates.

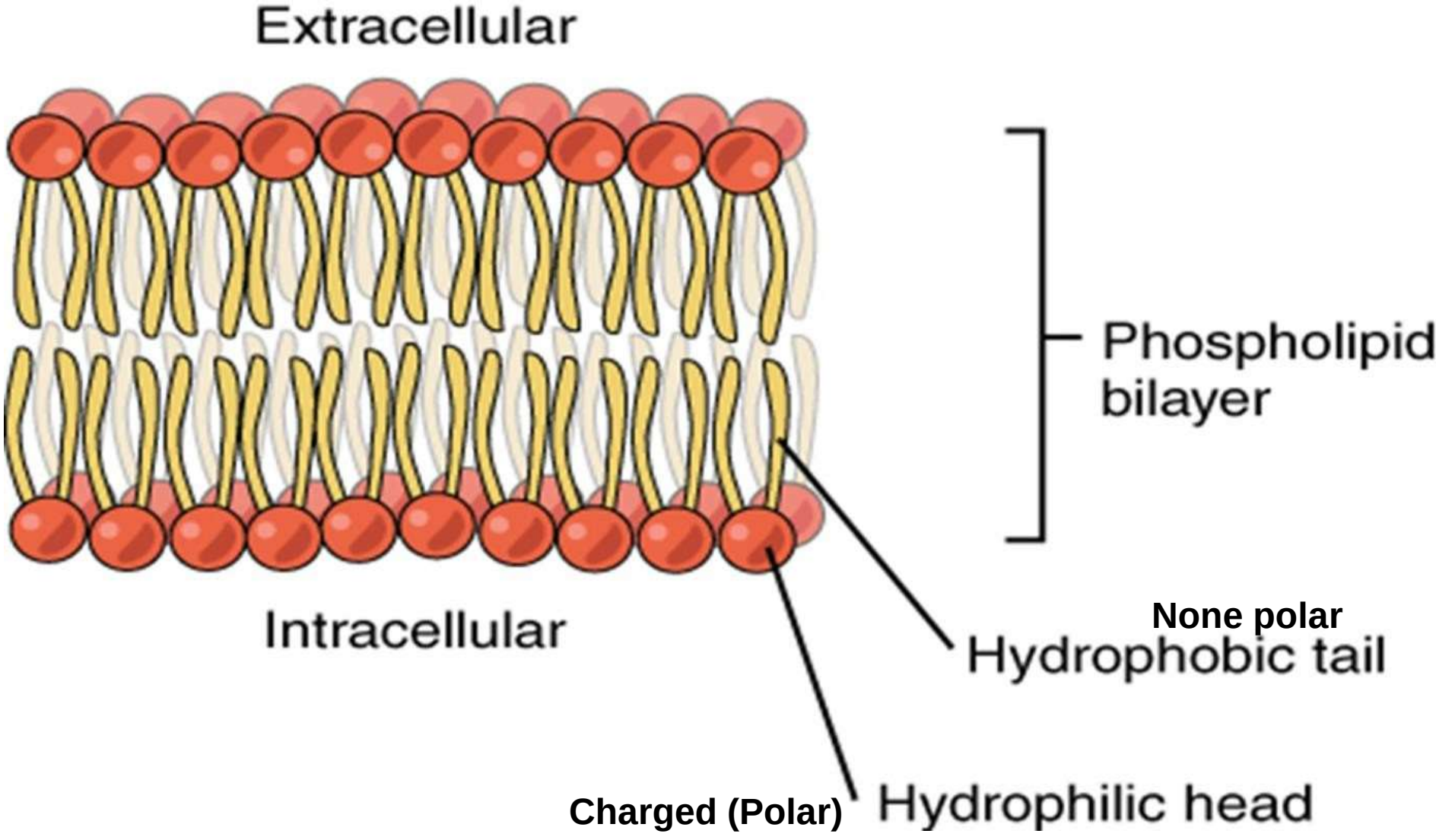



Cell Membrane
42% Lipids
(semipermeable allows passes only the fat-soluble substances to pass)
Phospholipids
(2 layers= lipid bilayer)
55% Carbohydrates
(cell-cell adhesion, cell recognition and cell identification= marker)
Glycolipids
(Glycocalyx)
Glycoproteins
3% Proteins
channels, carriers and receptors)
Integral (=transmembran)
Periphieral (outer & inner)

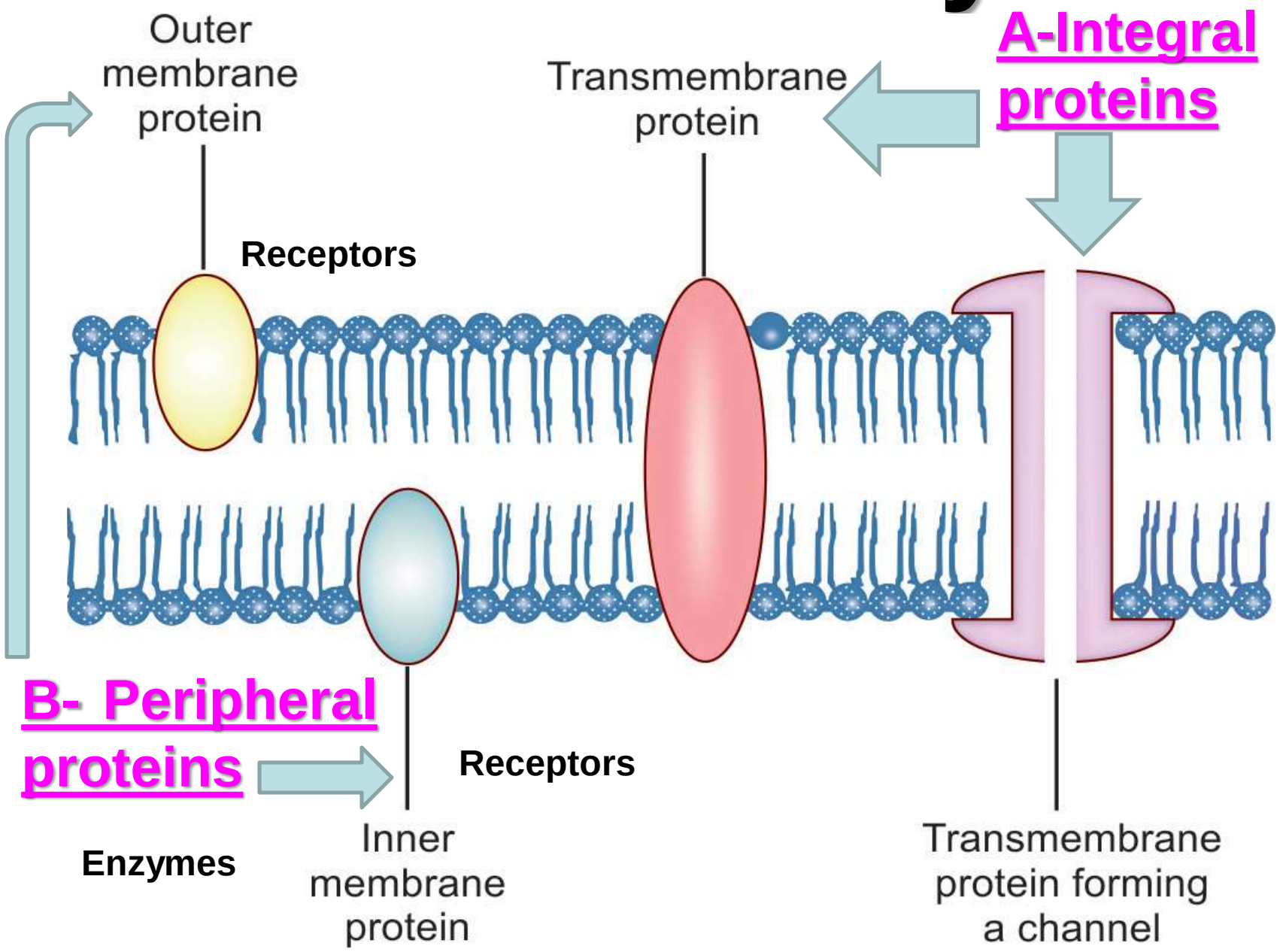
1-Lipid Bilayer



1-Lipid Bilayer



2. Protein Layer



Types of Channels

Open channels:

Always opened (without gates).

Types:

A- Sodium leak channels

B- Potassium leak channels

Gated channels:

Channels guarded by gates

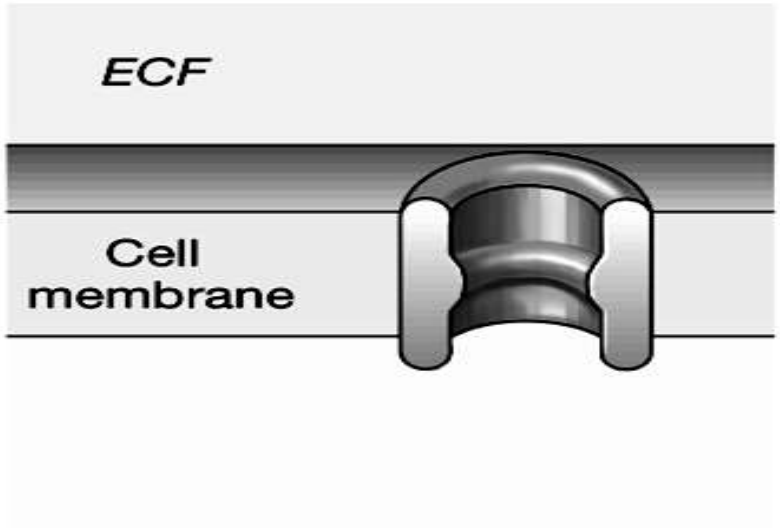
Types:

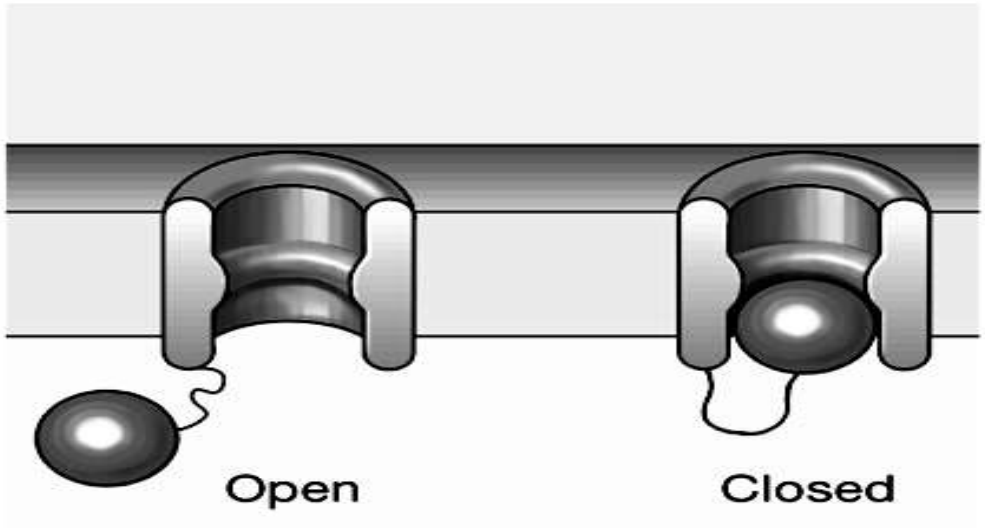
1-Voltage gated:
opened by change voltage of channel

2- Ligand gated:
opened by binding with chemical substance

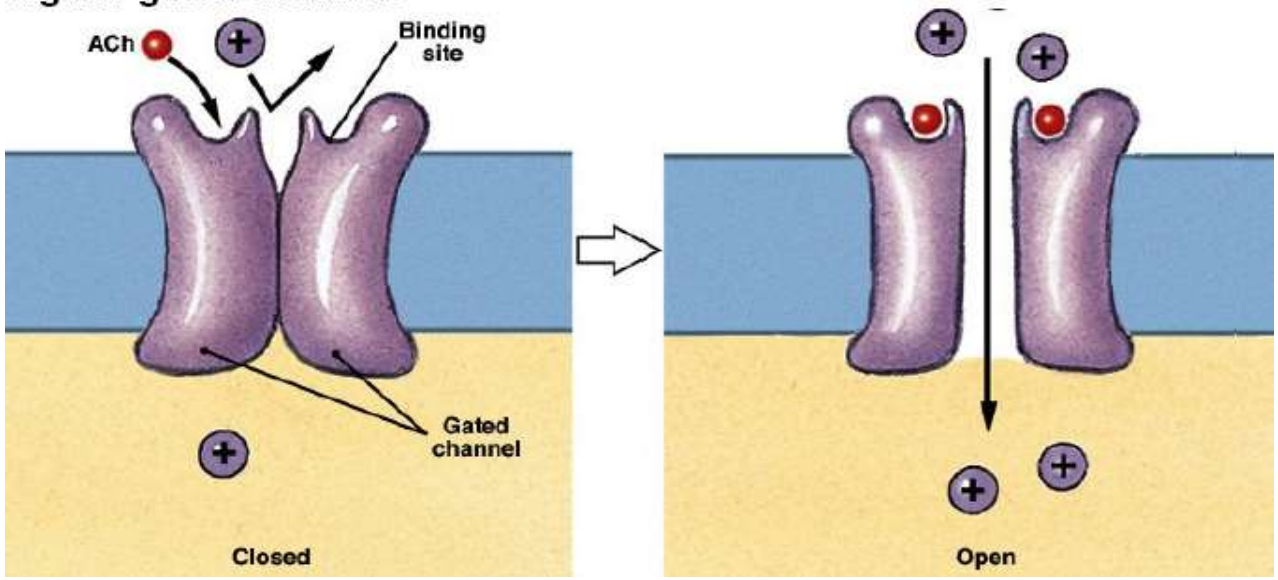
(a) Open channels have gates (not shown) but spend most of their time in the open state.

(b) Gated channels are usually closed. They open in response to chemical, mechanical, or electrical signals.

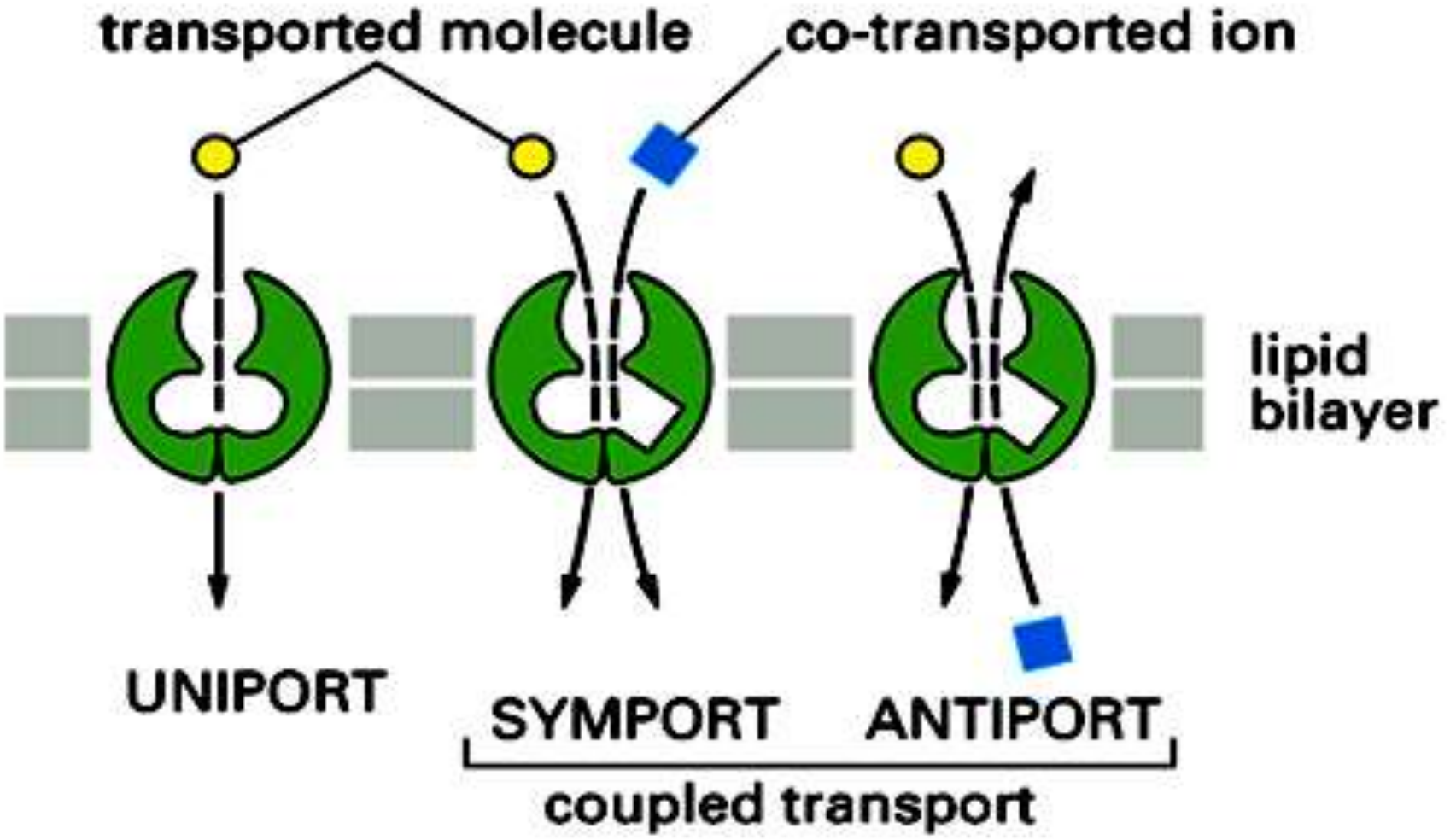




Ligand gated channels



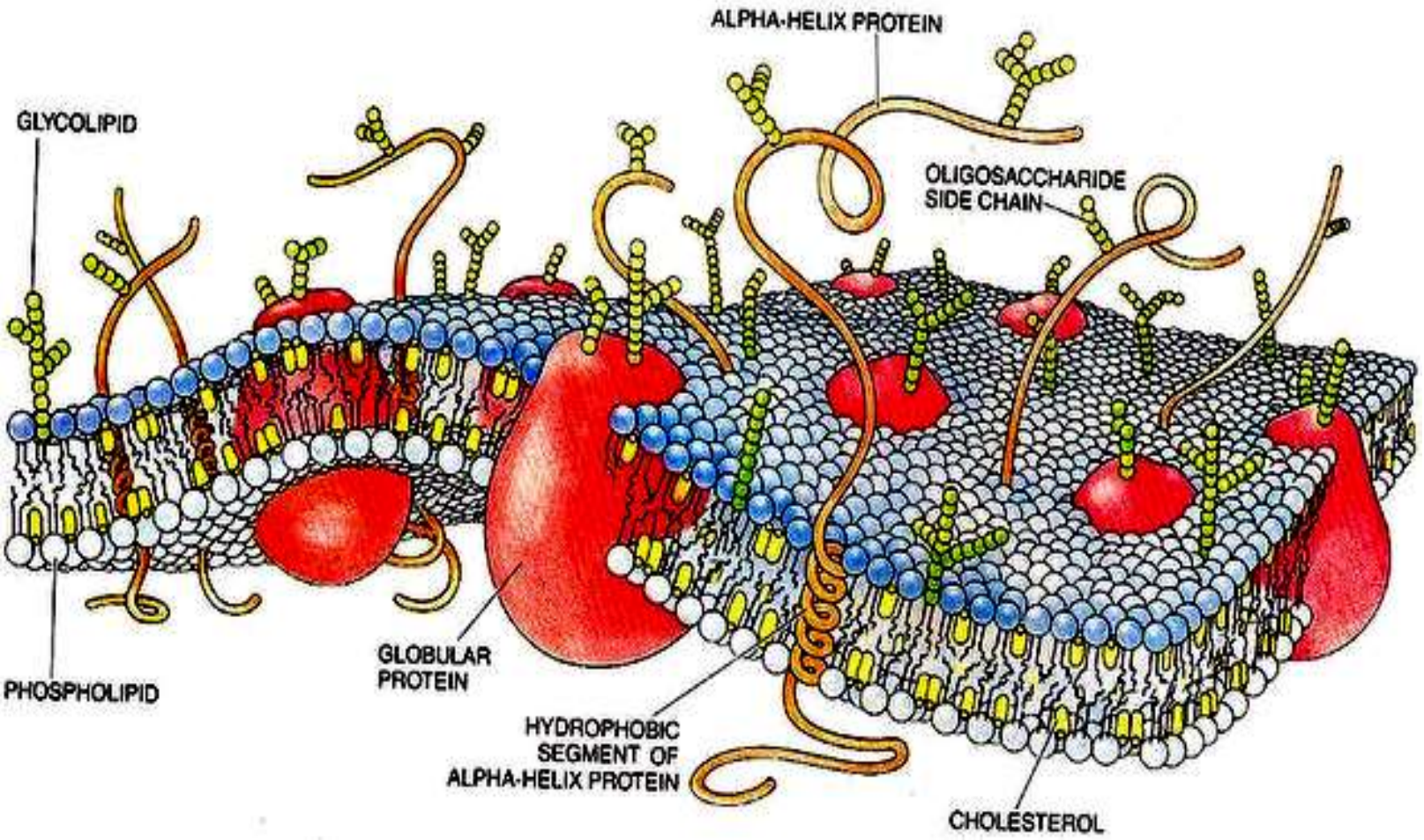
Types of Carrier

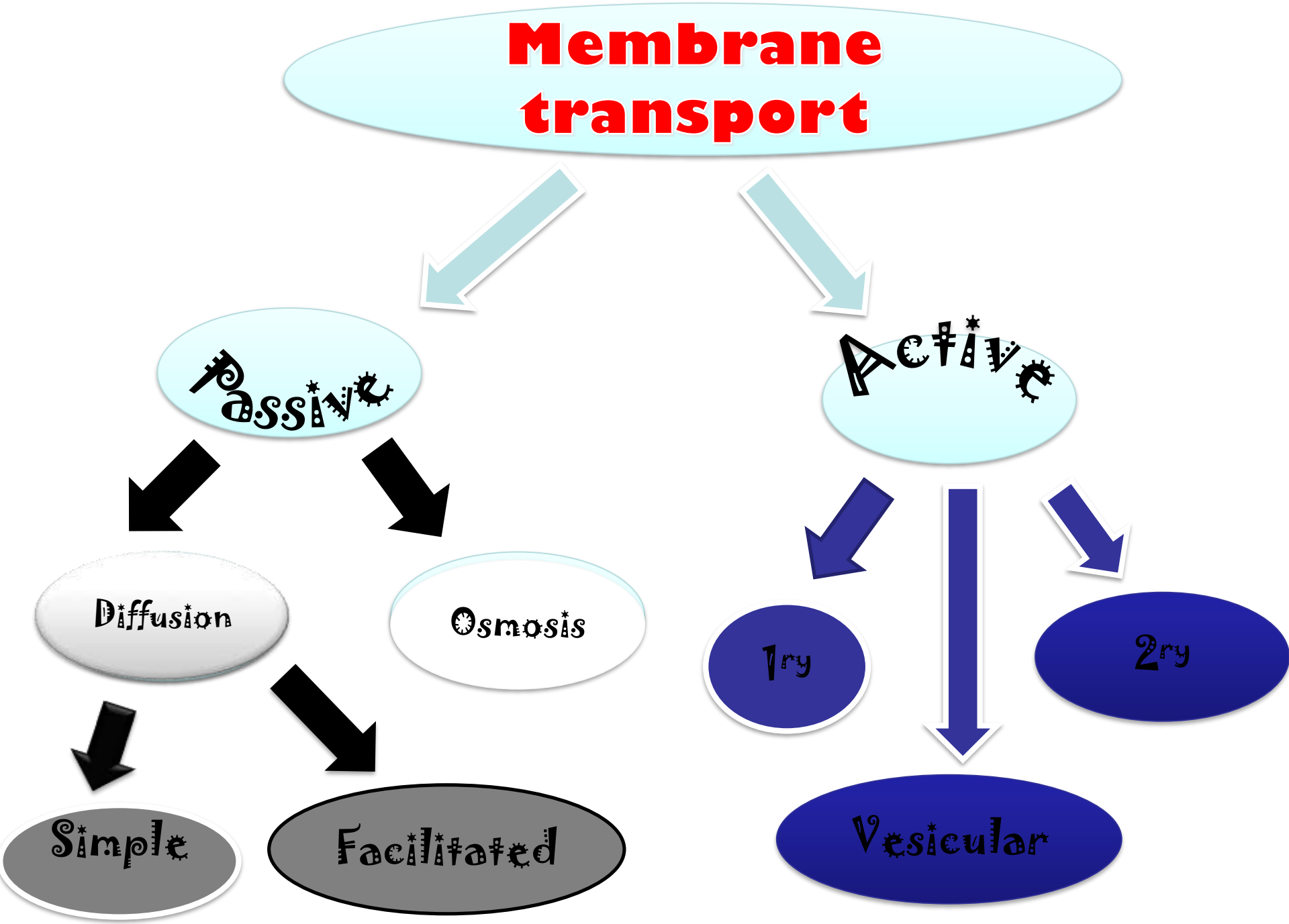


e.g Na^+ and glucose carrier.

e.g Na^+-K^+ pump.

TRANSPORT ACROSS CELL MEMBRANES




Membrane transport
Passive
Active
Diffusion
Osmosis
1ry
2ry
Simple
Facilitated
Vesicular

Types of Transport

Passive transport (diffusion)

No need of energy.

May or may not need carrier.

Occurs with gradient (concentration, electrical, pressure).

Active transport

Needs energy.

Needs carrier.

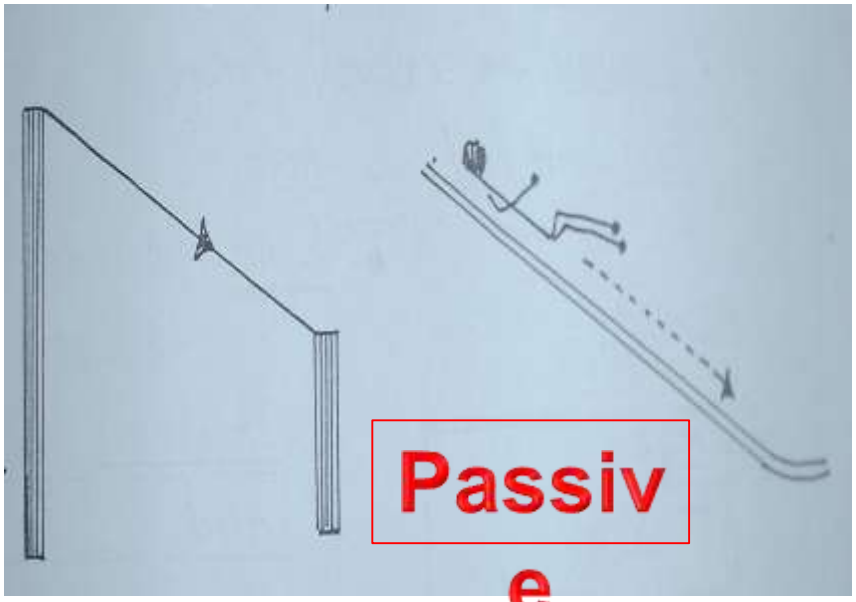
Occurs against gradient (concentration, electrical, pressure).

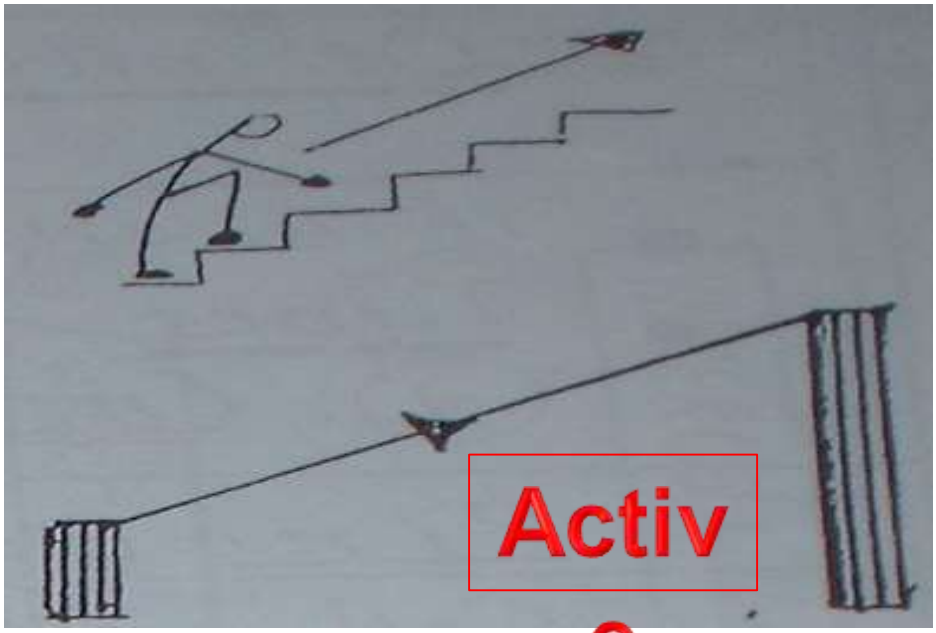
- **Downhill:**
  - From high concentration to low concentration

weeee

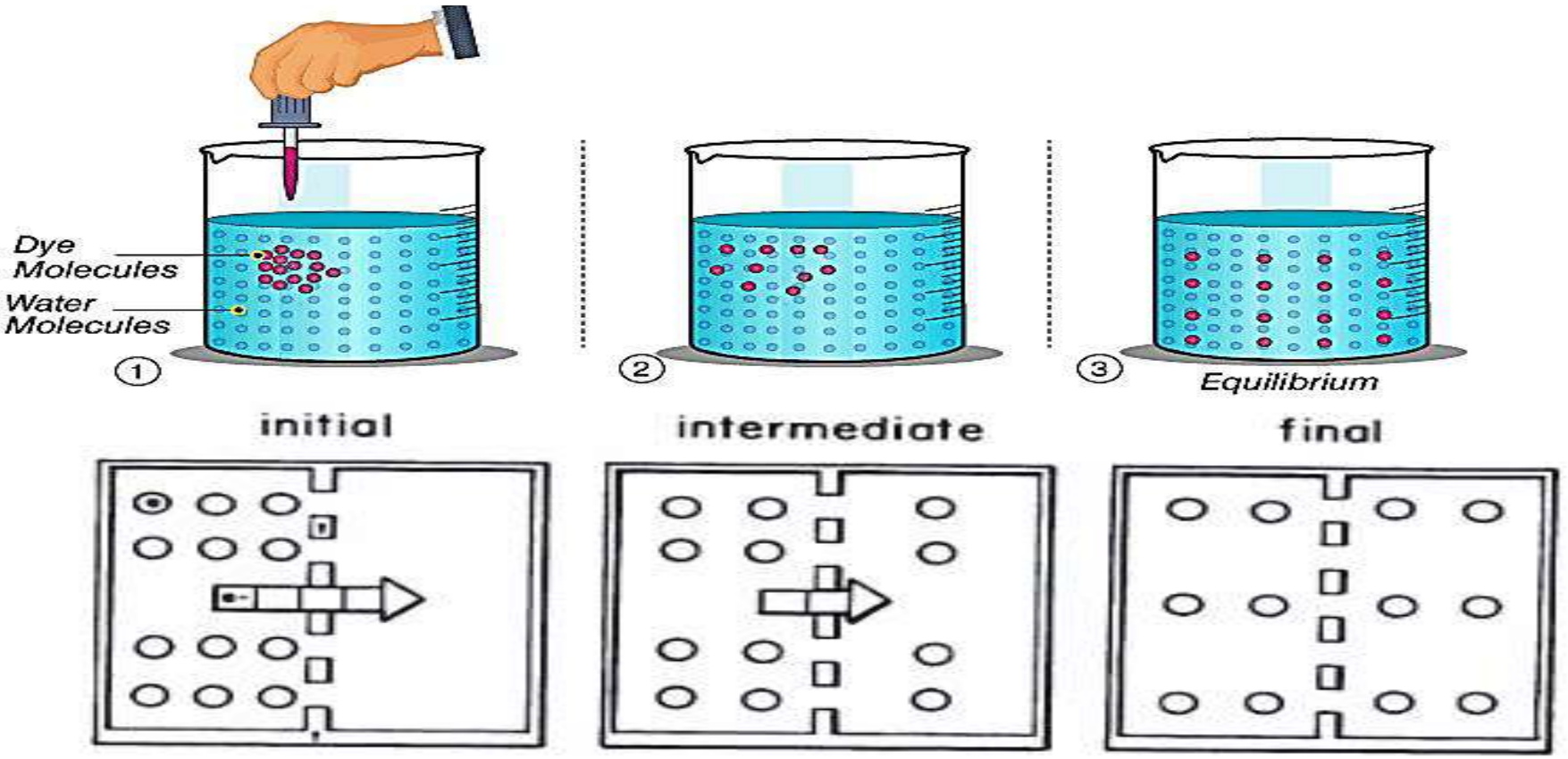
- **Uphill:**
  - From Low concentration to high concentration

ohhhhh





Simple Diffusion



-At equilibrium (when the concentration is equal on both sides) the flow rate is zero.

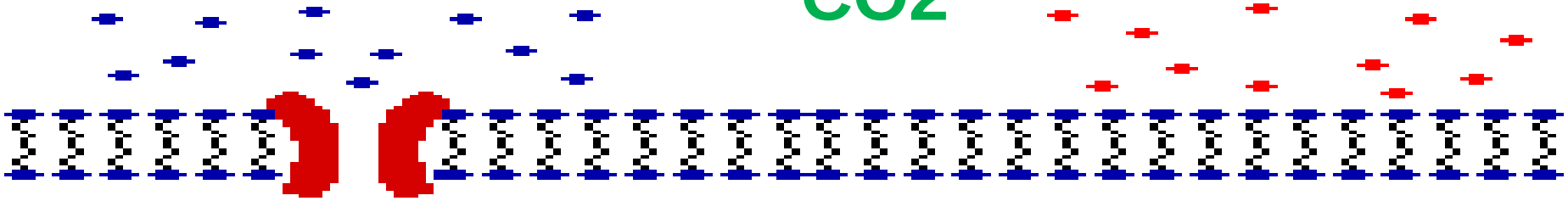
- What is the rate of simple diffusion at equilibrium?

- = Zero.

Mechanism of Simple Diffusion

B- through protein channels e.g. ions transport

A-transport through the lipid bilayer e.g. O2 & CO2



Factors Affecting Diffusion

i-The concentration gradient= direct proportion

ii- The electrical gradient = direct proportion

iii-The pressure gradient = direct proportion

iv-Temperature = direct proportion.

v-The surface area = direct proportion.

vi - Lipid solubility = direct proportion.

Vii- Number of protein channels= direct proportion

viii – Thickness of membrane = inverse proportion.

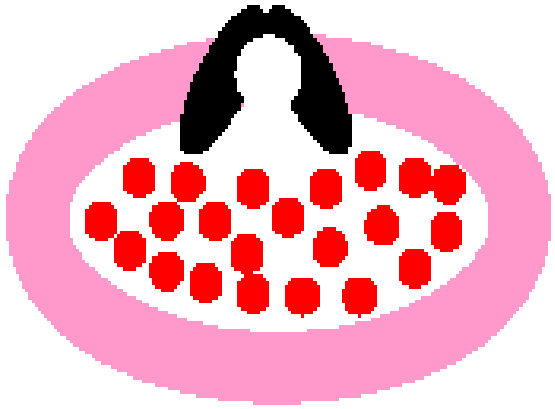
IX- Molecular weight of substances = inverse proportion.

Mechanism of Facilitated Diffusion

1-The molecule to be transported attaches to a binding site on the carrier protein on one side of the membrane.

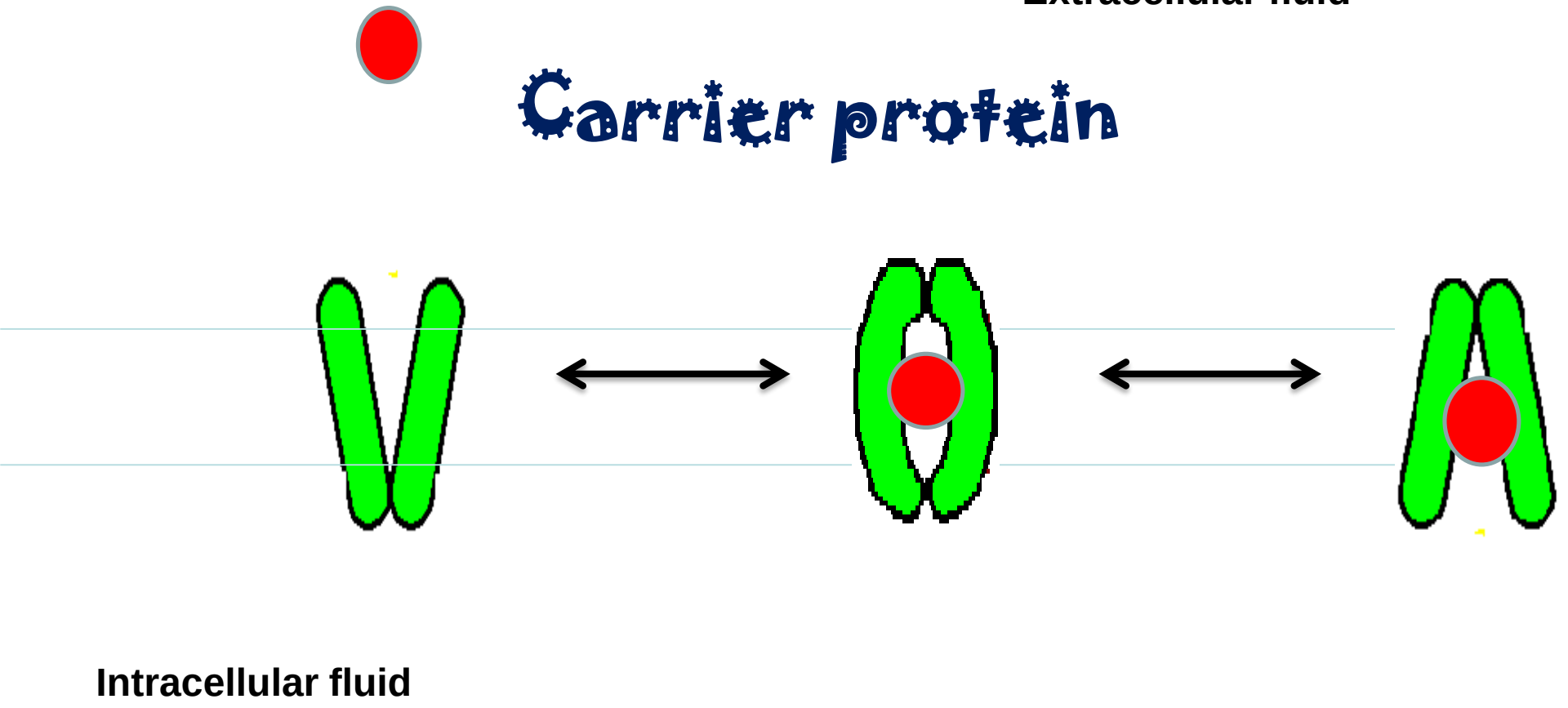
2- **Carrier** opens to the opposite side of the membrane.

3-Then, the molecule detaches from the carrier



carrier opens to the opposite side of the membrane

Extracellular fluid



Intracellular fluid

Difference between simple and facilitated diffusion

- 1-Character of molecule (small, un-polar and lipid soluble in simple).
- 2-Presence of carrier (in facilitated diffusion).

A-Speciality: Each carrier protein is specialized to transport a specific substance.

B- Saturation property: Transport until carrier reaches a maximum (= transport maximum).

C-Competition: Several closely related compounds may compete for a ride across the membrane on the same carrier.

Simple Vs Facilitated diffusion

Simple diffusion

-No need of carrier.

(No transport maximum

No competitive inhibition)

-No need of energy.

-Occurs with gradient
(concentration, electrical, pressure).

Mechanism:

A-transport through the lipid bilayer as O2 & CO2

B- through protein channels as ions transport

Facilitated diffusion

Needs carrier: Has transport maximum and competitive inhibition)

No need of energy.

Occurs with gradient
(concentration, electrical, pressure).

Mechanism:

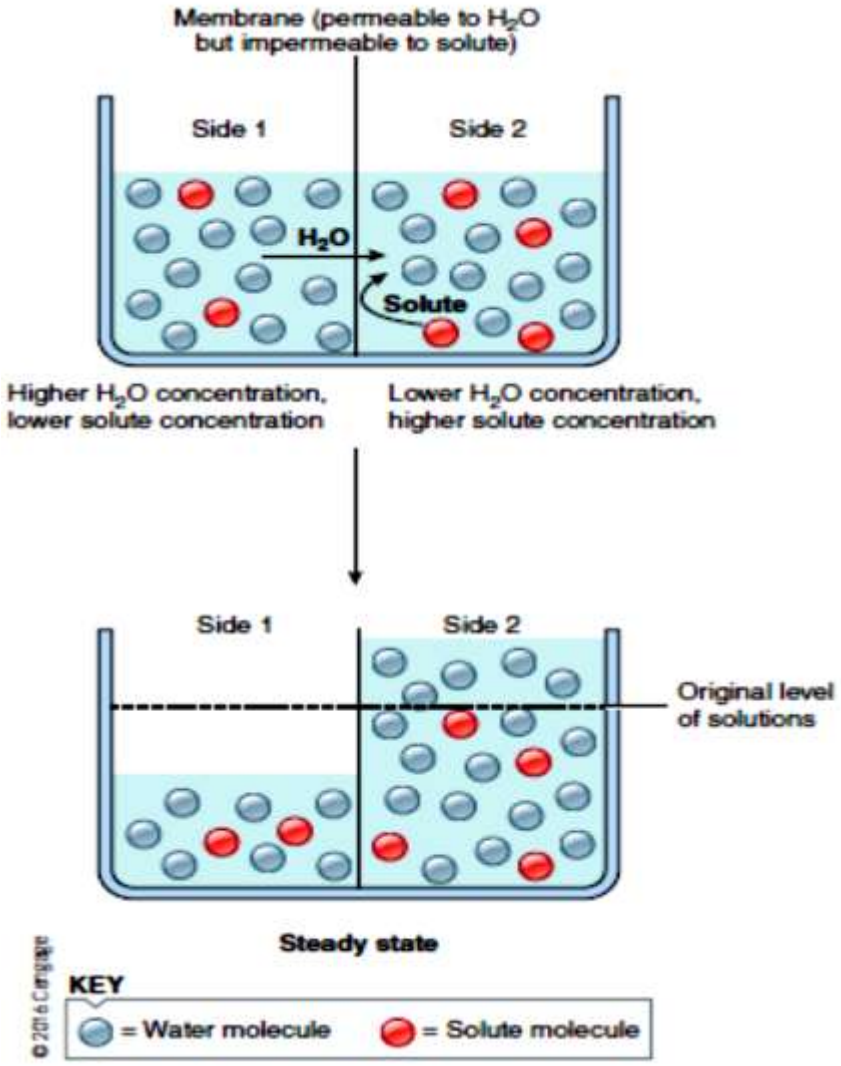
By carrier

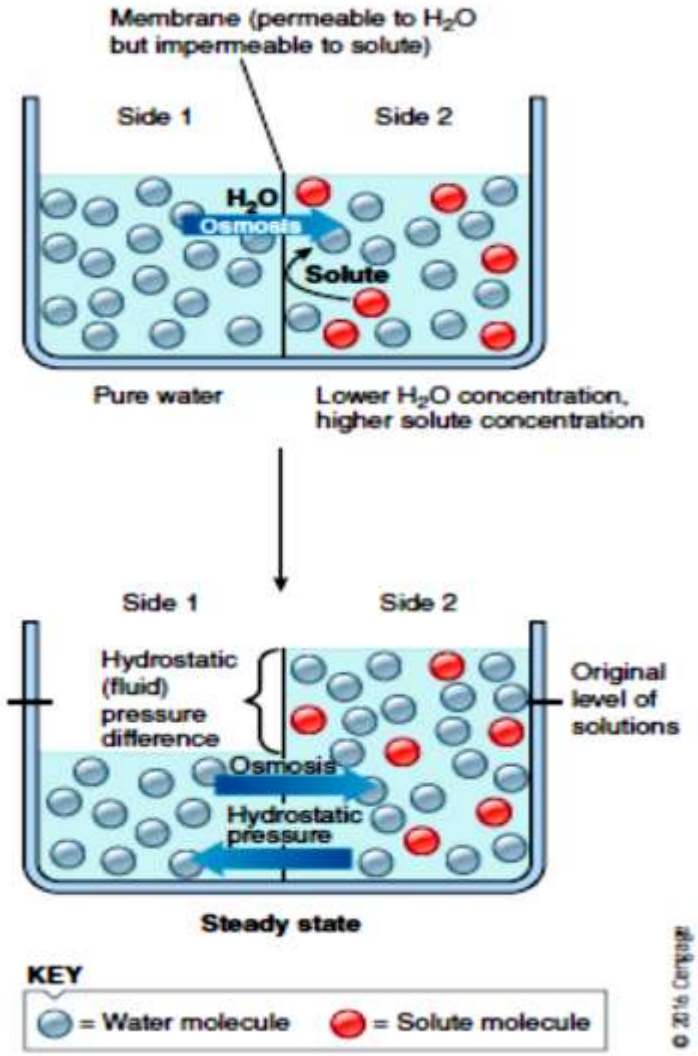
As transport of glucose & most amino acids.

- Why rate of facilitated diffusion will not increase after it reach maximum rate insipte of increase concentration?

- This is due to saturation of the carrier protein which is limited per each cell.

3-Osmosis:


Membrane (permeable to H_2O but impermeable to solute)
Side 1
Side 2
H_2O
Solute
Higher H_2O concentration, lower solute concentration
Lower H_2O concentration, higher solute concentration
Side 1
Side 2
Original level of solutions
Steady state
KEY
= Water molecule
= Solute molecule


Membrane (permeable to H_2O but impermeable to solute)
Side 1
Side 2
H_2O
Osmosis
Solute
Pure water
Lower H_2O concentration, higher solute concentration
Side 1
Side 2
Hydrostatic (fluid) pressure difference
Original level of solutions
Osmosis
Hydrostatic pressure
Steady state
KEY
= Water molecule
= Solute molecule

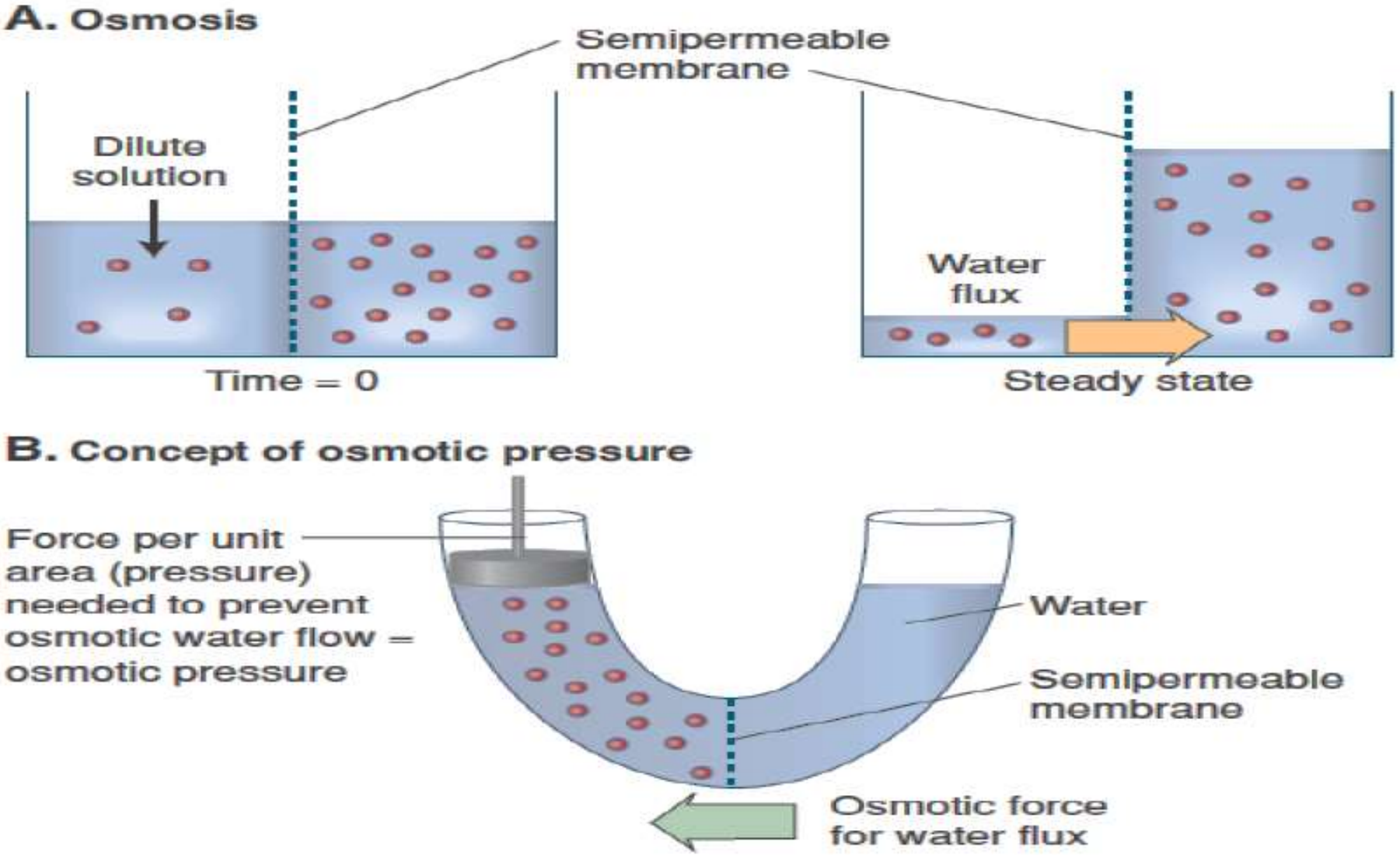
3-Osmosis:

- It is the diffusion of water from low salt concentrations to high concentrations through a semipermeable membrane (permeable to water not to the salts).
- Water passes through channels, known as aquaporins.

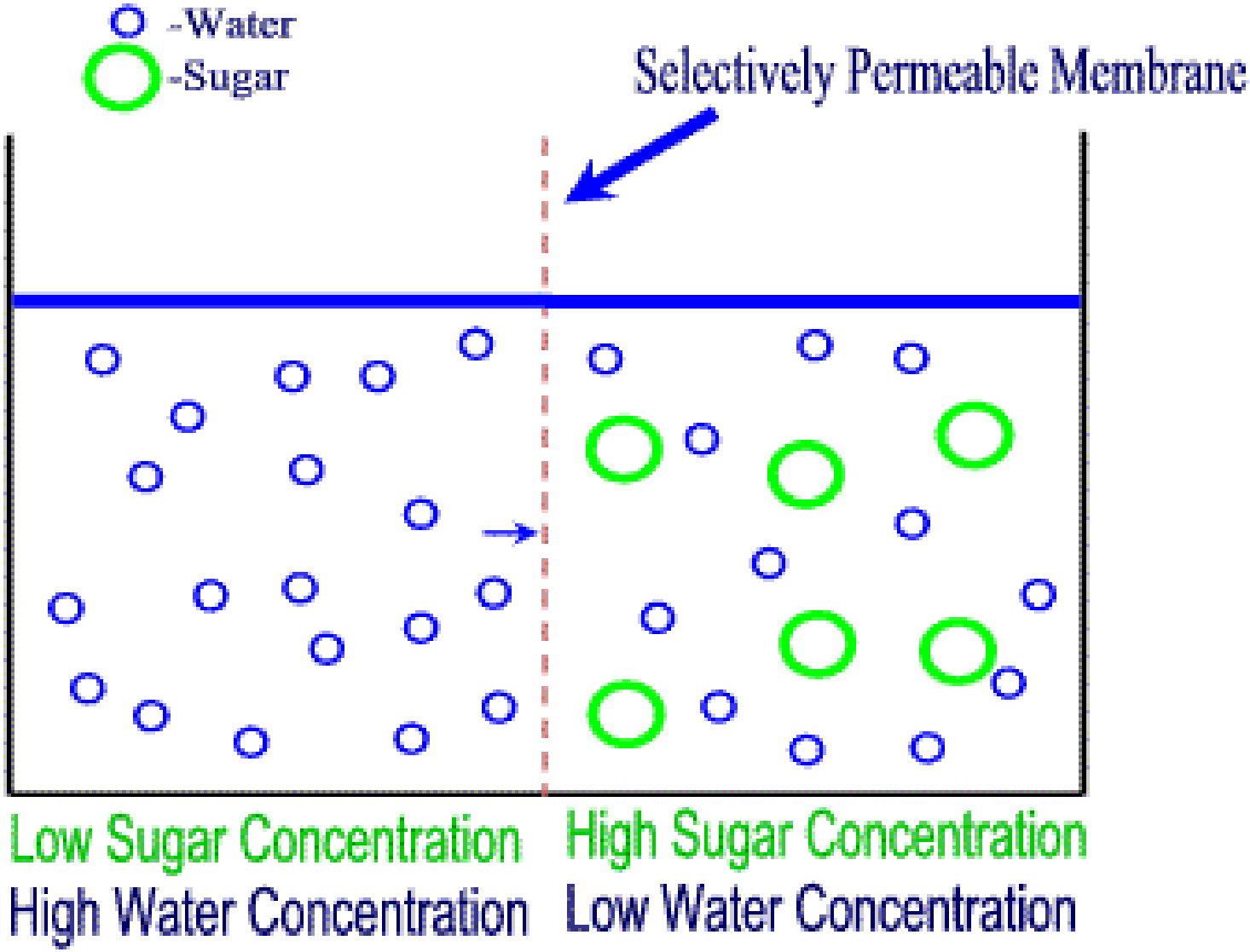
3-Osmosis:

- -Pressure which when applied on the side of higher salts prevents the osmosis is called osmotic pressure. The osmotic pressure depends up on the number of molecules dissolved in a solution.

OSMOSIS


A. Osmosis
Semipermeable membrane
Dilute solution
Water flux
Time = 0
Steady state
B. Concept of osmotic pressure
Force per unit area (pressure) needed to prevent osmotic water flow = osmotic pressure
Water
Semipermeable membrane
Osmotic force for water flux

Osmosis


-Water
-Sugar
Selectively Permeable Membrane
Low Sugar Concentration
High Water Concentration
High Sugar Concentration
Low Water Concentration

Classification of Fluids (Tonicity)

Isotonic solution:

It is the solution which has the same osmolality as plasma = Ringers (0.9% NaCl; 5% glucose).

Hypotonic solution

It is the solution which has osmolality lower than that of plasma.

Hypertonic solution

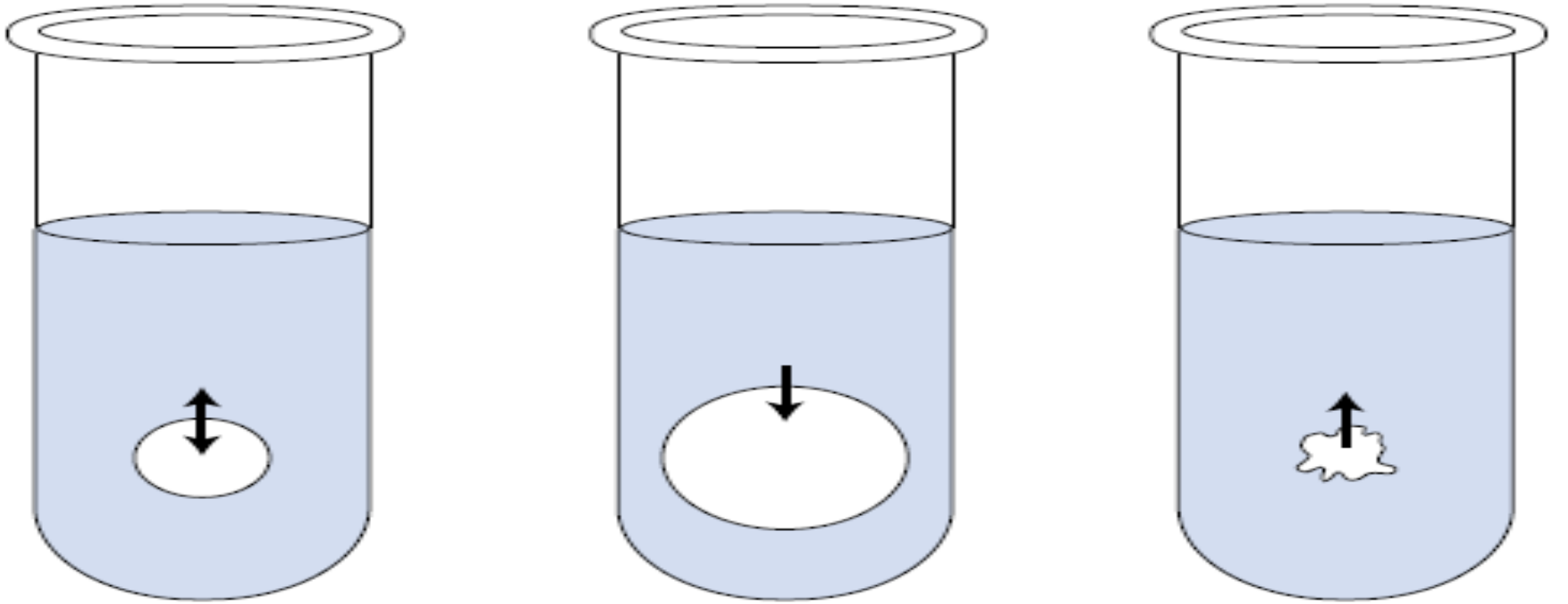
It is the solution which has osmolality greater than the osmolality of plasma

EXAMPLE OF OSMOSIS

Osmotic pressure equals that of plasma is called isotonic

Osmotic pressure lesser than that of plasma is called hypotonic

Osmotic pressure higher than that of plasma is called hypertonic

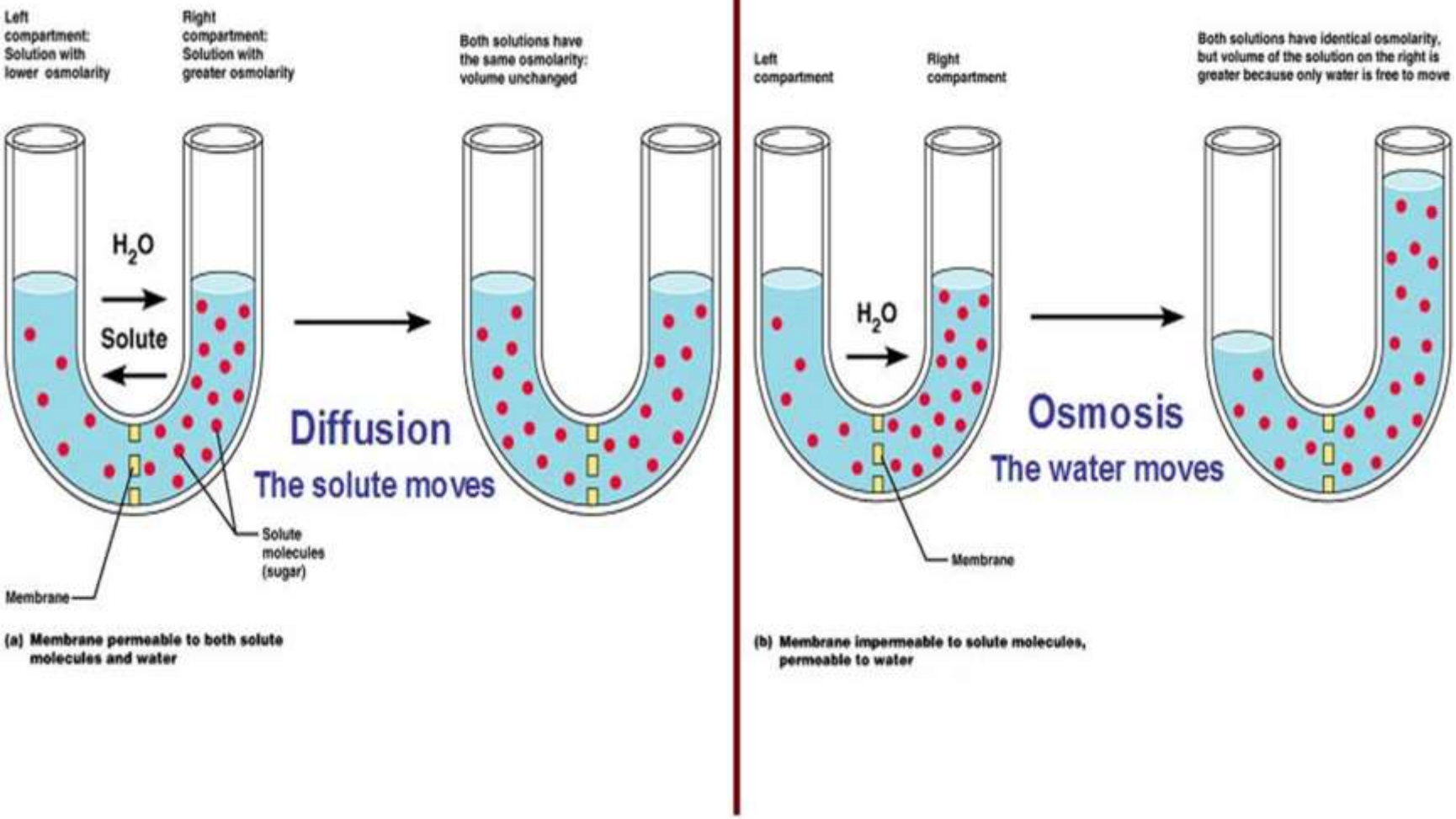


A
Isotonic solution

B
Hypotonic solution

C
Hypertonic solution

Diffusion Vs. Osmosis



Thank You