

3

Cell Membrane

- Very important
- Extra information
- Terms

**Nothing is impossible , the word
itself says I AM POSSIBLE !**





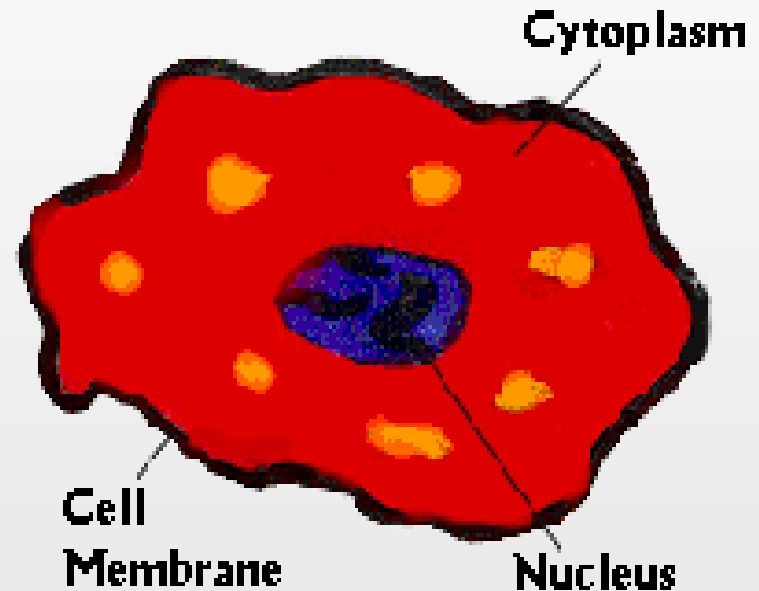
Objectives



- **Describe the fluid mosaic model of membrane structure and function.**
- **Define permeability and list factors influencing permeability.**
- **Identify and describe carried-mediated transport processes: Primary active transport, secondary active transport, facilitates diffusion.**

- Comprises three principal parts:

- 1- Plasma (cell) membrane.
- 2- Cytoplasm & organelles.
- 3- Nucleus.



Cell membrane

❖ General characteristics of cell membrane:

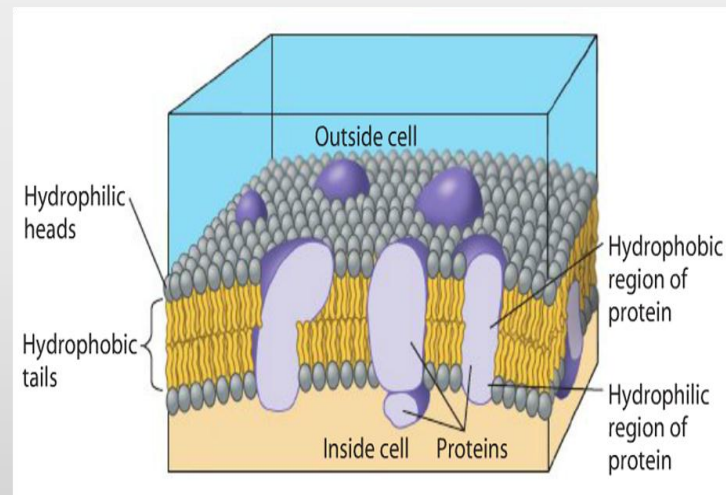
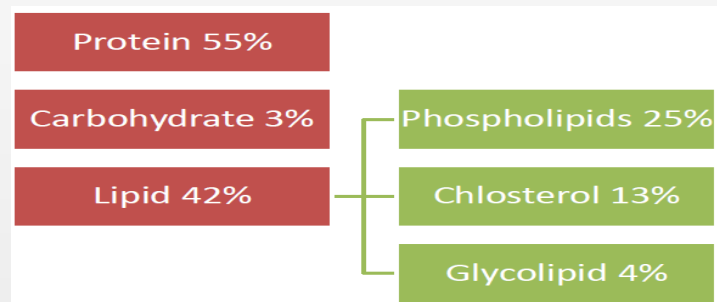
- It covers the cell.
- It is a fluid and not solid.
- It is 7-10 nanometer thick.
- Thin , Pliable and elastic.
- It is also referred to as the **plasma membrane**.

❖ The Plasma Membrane:

- Main constituents of plasma membrane are **phospholipids**.

Hydrophilic → Polar (water loving)
 Hydrophobic → non-polar (water hating)

Composition of the cell membrane:



- Organized in a **bilayer of phospholipid molecules**.
 - Glycerol head (**hydrophilic**).
 - Two fatty acid “tails” (**hydrophobic**).
 - Heads (hydrophilic) facing **ICF** and **ECF** and tails (hydrophobic) face each other in the interior of the bilayer (**Amphipathic**).



“Hydrophilic head + Hydrophobic tail = Amphipathic “

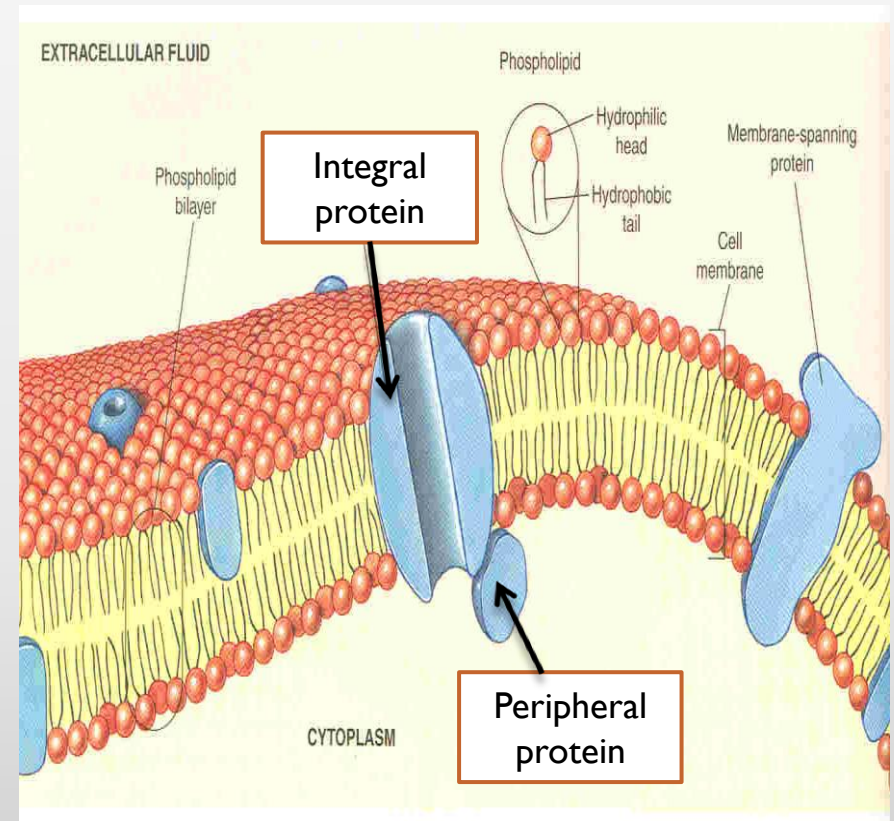
- Proteins integrated into phospholipid bilayer separated into 2 groups:

1-Integral protein:

- Span "cross" the membrane.
- Proteins provide structural channels or pores.
- Carrier proteins.

2-Peripheral protein:

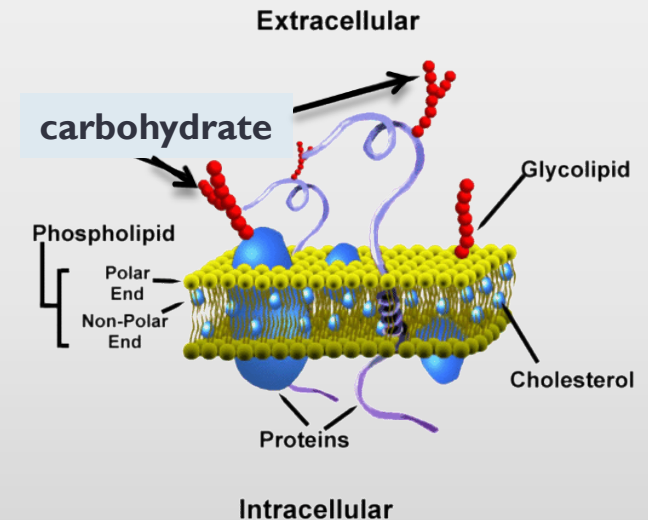
- Present **in one side** .
- Hormone receptors.
- Cell membrane antigens.



- **Glycoproteins:** (most of it ,Most of integral proteins are **glycoproteins**)
- **Glycolipids:** (1/10)
- **Proteoglycans:** (mainly carbohydrate substance bound together by protein)
- **Glycocalyx:** (loose coat of carbohydrates)

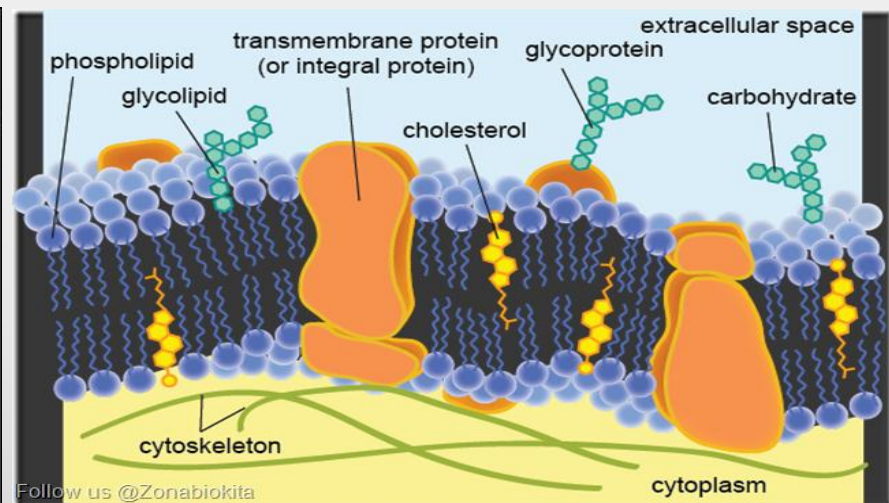
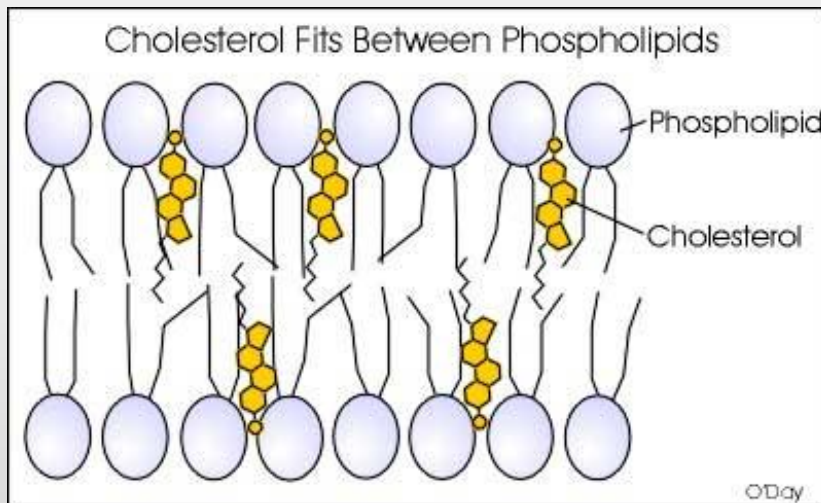
❖ Function of carbohydrates:

- Attaches cell to each others.
- Act as **receptors substances** (help ligand to recognize its receptor)
- Some enter into immune reactions.
- Give most of cells overall -ve surface.(to replace other negative object)



Cholesterol

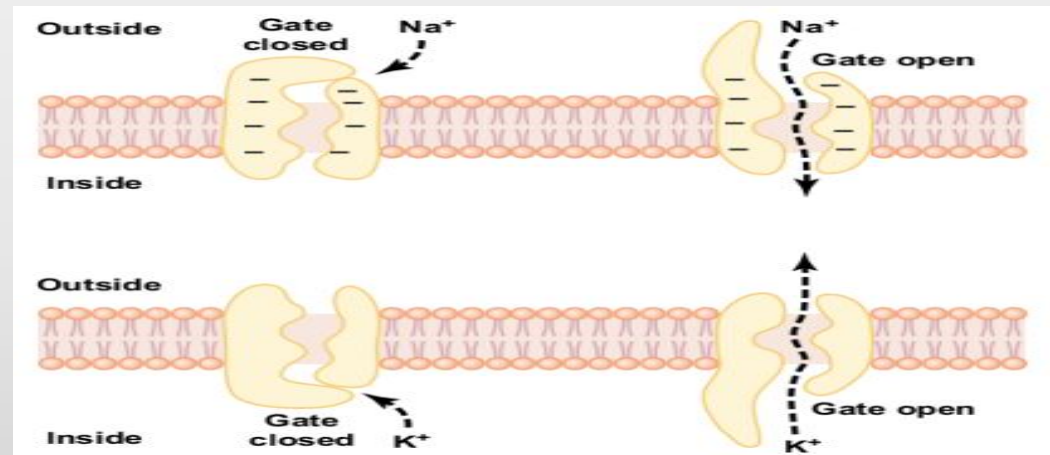
- present in membranes in varying amounts.
- controls much of the fluidity of the membrane.
- increases membrane flexibility and stability.



Transport Through The Cell Membrane

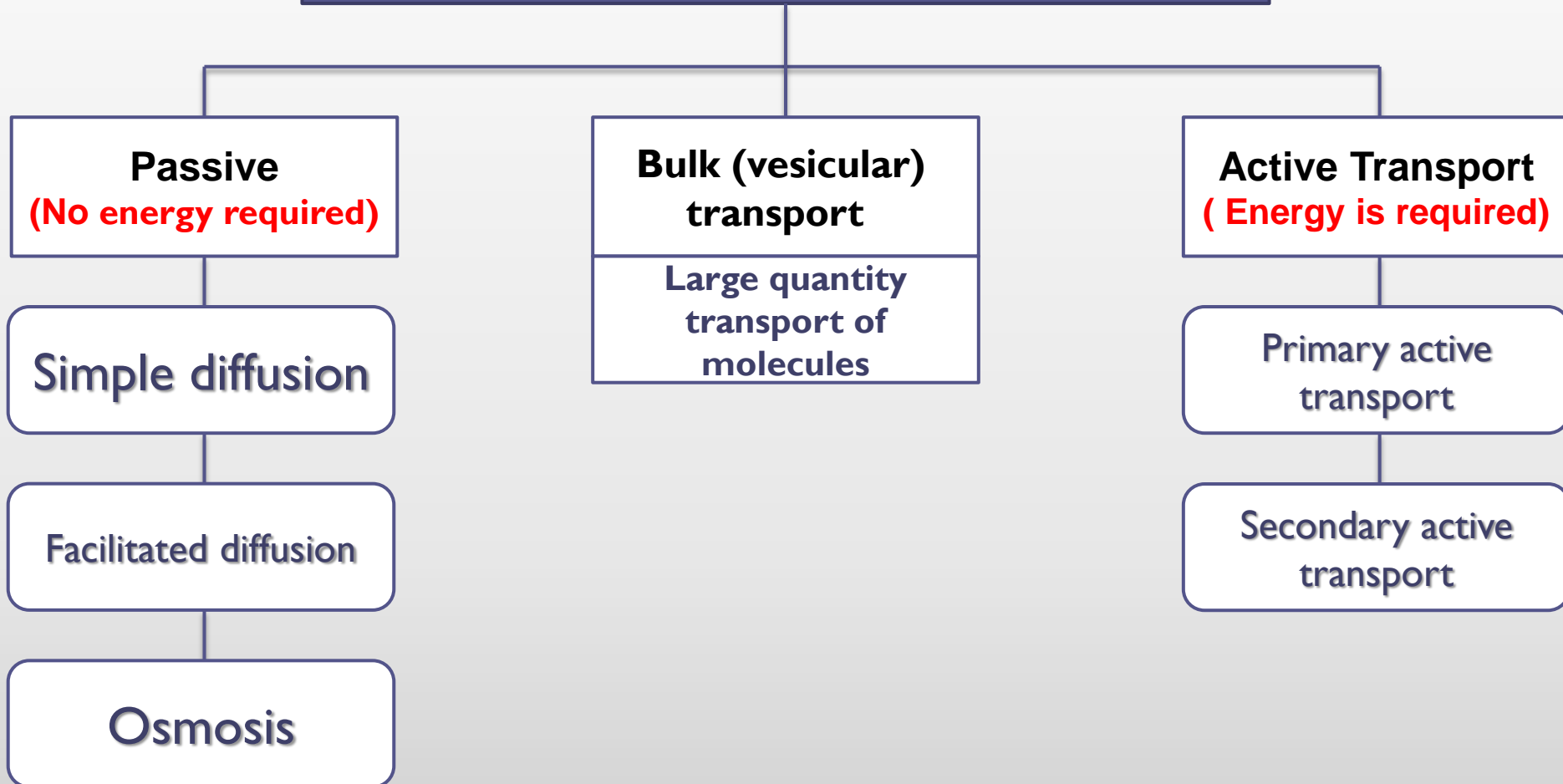
- Cell membrane is **selectively permeable** . (النفذية الاختيارية)
- Substances that pass through the **protein** → water – soluble substances (ions , glucose).
- Directly through the **lipid bilayer** → fat – soluble substance (O_2 , CO_2 , N_2 , alcohol).

All substances enter into the cell either by **proteins** or by **lipid bilayer**



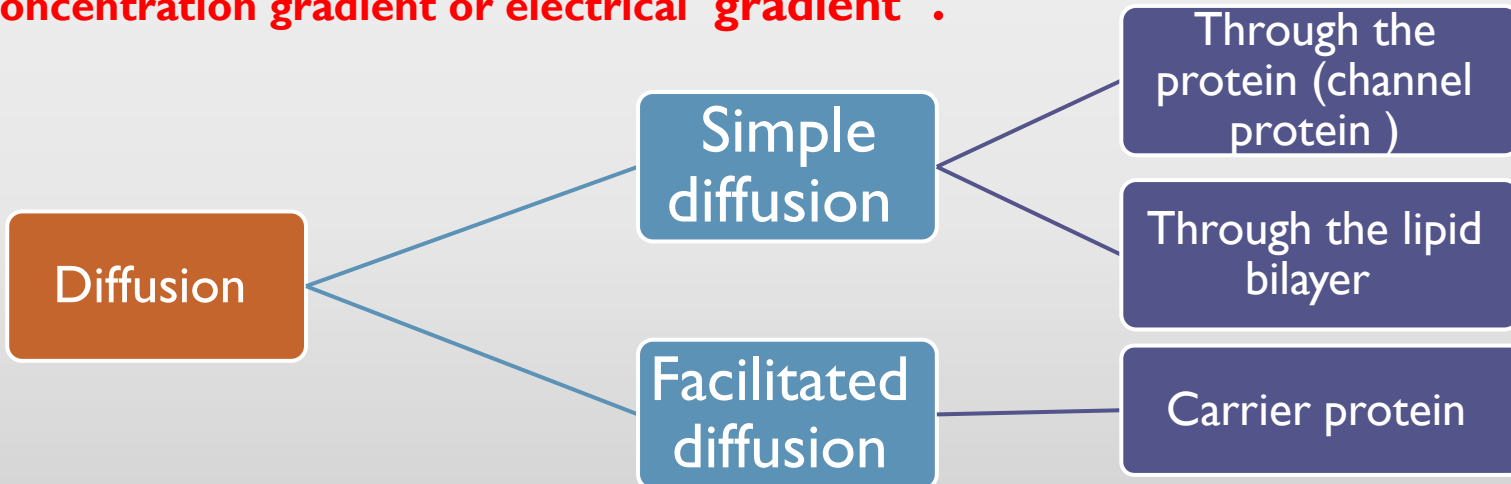
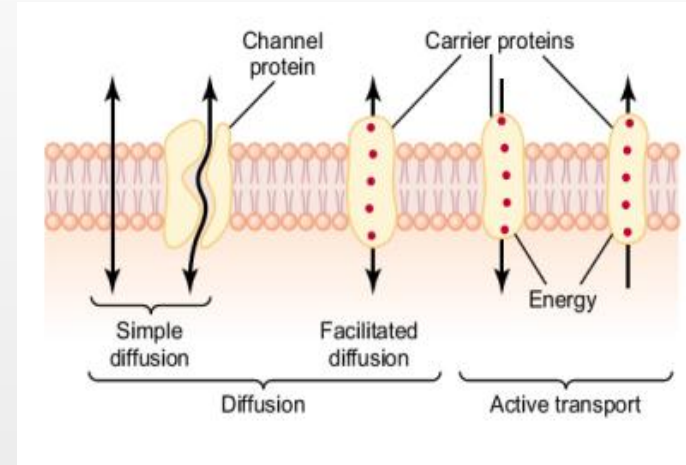
an example of how protein works as a channel for ions

Types of membrane movement



❖ Diffusion :

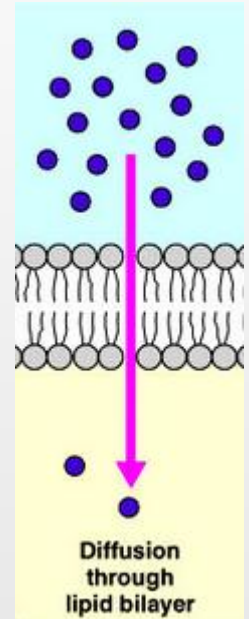
- **Random movement of substance either through the membrane directly or in combination with carrier protein down an electrochemical gradient.**
- **Simple diffusion & facilitated transport do not require input of energy(ATP). Instead , it is s powered by : “concentration gradient or electrical gradient”.**



Passive Transport (Simple diffusion)

I. Simple diffusion :

- **Non-carrier mediated** transport down an electrochemical gradient.
- Diffusion of **non-electrolytes (uncharged)** from **high** concentration to **low** concentration.
- Diffusion of **electrolytes (charged)** depend on both chemical as well as electrical potential difference.



Simple diffusion is the only form of transport that is not carrier-mediated.

Passive Transport (Simple diffusion)

Simple diffusion

1- through the lipid bilayer

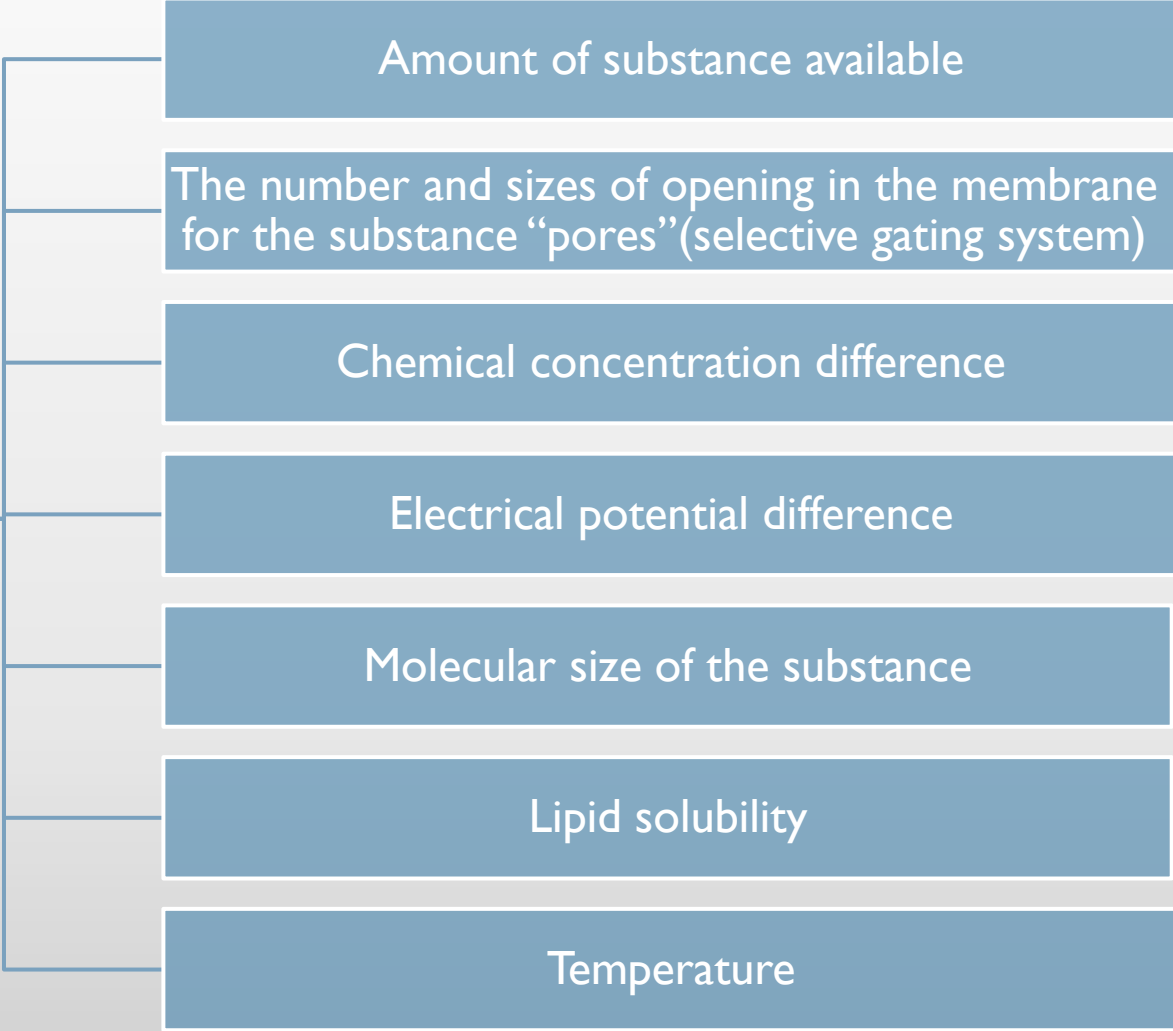
- **Non-carrier mediated** (dissolving in plasma membrane).
- **Small and lipid-soluble substances** (uncharged substances, gases, alcohol, steroid and general anaesthetic).

2- through the channel protein

- Its require **transport protein** (channel protein).
- **Responsible for allowing transport of the majority of molecules**
- **Large and lipid-insoluble substances** (charged molecule, ions).

Passive Transport (Simple diffusion)

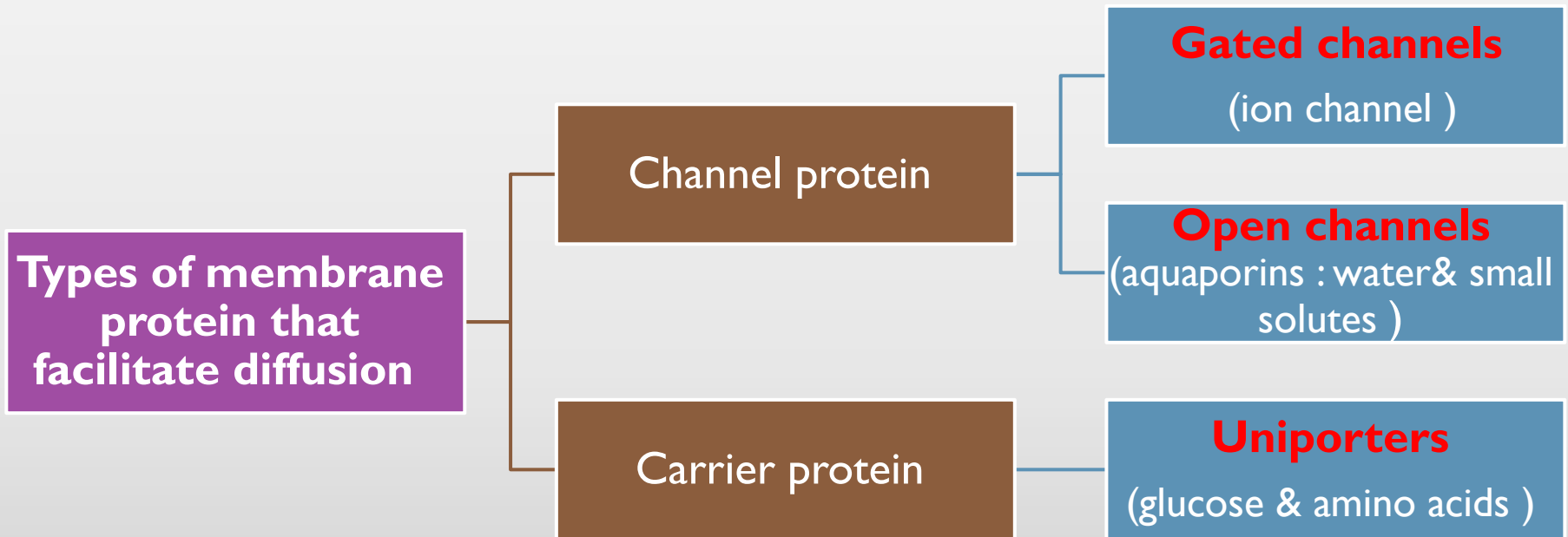
Rate of simple diffusion



Passive Transport (Facilitated diffusion)

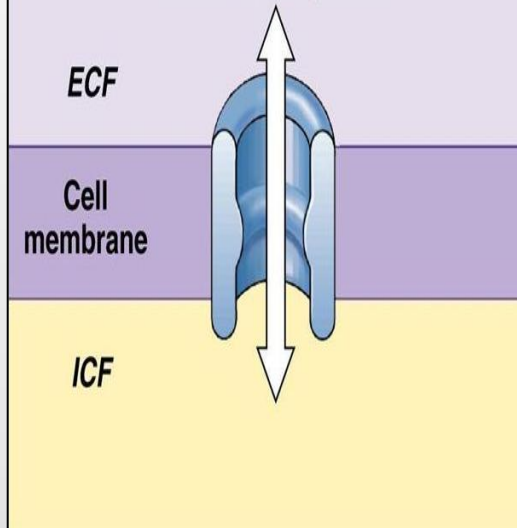
2. Facilitated diffusion :

- **Carrier mediated** transport down an electrochemical gradient.

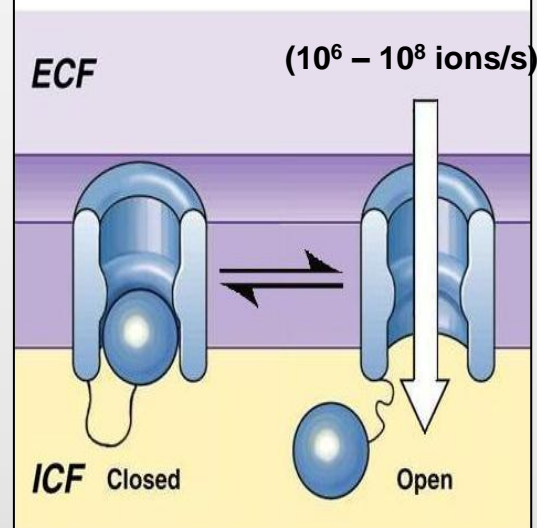


Channels

Open channels create a water-filled pore.

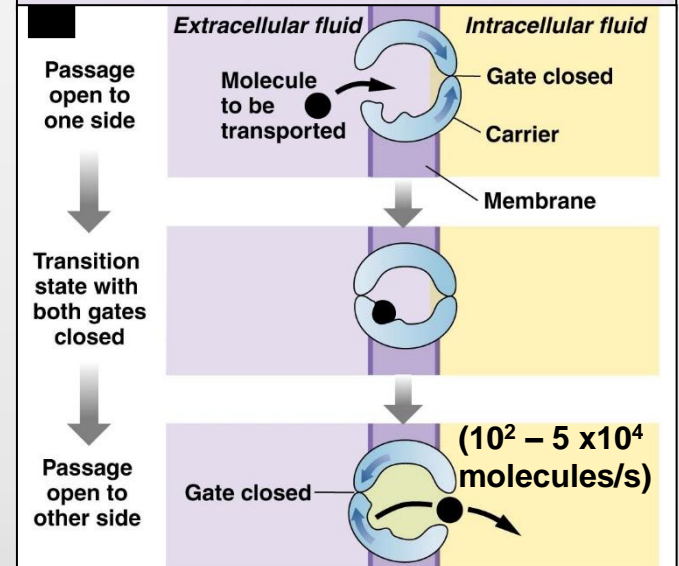


Gated channels are usually closed. They open in response to chemical, mechanical, or electrical signals.



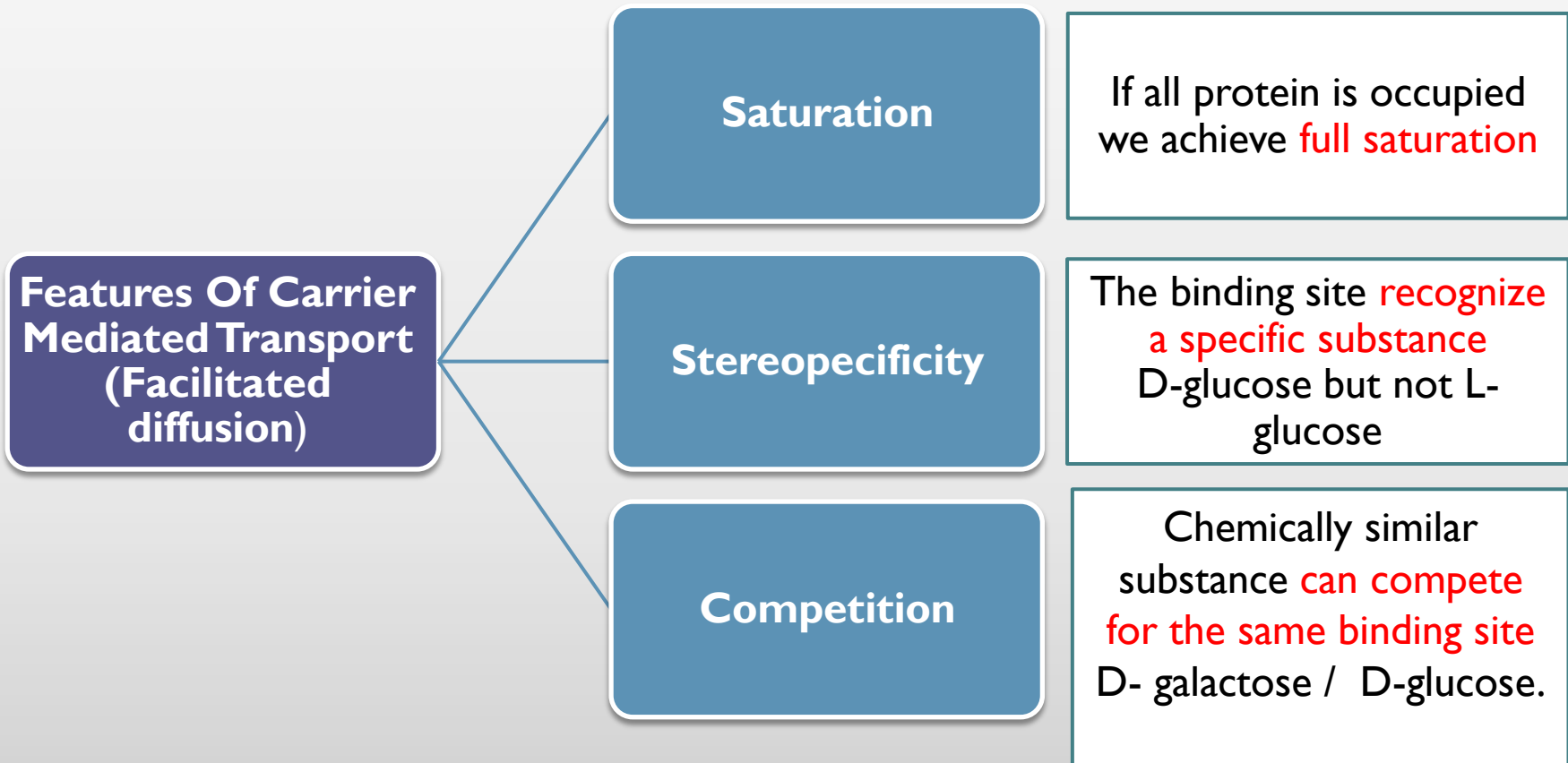
Carriers

Carriers never form an open channel between the two sides of the membrane.



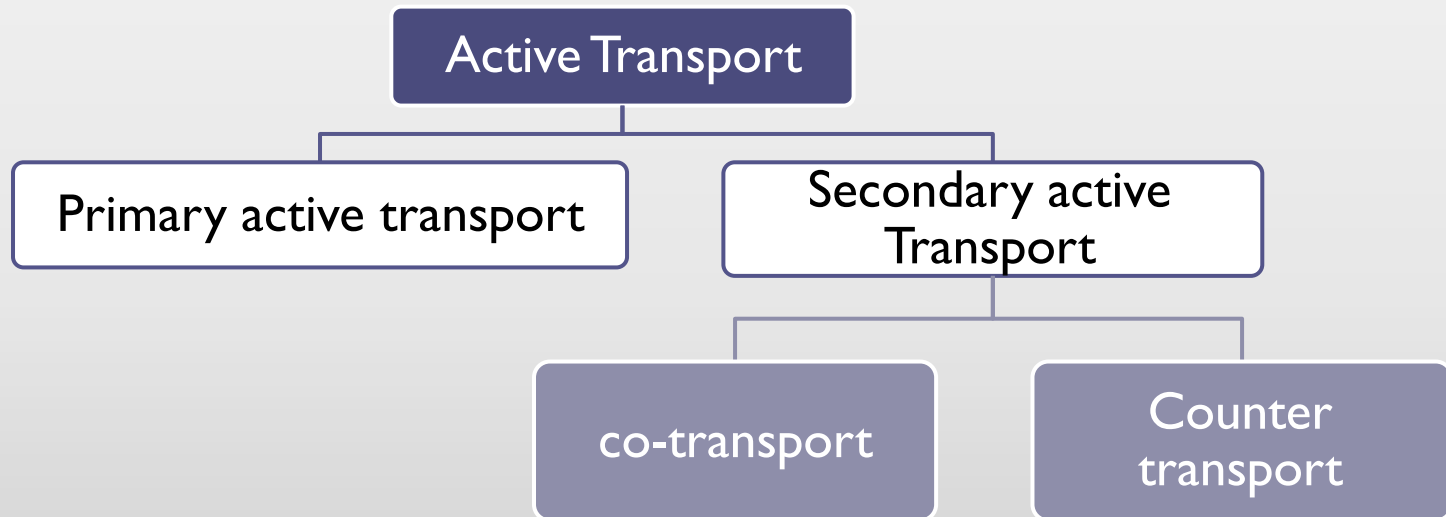
Passive Transport (Facilitated diffusion)

- Diffusion continues until equilibrium is reached or terminated.



❖ Active Transport:

- Transport (**Uphill**) \longrightarrow **Against** electrochemical gradient. from **low** concentration to **high** concentration “النقل الطمّاع”
- Required energy (**direct & indirect**).
- Required carrier – protein.



I. Primary Active Transport:

- Energy is supplied **directly** from hydrolysis of **ATP**.
- **ATP** → **ADP + P + energy**
- **ATP-powered pumps (ATPases)**

Examples of (primary active transport) :

**Na⁺ / K⁺
ATPase**

**H⁺ / K⁺
ATPase**

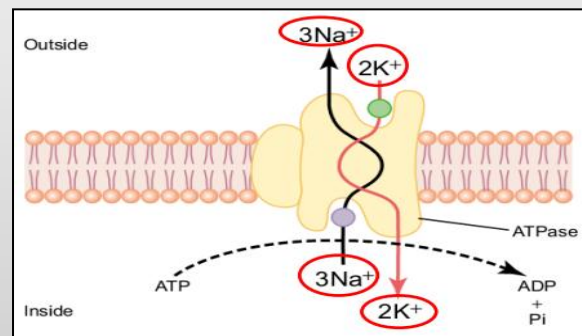
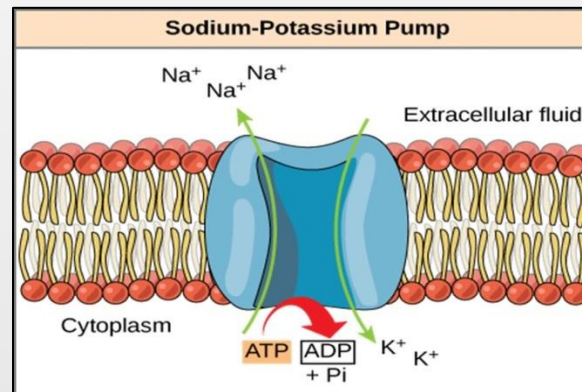
**Ca⁺² / H⁺
ATPase**

❖ Sodium-Potassium pump ($\text{Na}^+ / \text{K}^+ \text{ATPase}$):

- It is present in all cell membranes.
- In some cells (e.g., neurones), energy needed to move these ions uses **70%** of all ATP production of the cell.

Characters

- Carrier protein.
- Binding site for Na^+ inside the cell.
- Binding site for K^+ outside the cell.
- It has ATPase activity.
- **3 Na^+ out 2 K^+ in** “**Electrogenic pump**”.



Functions

- Maintaining Na^+ and K^+ concentration difference .
- Maintaining $-ve$ potential inside the cell.
- Maintains a normal cell volume.
- It is the basis of nerve signal transmtion .

❖ primary active transport of calcium (**Ca²⁺ / H⁺ ATPase**):

- sarcoplasmic reticulum (SR).
- Mitochondria.
- in some cell membranes.

Function

- Maintaining a low Ca²⁺ concentration inside the cell.

❖ primary active transport of hydrogen ions (**H⁺ / K⁺ ATPase**):

- stomach.
- kidneys.

Function

- pump to the lumen.
- H⁺/K ATPase inhibitors (treat ulcer disease). (omeprazol)

أدوية لعلاج تقرحات الجهاز الهضمي

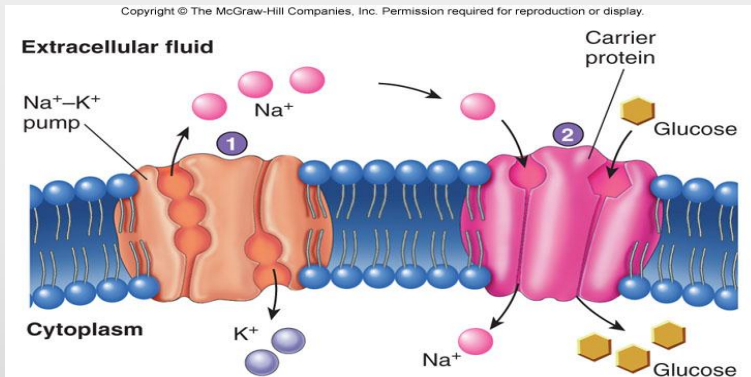
2. Secondary Active Transport (Co- transport and counter transport) :

Transport of one or more solutes **against** an electrochemical gradient, coupled to the transport of another solute **down** an electrochemical gradient.

- “downhill” solute is **Na⁺**
- Energy is supplied indirectly form primary transport.

❖ Co-transport:

- All solutes move **in the same direction** “ inside cell”.
 - Na^+ - glucose Co-transport.
 - Na^+ - amino acid Co-transport.
- in the intestinal tract & kidney.



1. A Na^+-K^+ pump (ATP-powered pump) maintains a concentration of Na^+ that is higher outside the cell than inside.
2. Sodium ions move back into the cell through a carrier protein (symporter) that also moves glucose. The concentration gradient for Na^+ provides energy required to move glucose against its concentration gradient.

❖ Counter transport:

- Na^+ is **moving to the interior causing other substance to move out.**
- $\text{Ca}^{+2} / \text{Na}^+$ exchanger (present in many cell membranes)
- Na^+ / H^+ exchange in the kidney.

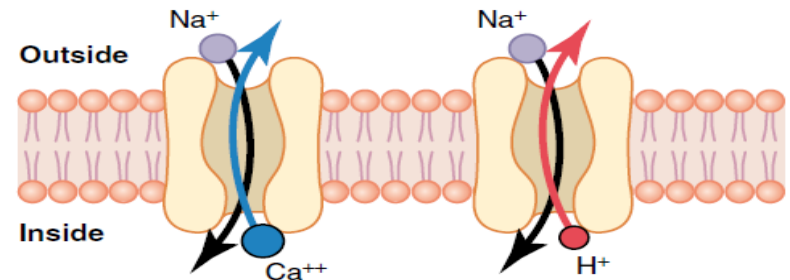


Figure 4-14 Sodium counter-transport of calcium and hydrogen ions.

- [Quiz1](#) & [Quiz2](#) check your understanding !

- **Recommended videos:**

<https://www.youtube.com/watch?v=prfMUwjobo8>

<https://www.youtube.com/watch?v=9RB86AC0h5g>

<https://www.youtube.com/watch?v=P-imDCItxWw>

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