



Physiology  
team



3

## Cell Membrane Structure And Transport Across Cell Membrane

Important

Extra  
explanation

Girls  
notes

Boys  
notes

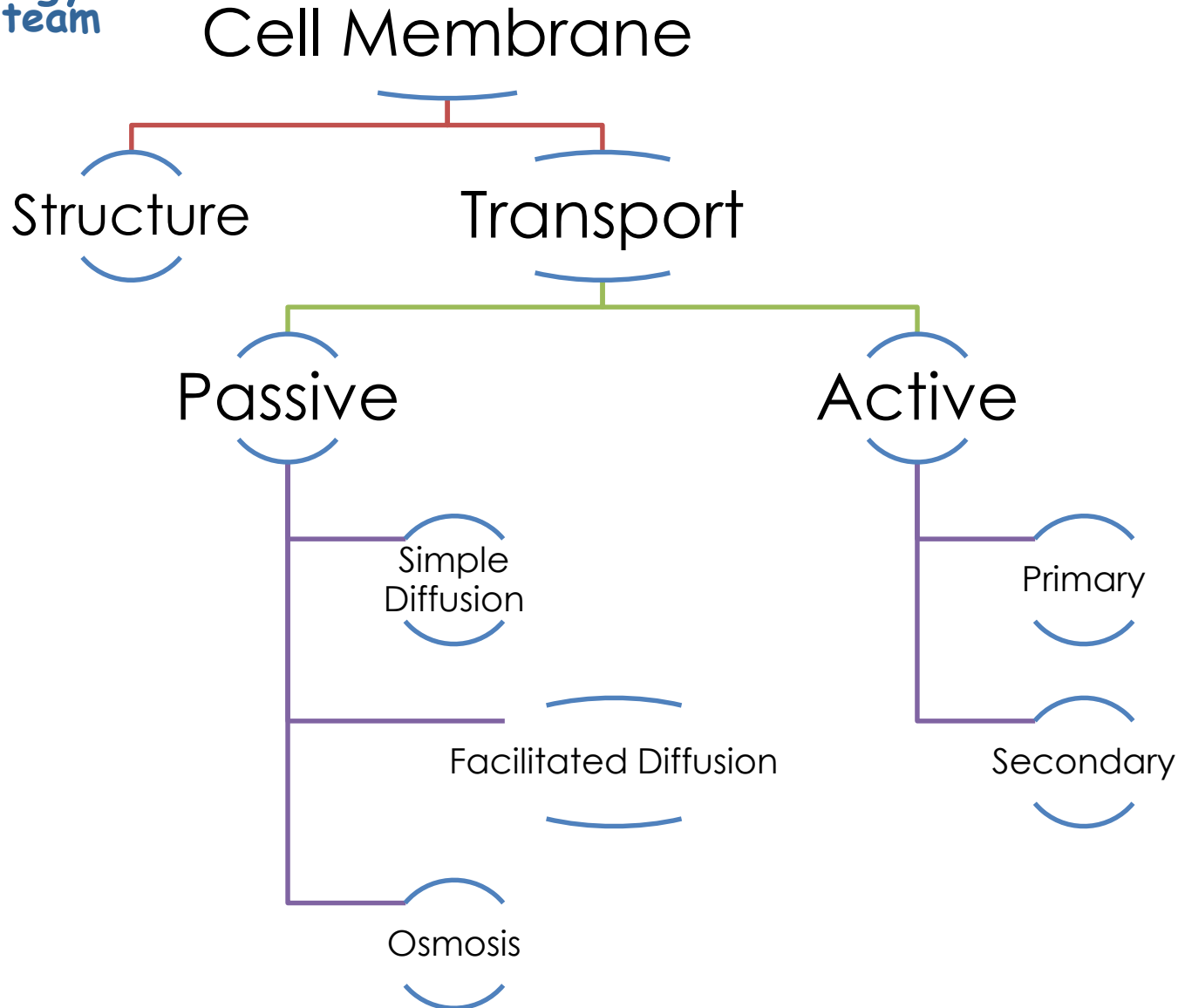
قال الشيخ ابن عثيمين رحمه الله :  
القلب وعاء إذا امتلأ بشيء لم يبق للشيء الآخر محل ،  
فإذا امتلأ بحب الدنيا انشغل عن حب الله عز وجل  
ورسوله صلى الله عليه وسلم وصار الإنسان ليس له هم  
إلا الكسب  
(366ص / 9 ج / شرح بلوغ المرام )

## Objectives

**At the end of this session, the students should** ➤  
**be able to:**

- 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, facilitated diffusion.

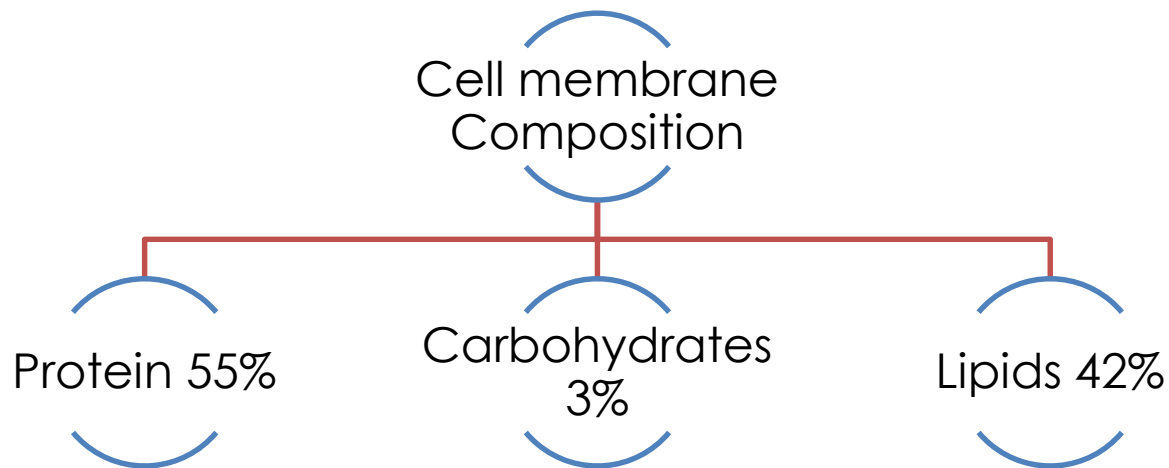
# Mind Map



# Cell Membrane

## General characteristics of Cell membrane:

- Lipid bilayer (**phospholipids**)
- Covers the cell.
- It's fluid not solid.
- 7 - 10 nanometer thick. (thin)
- Also referred to **as plasma membrane.**

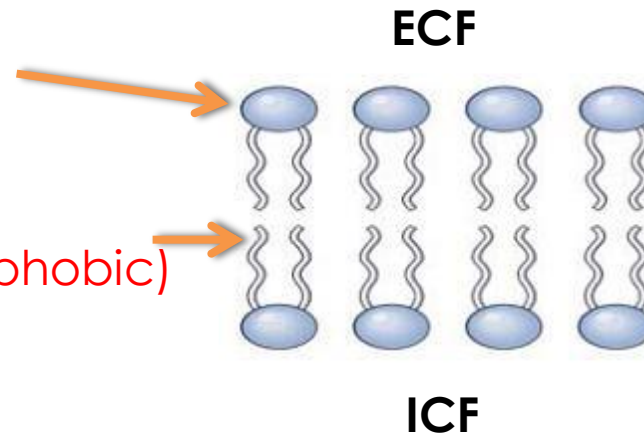


## Cell membrane : Lipids

### ❖ Phospholipids (**Amphipathic**) :

1. **Glycerol head** (hydrophilic).

2. **Two fatty acid "tails"** (hydrophobic)



- Heads (hydrophilic) facing **ICF and ECF** and tails (hydrophobic) **face each other** in the interior of the bilayer

# Cell membrane : Proteins

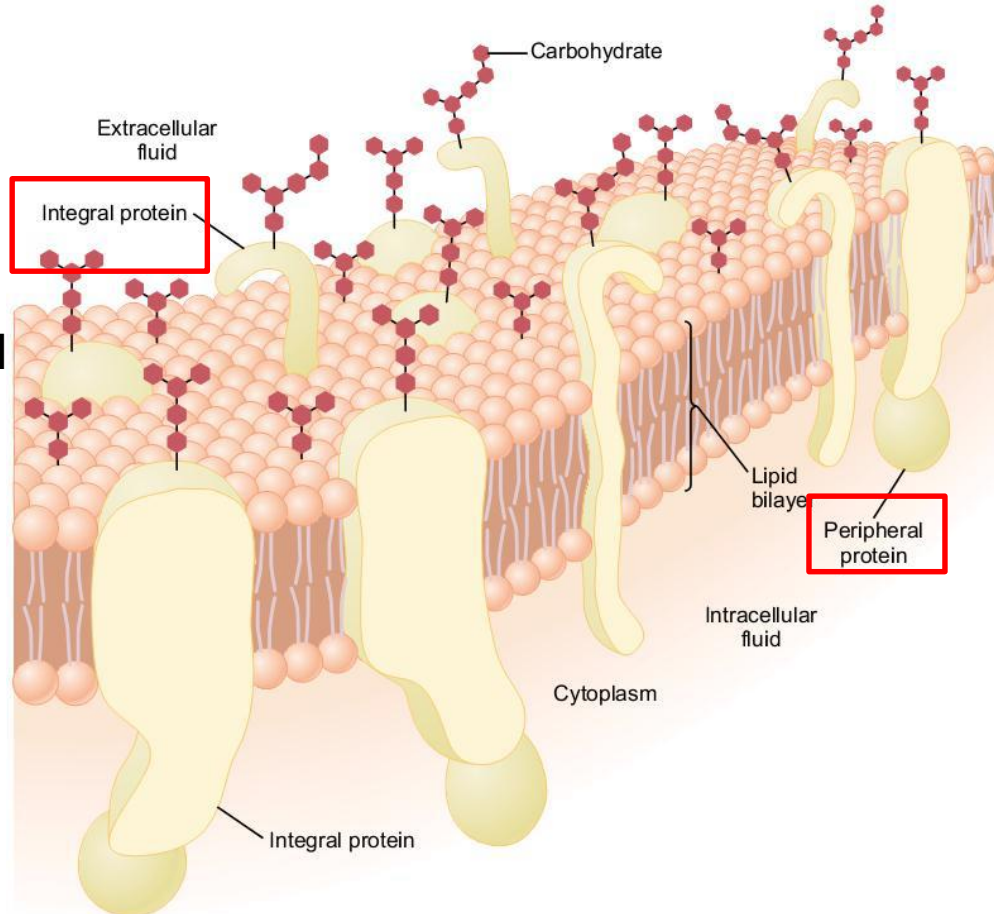
## ❖ Proteins:

### 1-Integral proteins:

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

### 2-Peripheral protein:

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

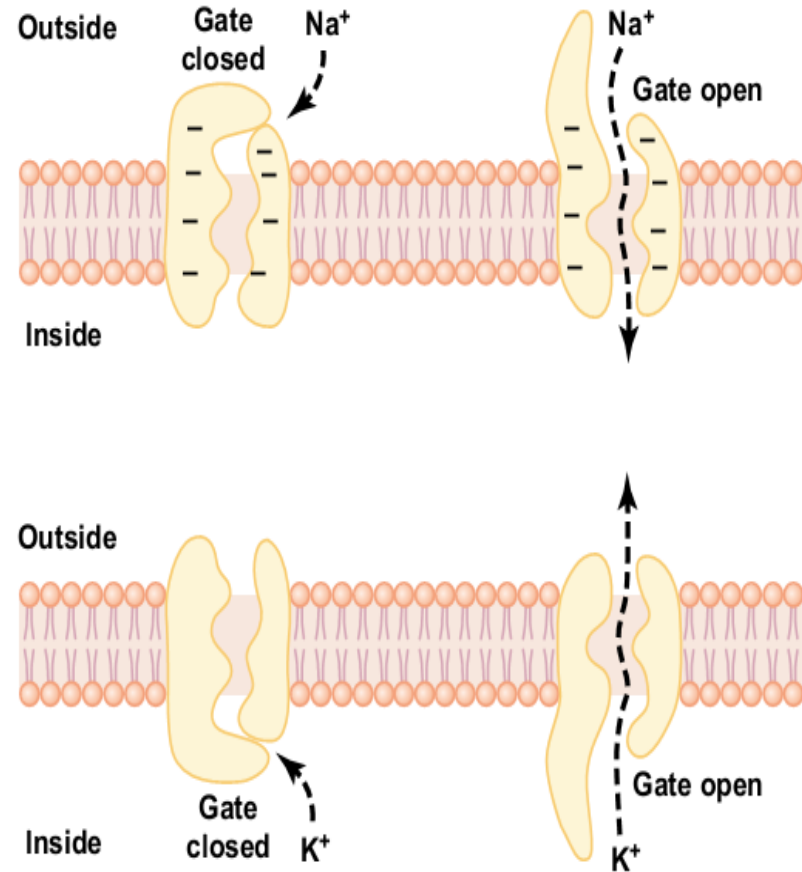


# Cell membrane : Proteins

This an example of how protein works as a channel for ions :

- 1) by electric .
- 2) by ligand gated:  
(explanation)

many ion channels open or close in response to binding a small sign molecule or "ligand" مثل المفتاح





# Cell membrane : Carbohydrates



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## ❖ Carbohydrate :

### 1-Glycoproteins

(**Most** of integral proteins are **glycoproteins**).

### 2-Glycolipids

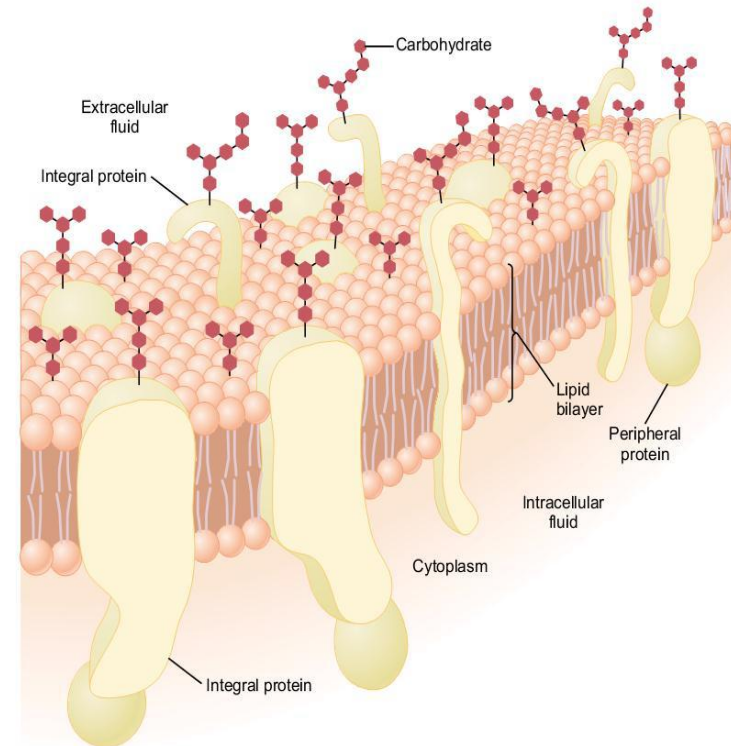
(Represent 1/10 of the membrane lipids)

### 3-Proteoglycans

(mainly carbohydrate substance bound together by protein)

### 4-Glycocalyx

(the entire **outside surface** of the cell often has a loose carbohydrate coat called the **glycocalyx**)







## Cell membrane ; Carbohydrates

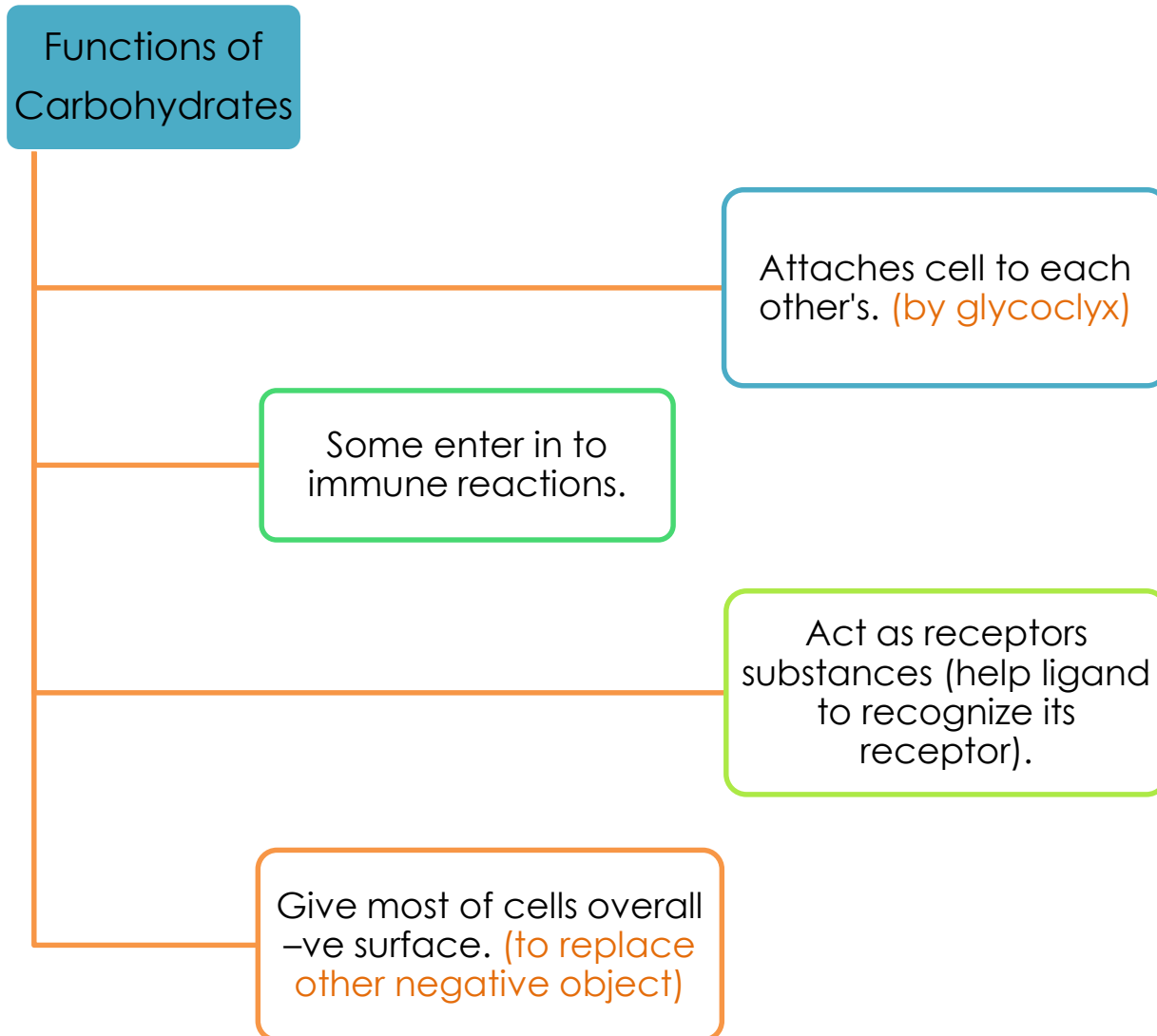


“ **glyco** ” part is in the surface forming.

The “glyco” portions of these molecules (glycoproteins & glycolipids) almost invariably protrude to the outside of the cell, dangling outward from the cell surface

أي أن الكربوهيدرات المرتبطة بالدهون والبروتينات تكون بارزة  
ومتدلّية من سطح الخلية

## Cell membrane : Carbohydrates



## Cell membrane : Transport

- Cell membrane is **Selectively Permeable**
- Through the proteins → (Water -soluble substances e.g. ions, glucose)
- Through the lipid bilayer → (Fat -soluble substance e.g. O<sub>2</sub>, CO<sub>2</sub>, N<sub>2</sub>, alcohol)

جميع المواد تدخل للخلايا إما عن طريق البروتين أو عن طريق طبقتي الدهون

## Types of membrane movement

Passive Transport  
(NO Energy required )

Simple  
Diffusion  
(no carrier)

Facilitate  
d Diffusion

Osmosis

Active Transport  
( Energy is  
required )

Primary  
Active  
Transport

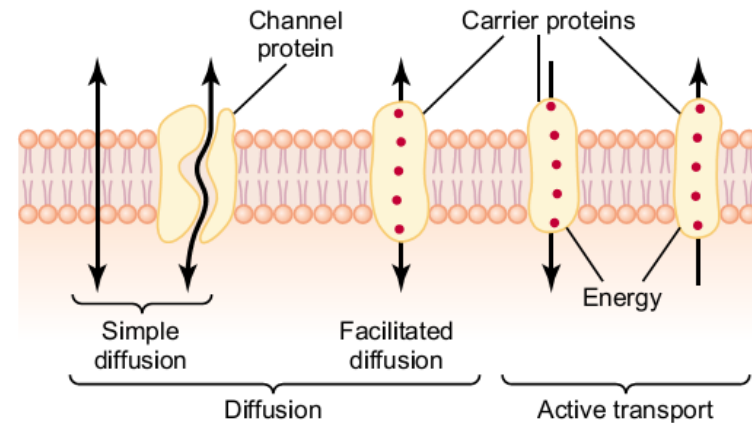
Secondary  
Active  
Transport

N.B: Simple diffusion is the only form of transport that is *not* carrier-mediated.

## ❖ Diffusion :

Random movement of substance either through the membrane *directly* or in combination with *carrier protein* down an electrochemical gradient.

**Downhill** transport (Simple diffusion & facilitated) don't require input of energy(ATP). Instead, its powered by Concentration gradient or electrical gradient.



## Cell membrane : Passive transport



# Diffusion

## Simple

Non-carrier mediated transport down an electrochemical gradient.

Diffusion of nonelectrolytes (uncharged) from high concentration to low concentration.

Diffusion of electrolytes (charged) depend on both chemical as well as electrical potential difference.

## Facilitated

Carrier mediated transport down an electrochemical gradient.



## Cell membrane : Passive transport



### Rate of Simple Diffusion

Amount of substance available

Increasing in diffusion due to increasing in amount

The number of opening pores in the cell membrane

Increasing in diffusion due to increasing in number of pores

Chemical concentration difference net diffusion =  $P \times A (C_O - C_I)$

the rate of net diffusion into the cell is proportional to the concentration on the outside minus the concentration on the inside  $C_O =$  Concentration Outside -  $C_I =$  Concentration Inside

Electrical potential difference. EPD =  $\pm 61 \log \frac{C_1}{C_2}$

the electrical charges of the ions cause them to move through the membrane even though no concentration difference exists to cause movement

Molecular size of the substance

Increasing in diffusion due to decreasing in molecular size

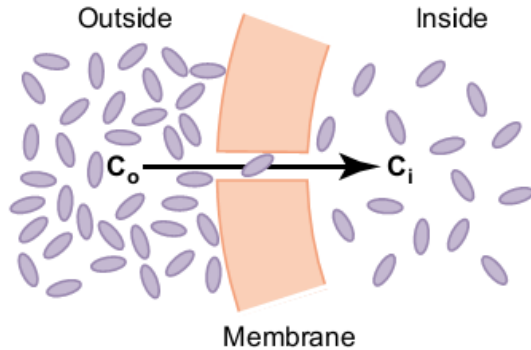
Lipid solubility

Increasing in diffusion due to increasing in lipid solubility

Temperature

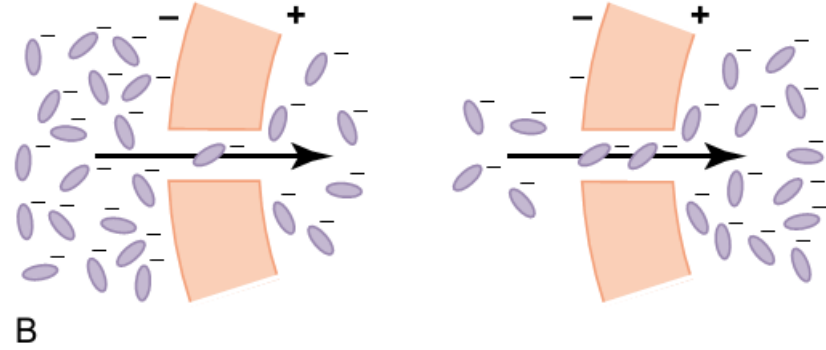
Increasing in diffusion due to increasing in heat

## Cell membrane : Passive transport



A

**Chemical concentration  
difference**  
**net diffusion =  $P \times A (C_o - C_i)$**



B

**Electrical potential difference.**  
**EPD =  $\pm 61 \log C_1/C_2$**

Not that important



## Cell membrane : Passive transport



### Features Of Carrier Mediated Transport (Facilitated diffusion & Active transport)

#### Saturation

If all protein is occupied we achieve full saturation

#### Stereo specificity

The binding site recognize a specific substance e.g. D-glucose but not L-glucose.

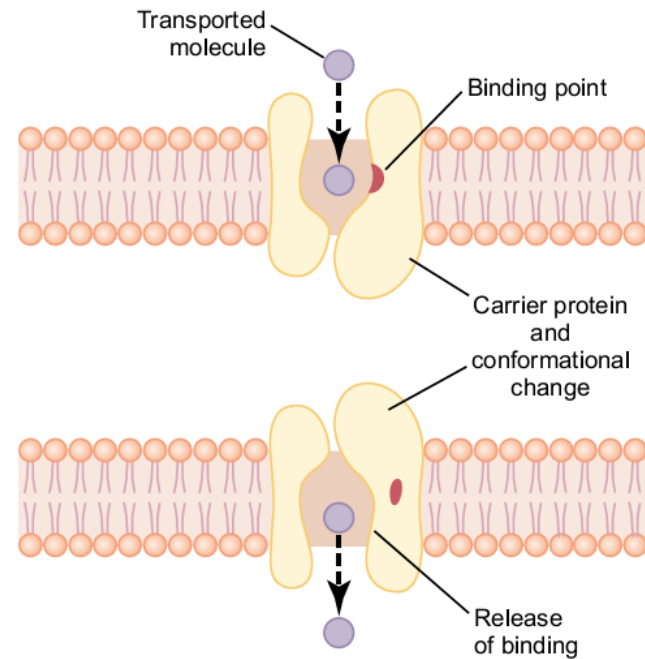
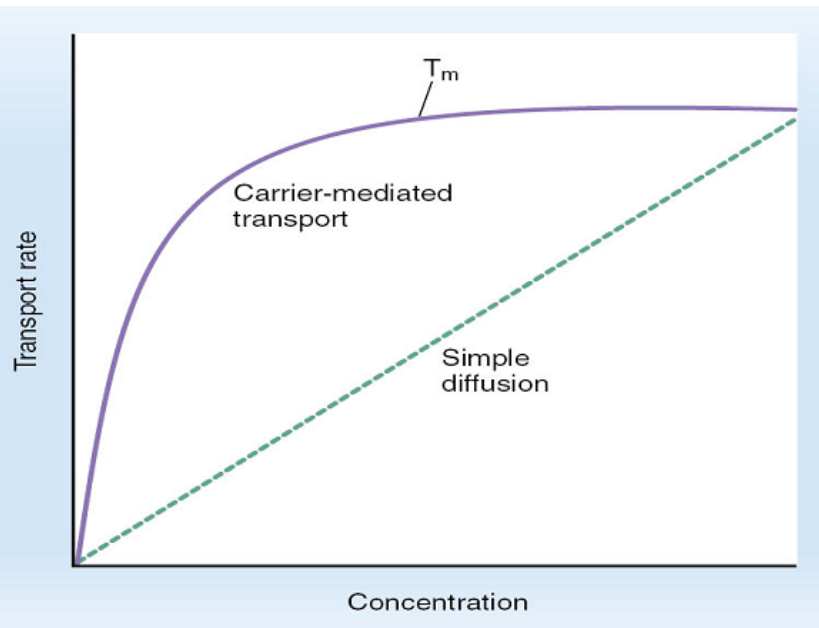
#### Competition

Chemically similar substance can compete for the same binding site.

## Cell membrane : Passive transport

Substance → binding site → substance protein complex  
→ conformational changes → release of substance.

**$T_m$  = Saturation**



**Figure 4-7**

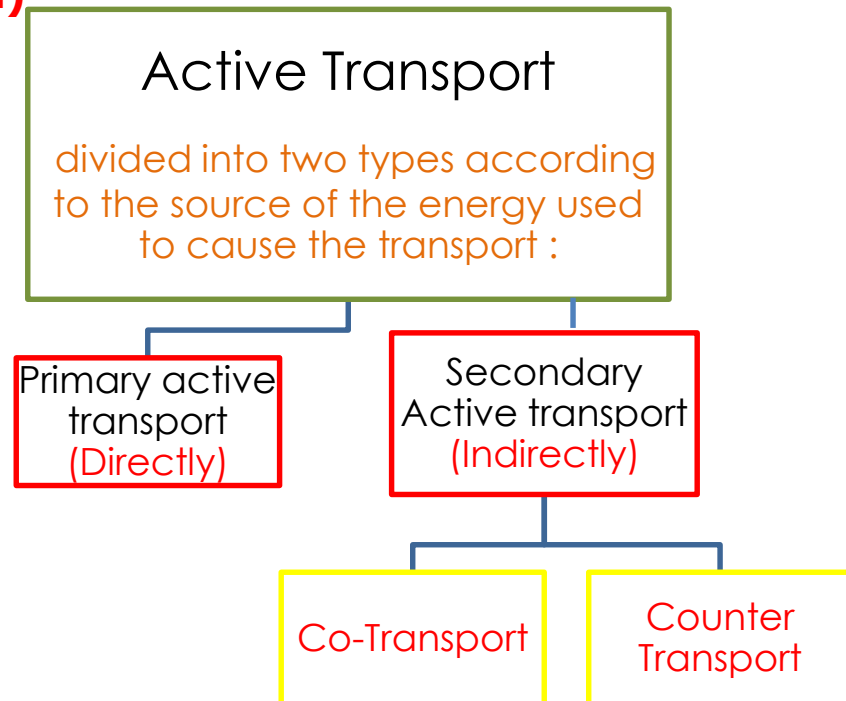
Postulated mechanism for facilitated diffusion.

## Cell membrane : Active transport



### ❖ Active Transport :

- Transport (**uphill**) → against electrochemical gradient.
- Required energy (**Direct & Indirect**)
- Required **carrier – protein**.



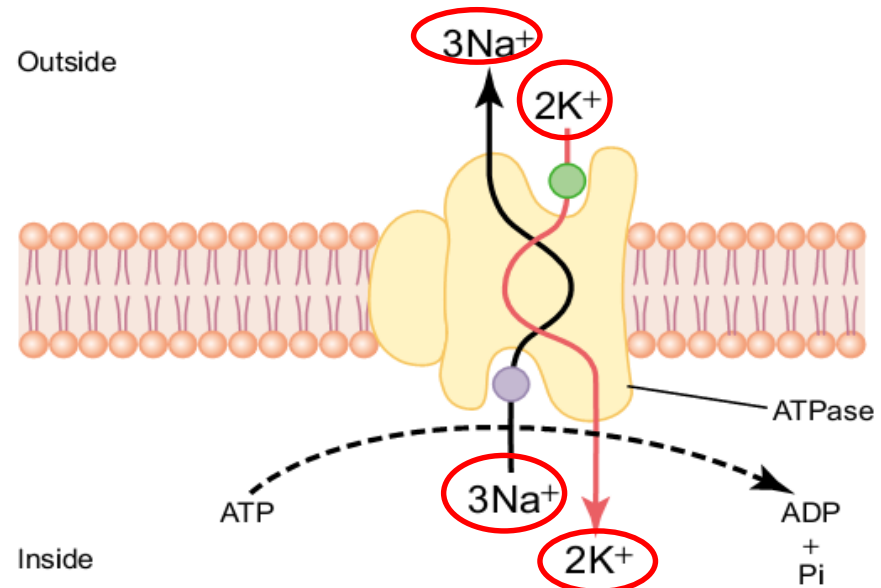
## ➤ Primary Active Transport :

**Energy is supplied directly from ATP.**  
**ATP → ADP + P + energy.**

### A. Sodium-Potassium pump (Na<sup>+</sup>-K<sup>+</sup> pump):

- Its present in all cell membrane

- **3 Na<sup>+</sup> in** → **out.**
- **2 K<sup>+</sup> out** → **in.**



## Cell membrane : Active transport



### CHARACTERISTICS OF THE ( $\text{Na}^+$ - $\text{K}^+$ PUMP )

- 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.

### FUNCTIONS OF THE PUMP

- A. Maintaining  $\text{Na}^+$  and  $\text{K}^+$  concentration difference .
- B. Maintaining -ve potential inside the cell.
- C. Maintains a normal cell volume.
- D. It's the basis of nerve signal transmission .



## Cell membrane : Active transport



### B. primary active transport of calcium ( $\text{Ca}^{2+}$ ATPase):

- Site:
  - Sarcoplasmic reticulum (SR).
  - Mitochondria.
  - in some cell membranes.
- Function:

**Maintaining a low  $\text{Ca}^{2+}$  concentration inside the cell.**

### C. primary active transport of hydrogen ions $\text{H}^{+}$ - $\text{K}^{+}$ ATPase:

- Site:
    - Stomach.
    - Kidneys.
  - Function:
    - **pump to the lumen.**
    - **$\text{H}^{+}$ - $\text{K}^{+}$  ATPase inhibitors (treat ulcer disease).**
- (omeprazole)**

تمنع خروج H  
وبالتالي تعالج  
القرحة.

## Cell membrane : Active transport



### ➤ Secondary Active Transport:

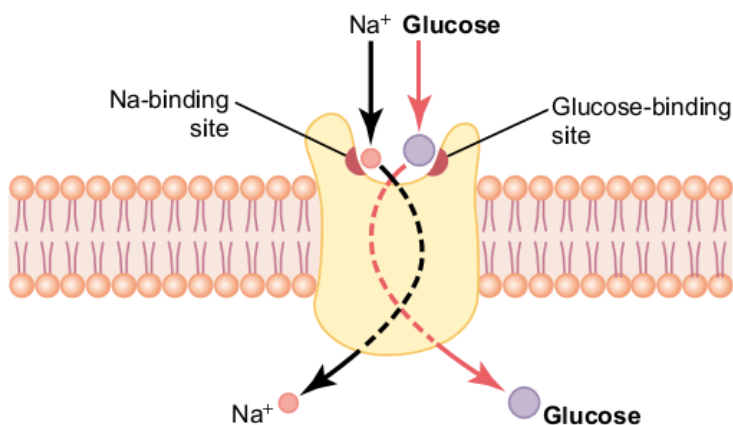
- **Co- transport OR Counter transport:**

is 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.

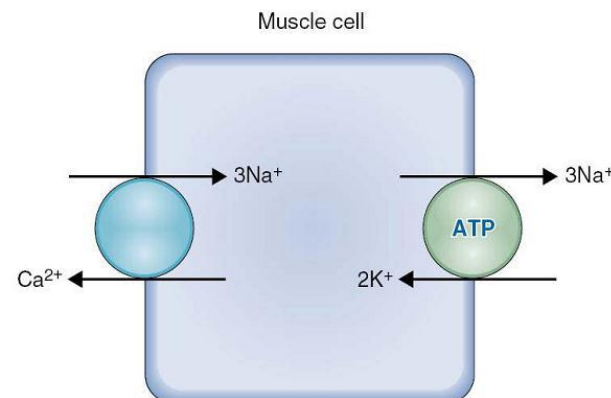
## Co-Transport

- All solutes move in the same direction to "inside the cell".
- **Na<sup>+</sup> - glucose Co-transport.**
- **Na<sup>+</sup> - amino acid Co-transport.**



## Counter Transport

- Na<sup>+</sup> is moving to the interior causing other substance to move out.
- **Ca<sup>2+</sup> - Na<sup>+</sup> exchange.**
- **(Present in many cell membranes)**





## Cell membrane : Active transport



### What the difference? (Explanation Only)

1-In primary active transport, the energy is derived directly from breakdown of adenosine triphosphate (ATP) or of some other high-energy phosphate compound.

2-In secondary active transport, the energy is derived secondarily from energy that has been stored in the form of ionic concentration differences of secondary molecular or ionic substances between the two sides of a cell membrane, created originally by primary active transport.



## Summary



- The cell membrane consists of protein, lipid and carbohydrates.
- The cell membrane is selectively permeable.
- The solutes can enter the cell either with protein or lipid.
- Types of membrane transport are: diffusion, active transport and osmosis.
- In diffusion there is no need for energy, but in active transport we need energy, because it is against the electrochemical gradient.

## Some YouTube Videos



1-

[https://www.youtube.com/watch?v=kfy92hd\\_aAH0](https://www.youtube.com/watch?v=kfy92hd_aAH0) **ACTIVE AND PASSIVE TRANSPORT**

2-

<https://www.youtube.com/watch?v=awz6lls3hQ> **NA<sup>+</sup>K<sup>+</sup> PUMP**

3-

<http://bk.psu.edu/clt/bisc4/ipweb/systems/systems/fluids/index.html>

**(it is important for the first 5 lectures)**

## Check your understanding!



**Q1: Which of the following statement is true about cell membrane?**

- A- It is a solid membrane
- B- It is 11 nanometer thick
- C- It is hydrophilic
- D- It is Amphipathic

**Q2: The Cell membrane phospholipids consist of two fatty Acids which is “hydrophilic”.**

- A- True
- B- False

**Q3: In “Sodium – Potassium pump” which of these will happen?**

- A-  $2\text{Na}^+$  in &  $2\text{K}^+$  out
- B-  $2\text{Na}^+$  in &  $3\text{K}^+$  out
- C-  $3\text{Na}^+$  in &  $2\text{K}^+$  out
- D-  $3\text{Na}^+$  out &  $2\text{K}^+$  in

**Q4: Which of the following act as receptor recognition in cell membrane?**

- A- Carbohydrates
- B- Proteins
- C- Lipids
- D- Both A and C

**Q5: Simple Diffusion is a carrier mediated transport down its electrochemical gradient.**

- A- True
- B- False



Check your understanding!



**Q6: Which of the following is an example for secondary active transport?**

- A- Na<sup>+</sup> - Amino acid Co-transport**
- B- Na<sup>+</sup> - K<sup>+</sup> pump**
- C- Active transport of calcium (Ca<sup>2+</sup> + ATPase )**
- D- Active transport of hydrogen ions ( H<sup>+</sup> - K )**

Done by :

ANSWERS:  
1-D  
2-B  
3-D  
4-A  
5-B  
6-A

Malak Saud AL-Khathlan, Rawan Ghandor, Nouf Alharbi, Mona Almoteb, Razan Alsubhi.