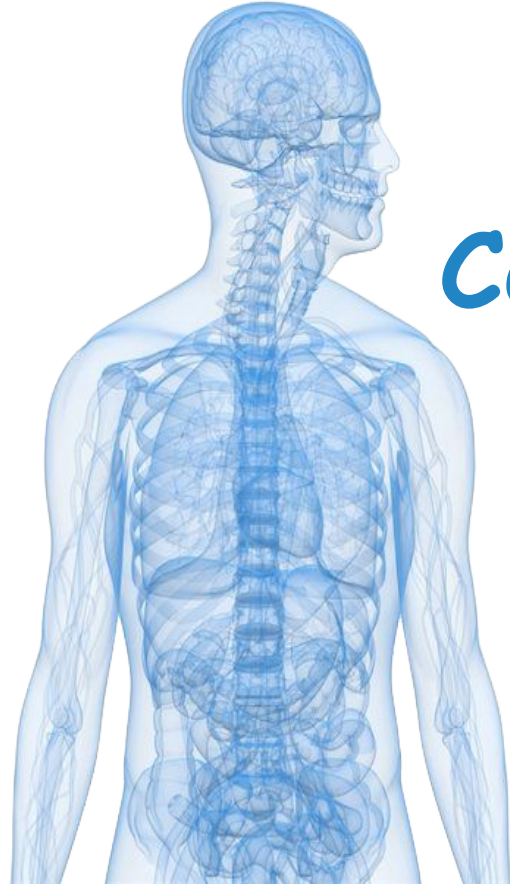


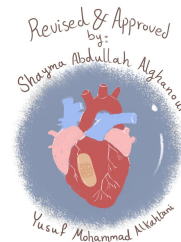
Cell membrane structure & transport



Team Leaders:

Haya Alenazi

Abdulrahman Alswat



Red: Important

Black: In Male & Female slides

Blue: In male slides

Pink: In female slides

Green: Notes & extra information

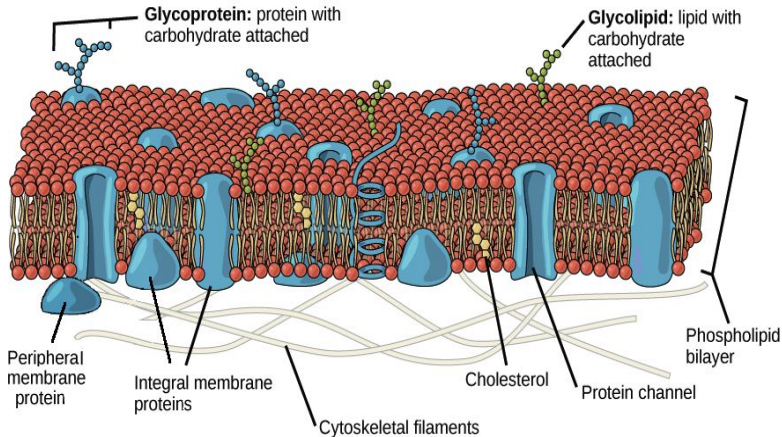
OBJECTIVES

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

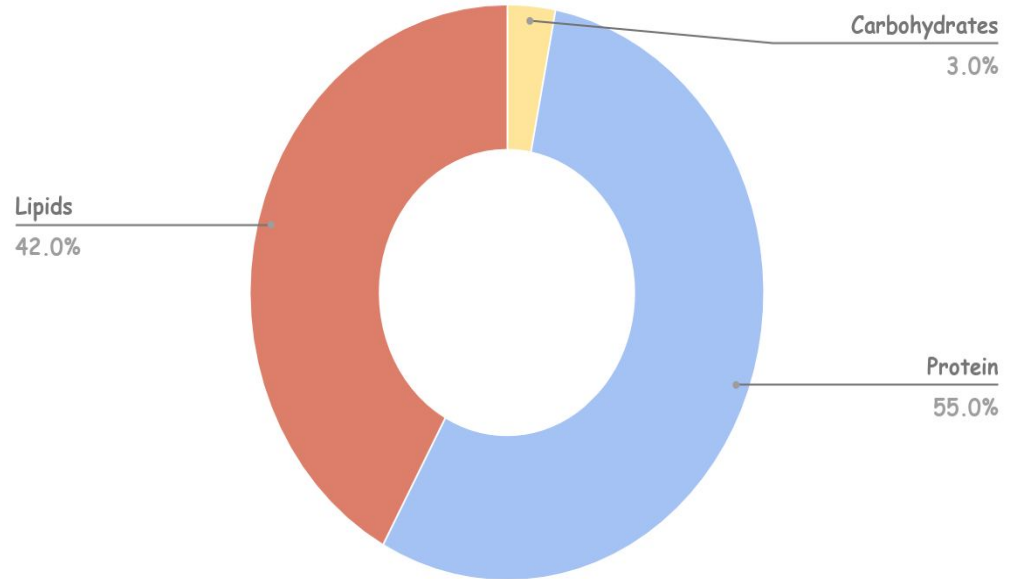
Cell Membrane (Plasma membrane)

Characteristics:

- It covers the cell.
- It is a fluid, not solid (**elastic**).
- Phospholipid bilayer.
- Thickness = 7.5 - 12 nm (**very thin**).
- Also known as “**cytoplasmic membrane**”.



Composition of Cell Membrane

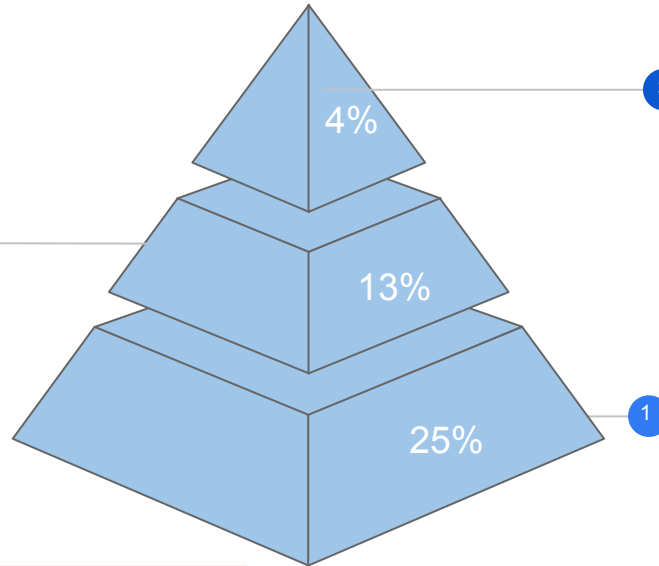
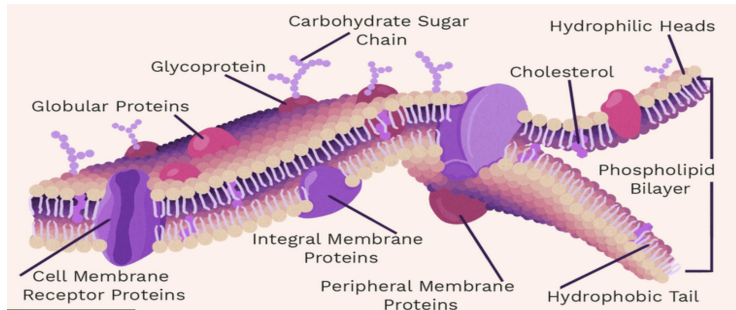


Lipids (42% of CM)

Cholesterol

Function: to increase membrane flexibility (fluidity of membrane) and stability

→ Present in varying amounts



Glycolipids

→ Structure: Lipid + carbohydrate (glucose)

Phospholipids (**Amphipathic**)

- Head: (**hydrophilic**) (glycerol molecule is attached to a phosphate group) facing ICF and ECF
- Tail: (**hydrophobic**) 2 fatty acids (long chains of hydrogen and carbon molecules) face each other in the interior of the bilayer

Proteins (55% of CM)

1) Integral proteins

- Span the membrane.
- Provide structural channels or pores.

Can **function** as:

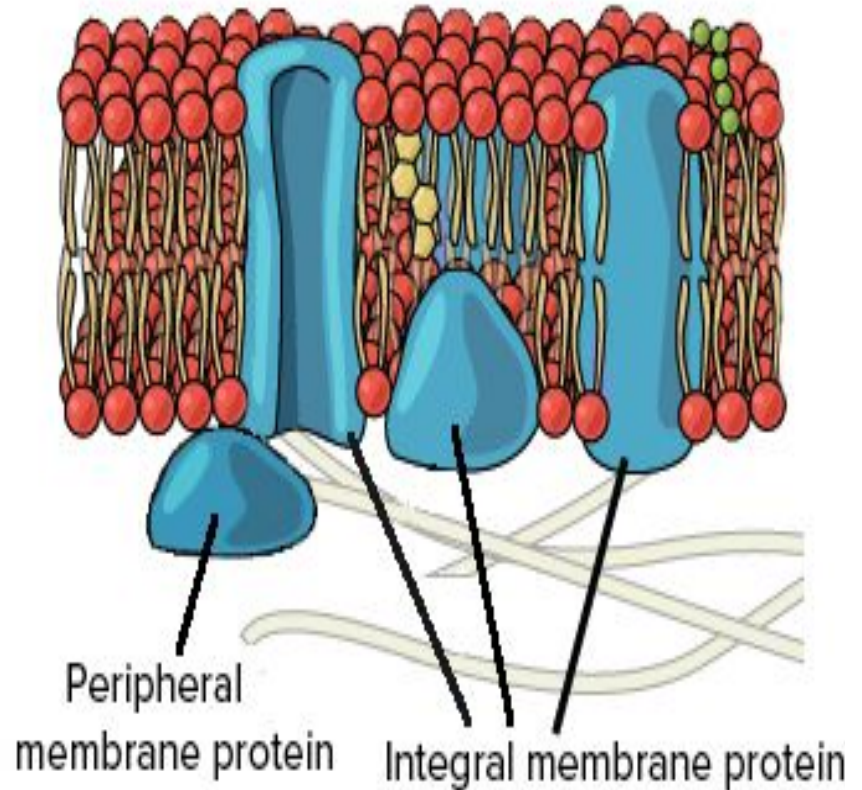
- Carrier proteins.

2) Peripheral proteins

- Present in one side .

Can **function** as:

- Hormone receptors.
- Cell surface antigens.



Carbohydrates (3% of CM)

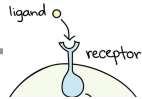
Carbohydrates				
	Glycoprotein	Glycolipids	Proteoglycans	Glycocalyx
Structure	Protein + Carb Mainly protein bound to carbohydrates	Lipid + carb	Mainly carbohydrate bound together by a protein	Loose coat of carbohydrates on the cell membrane
Portion	Most of the membrane carbohydrates	10% = 1/10		

"Glyco" part is in the surface forming

Function:

1) Attaches cells to each others

2) Act as receptors substances (help ligand to recognize its receptor)

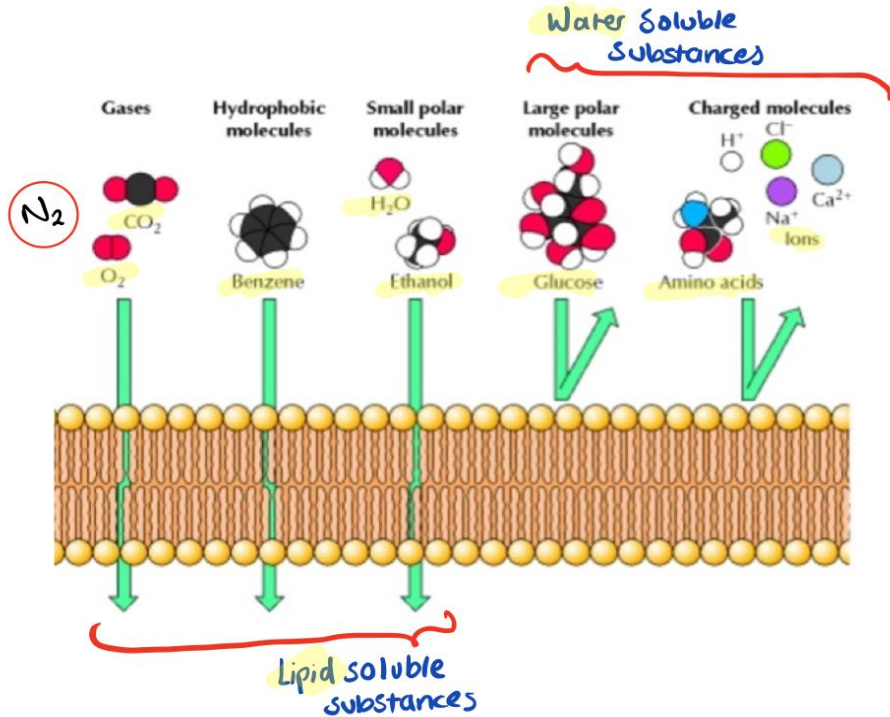


3) Some are involved in immune reactions

4) Gives most of cells an overall -ve surface

Transport Through The Cell Membrane

Cell membrane is **selectively permeable**.



Water soluble (hydrophilic) substances **cannot pass directly** through the lipid bilayer. In order for them to go in-and-out of the cell, they must pass through **carrier proteins**

Lipid soluble (hydrophobic) substances **can pass directly** through the lipid bilayer of the membrane.

Transport Through The Cell Membrane

Types of membrane transport

Passive Transport

(no ATP- powered by
electrochemical gradient)

1. **Diffusion.**
 - a. Simple diffusion
 - b. Facilitated diffusion
2. **Osmosis**

Active Transport

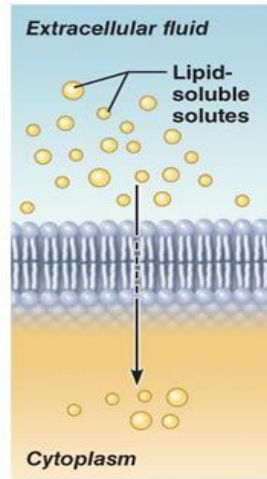
(requires ATP)

1. **Primary** active transport.
2. **Secondary** active transport.

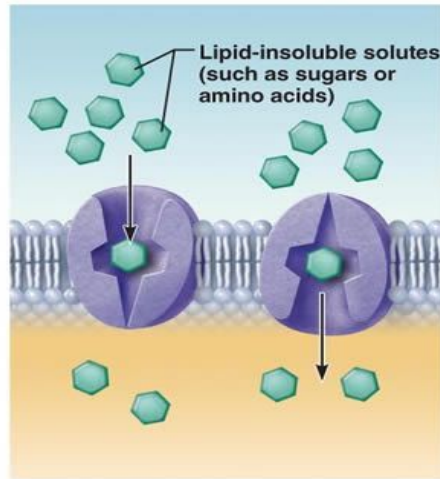
Passive transport: Diffusion

Definition:

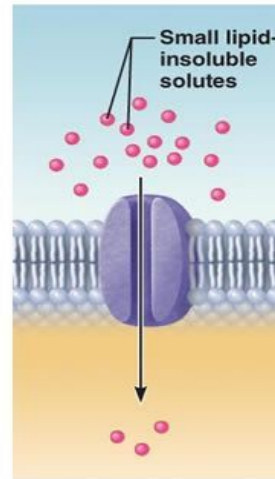
Random movement of substance either through the membrane directly or in combination with carrier protein **down** an **electrochemical** gradient.



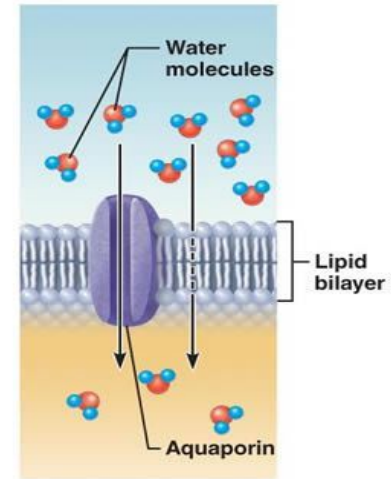
(a) Simple diffusion of fat-soluble molecules directly through the phospholipid bilayer



(b) Carrier-mediated facilitated diffusion via protein carrier specific for one chemical; binding of substrate causes transport protein to change shape



(c) Channel-mediated facilitated diffusion through a channel protein; mostly ions selected on basis of size and charge

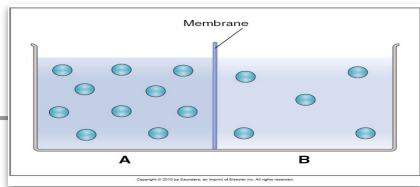


(d) Osmosis, diffusion of a solvent such as water through a specific channel protein (aquaporin) or through the lipid bilayer

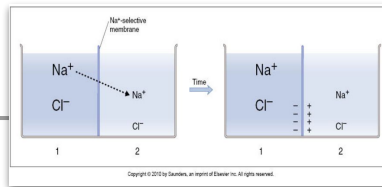
Passive transport: Simple diffusion

Simple diffusion

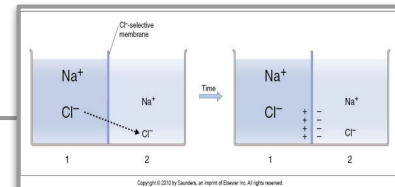
Non-carrier mediated transport down an electrochemical gradient from **high** concentration to **low** concentration.



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



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



Rate of Simple Diffusion Depends On:

01

The number of opening in the cell membrane for the substance (pores) selective gating system.

02

Amount of substance available

03

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

04

Electrical potential difference.

05

Molecular size of the substance.

06

Lipid solubility.

07

Temperature.

$$\text{Rate of diffusion} = P \times A (C_1 - C_2)$$

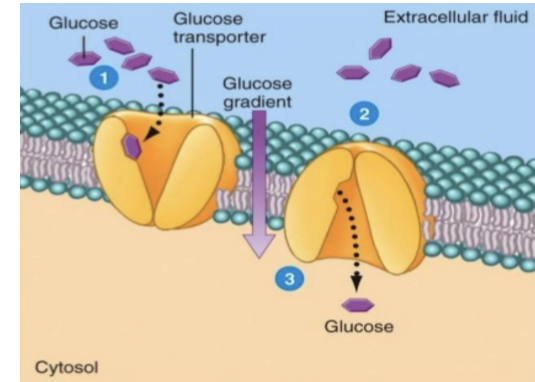
1. P = Permeability coefficient.
a. Temperature. b. Size of molecule. c. Solubility in lipids. d. Thickness of membrane.
2. A = surface area.
3. C₁-C₂ = gradient difference:
a. Concentration difference
b. b. Electrical difference.
c. Pressure difference.

Passive transport: Facilitated Diffusion (carrier-mediated)

Definition:

- The process that allows selective movement in and out of membrane
- Carrier mediated transports **down** an electrochemical gradient.

Transport glucose, most of amino acids (due to their big size).



Features Of Carrier-Mediated Transport

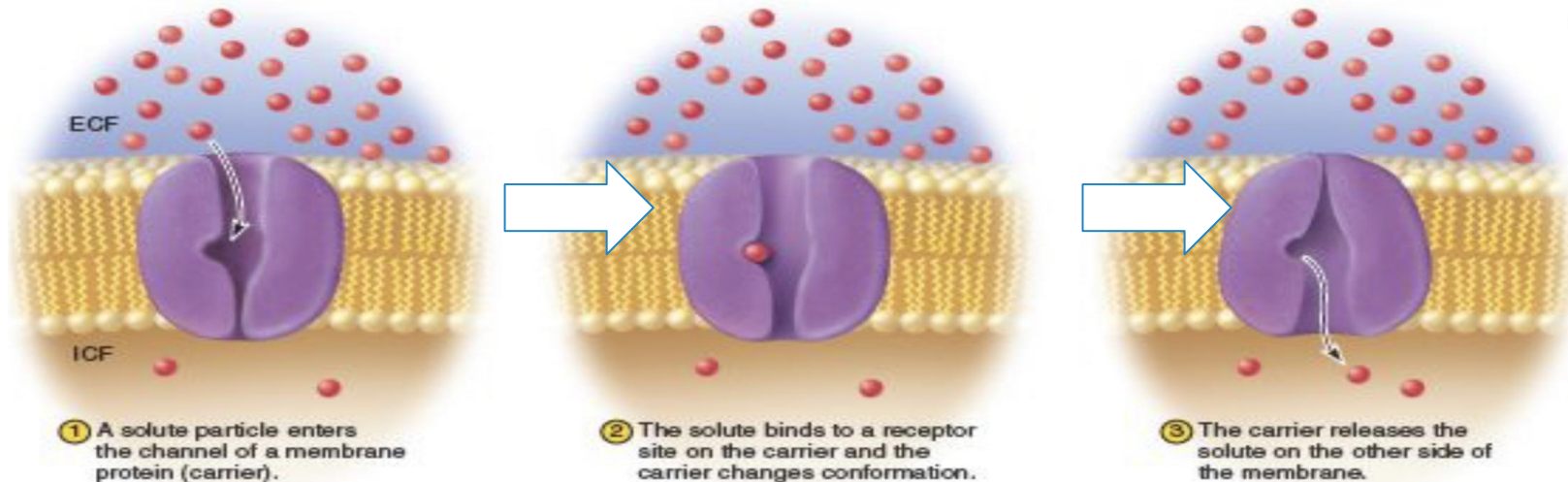
01	Saturation	Inc. concentration = inc. binding of protein, if all protein is occupied we achieve full saturation.
02	Stereospecificity	The binding site recognizes specific substances, D-glucose but not L-glucose
03	Competition	Chemically similar substances can compete for the same binding site. Ex. D-galactose and D-glucose

Passive transport: Facilitated Diffusion (carrier-mediated)

Revision: General steps for any carrier-mediated transport:

1. Solute binding at one side of the membrane (substance-protein complex)
2. Change in carrier conformation (shape), allowing solute to pass
3. Release of solute on the opposite side of membrane

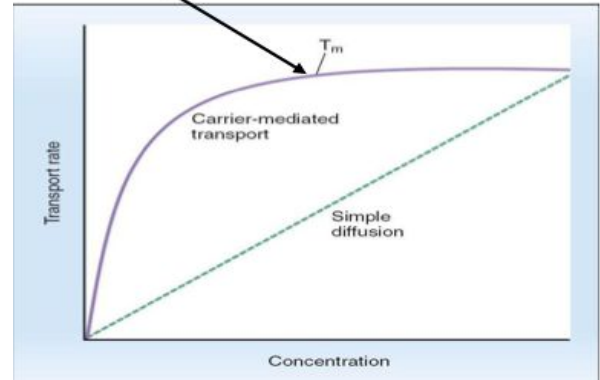
Substance → binding sites → substance-protein complex → conformational changes → release of substance



Passive transport: Comparison

Simple diffusion	Facilitated diffusion
<ul style="list-style-type: none">• Non carrier mediated transport.• The rate of diffusion increases proportionately with the concentration of the diffusing substance.	<ul style="list-style-type: none">• The rate of diffusion increases proportionately with the concentration of the diffusing substance until it reaches a transport maximum (T_{max}).• At T_{max}, an increase in the concentration of the diffusing substance does not increase the rate of diffusion.

T_m = transport maximum = the transport rate at which saturation occurs.



What limits maximum rate (V_{max}) of facilitated diffusion? Number of carriers

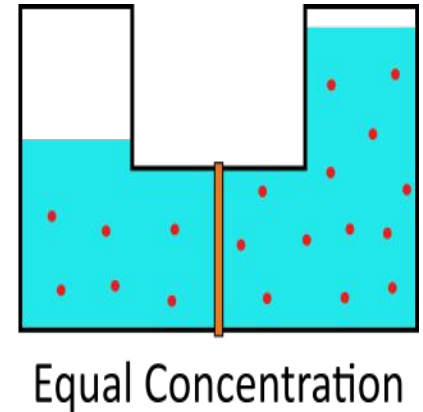
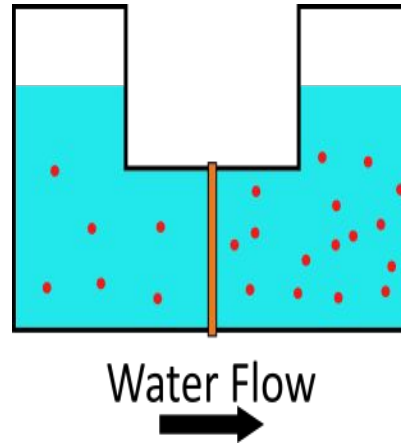
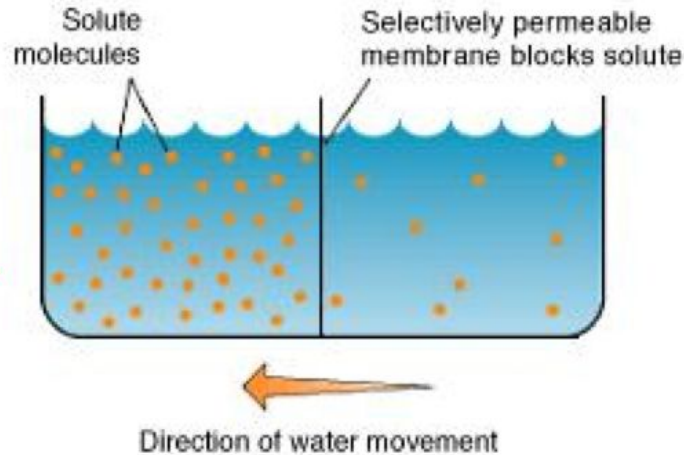
When does the facilitated diffusion reach (V_{max})?

The rate of diffusion reaches a maximum (V_{max}) when all the carriers are functioning as rapidly as possible

Passive transport: Osmosis

Definition:

- Net diffusion of water from a region of **high** water concentration to region of **low** water concentration. (It was explained in detailed in **body fluids and edema** teamwork presentation).



Active transport

Definition:

→ Transport (uphill) **against** electrochemical gradient, requires energy (direct or indirect source), as well as a carrier-protein.

Active Transport

Primary Active Transport (Direct energy- ATP)

Energy supplied **directly** from ATP.
 $\text{ATP} \rightarrow \text{ADP} + \text{P} + \text{energy}$.

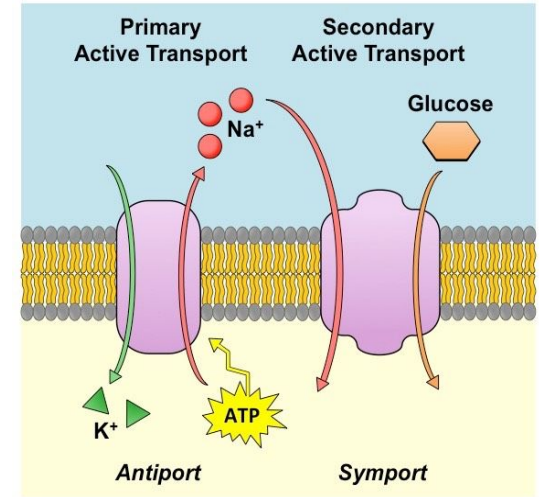
Examples:

- Sodium-Potassium Pump
- Calcium ATPase (Ca^{2+} ATPase)
- Hydrogen Ions H^{+} -K ATPase

Secondary Active Transport (Indirect energy)

Co-Transport

Countertransport



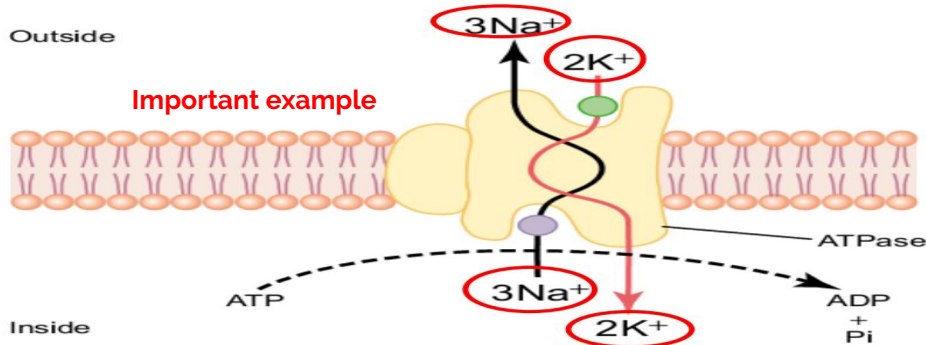
Primary Active Transport

A- Sodium-Potassium pump (Na-K pump):

1. Present in all cell membranes
2. 3 Na⁺ in → out
3. 2 K⁺ out → in

Function:

1. Maintaining Na⁺ and K⁺ concentration difference.
2. It's the basis of nerve signal transmission.
3. Maintaining -ve potential inside the cell
4. Maintains a normal cell volume.



Characteristics of Pump:

01	Carrier protein is formed from α and β subunits
02	Binding site for Na is inside the cell
03	Binding site for K is outside the cell
04	It has ATPase activity
05	3 Na out
06	2 K in

[Click](#) 🔍

Primary Active Transport

B- Primary active transport of calcium (Ca^{2+} ATPase).

Found in:

1. Sarcoplasmic reticulum (SR)
2. Mitochondria
3. Some cell membranes

Function:

→ Maintaining a **low** Ca^{2+} concentration inside the cell.

C- Primary active transport of hydrogen Ions H^+ -K ATPase.

Found in:

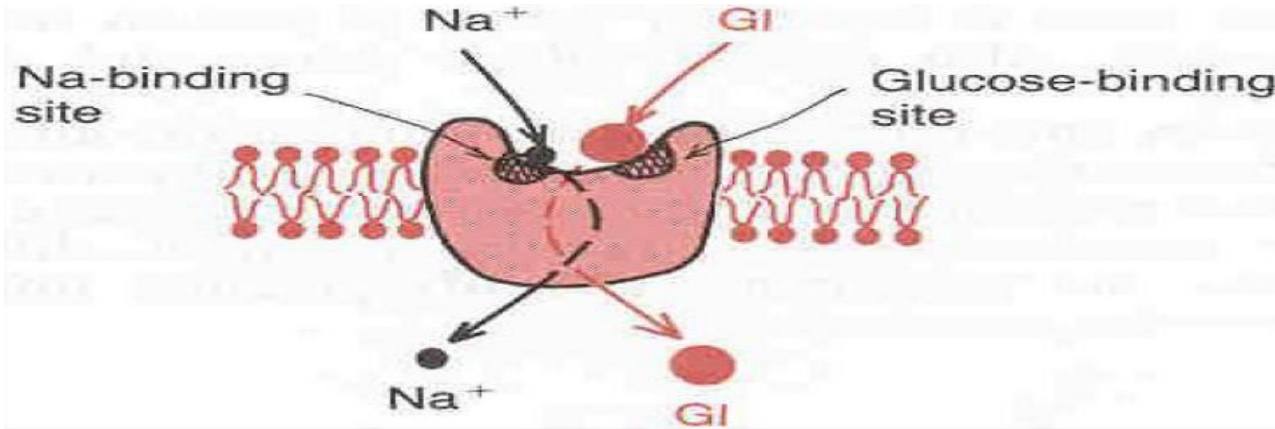
1. Stomach
2. Kidneys
3. Pump to the lumen
4. H^+ -K ATPase inhibitors (treat ulcer disease) (omeprazol= drug used)

(لما نوقف نقل الهيدروجين نقل حمضية المعدة الزائدة)

Secondary Active Transport

Definition

- It is the transport of one or more solutes **against** an electrochemical gradient, coupled to the transport of another solute **down** an electrochemical gradient.
 - Energy is supplied **indirectly** from primary transport
- "**downhill**" solute is Na (down the electrochemical gradient)
- "**uphill**" solute is Glucose (against the electrochemical gradient)



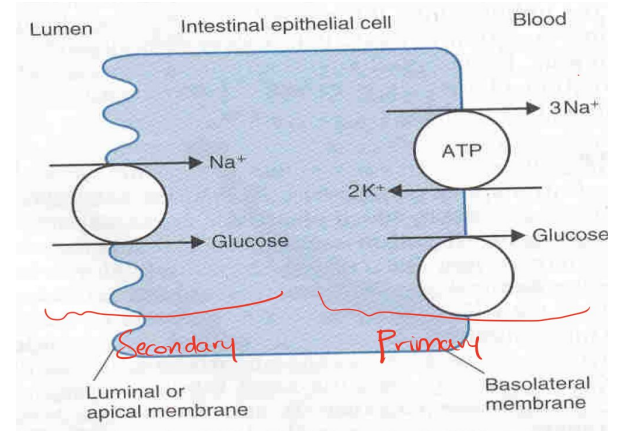
Secondary Active Transport

A) Co-transport:

- All solutes move in the **same direction** "inside cell".

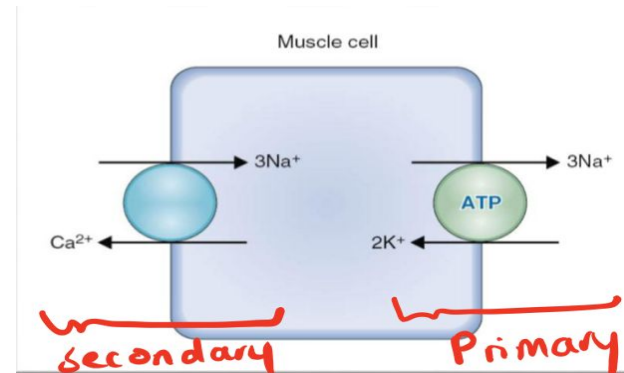
e.g.

1. Na^+ - glucose Co transport.
 2. Na^+ - amino acid Co transport.
- Found in: intestinal tract, kidney



B) Countertransport

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



QUIZ!

MCQs

Q1: Diffusion is Random movement of substance either through the membrane directly or in combination with carrier protein ____ an electrochemical gradient.

A) Against

B) Up

C) Down

D) None of the above

Q2: All solutes move in the same direction “ inside cell”.

A) Osmosis

B) Co transport

C) Countertransport

D) Passive transport

Q3: The binding site recognize a specific substance D-glucose but not L-glucose.

A) Competition

B) Saturation

C) Diffusion

D) Stereospecificity

Q4 : It's the basis of nerve signal transmission

A) Sodium-Potassium pump

B) Primary active transport of calcium

C) Primary active transport of hydrogen ions

D) Secondary Active transport

Q5: Water soluble (hydrophilic) substances ____ pass directly through the lipid bilayer

A) Can

B) Cannot

C) May

D) Both A and B

SAQ

Q1: What are the functions of peripheral proteins?

Q2: Where do we find Sodium-Potassium pump?

MCQs key answer :
(1) C
(2) B
(3) D
(4) A
(5) B

SAQ answer key :
(1) -Hormone receptors
(2) In all cell membranes

QUIZ!

MCQs

Q6: Increase membrane flexibility (fluidity of membrane) and stability

- | | | | |
|----------------|------------------|---------------|----------------|
| A) Glycolipids | B) Phospholipids | C) Glycocalyx | D) Cholesterol |
|----------------|------------------|---------------|----------------|

Q7: In the co-transport of glucose, which of the following travels downhill?

- | | | | |
|------------|-----------|--------|------------|
| A) Glucose | B) Sodium | C) A&B | D) Calcium |
|------------|-----------|--------|------------|

Q8: How many ATP's are required to activate Na-K pump?

- | | | | |
|------|------|---------|-----------|
| A) 1 | B) 2 | C) NONE | D) 1 NADH |
|------|------|---------|-----------|

Q9 : Which of the following is not a factor affecting the rate of simple diffusion?

- | | | | |
|--------------------------|-----------------|----------------|----------------------|
| A) Electrical difference | B) Surface area | C) Temperature | D) Stereospecificity |
|--------------------------|-----------------|----------------|----------------------|

Q10 : Carrier proteins are:

- | | | | |
|---|---|---|----------------------------------|
| A) Proteins attached to the surface of membrane | B) Proteins that function as enzymes and adhesion molecules | C) Proteins that selectively bind to small molecules and undergo a conformational change to release the molecule on opposite side | D) Proteins made up of a bilayer |
|---|---|---|----------------------------------|

MCQs key answer :
D (6)
B (7)
A (8)
D (9)
C (10)

Thank You

Team members:

- ▶ ماجد العسكر
- ▶ مشعل الثنيان
- ▶ **عبد العزيز الربيعه**
- ▶ باسل فقيها
- ▶ محمد بيارى
- ▶ محمد السلطان
- ▶ عبد الرحمن الدويش
- ▶ مرشد الحربي
- ▶ منيب الخطيب
- ▶ نايف الشهري
- ▶ فيصل العمري
- ▶ عبد العزيز الغليقة
- ▶ عبد العزيز السحيم

- ▶ حصة العليان
- ▶ شذى الظهير
- ▶ سمو الزير
- ▶ نورة الشثري
- ▶ سارة القحطاني
- ▶ ريناد الحميدي
- ▶ ياسمين القرني
- ▶ يارا الزهراني
- ▶ لمى الأحمدى
- ▶ ألاء السلمي
- ▶ سارة العيدروس
- ▶ بدور المبارك
- ▶ فرح البكر
- ▶ **سارة العبيد**



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