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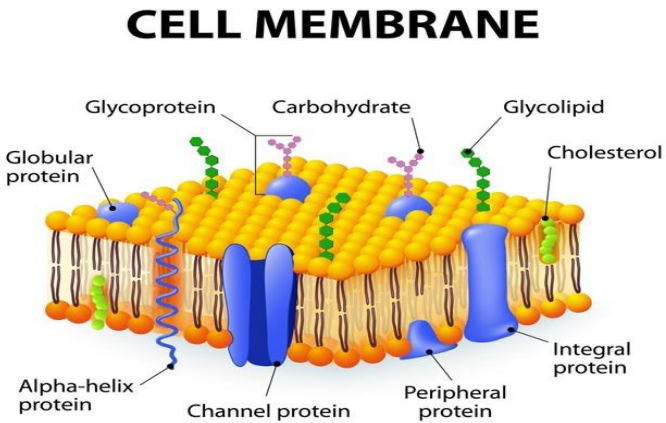
Cell Membrane structure and Transport across cell membrane

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, facilities diffusion, simple diffusion, osmosis
- Differentiate between passive and active transport mechanisms and give examples on each.

Characteristics Cell membrane

- It covers the cell
- Thin pliable and elastic 7-10nanometer
- It is a fluid and not solid
- Refer to as the Plasma membrane



Composition of cell membrane

Protein 55%

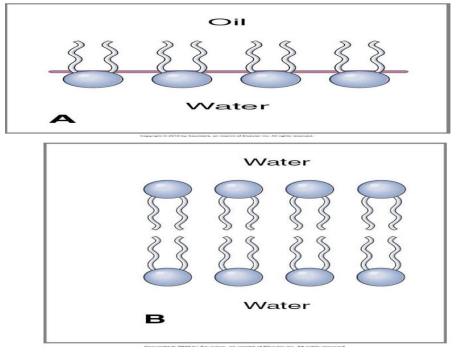
Lipid 42% :
•Phospholipids 25%
•cholesterol 13%
•Glycolipid 4%

Carbohydrates 3%

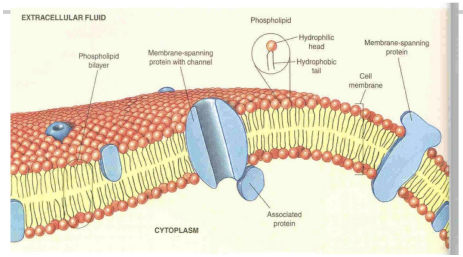
The Cell membrane phospholipids Consist of:

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
- It is called **Amphipathic**



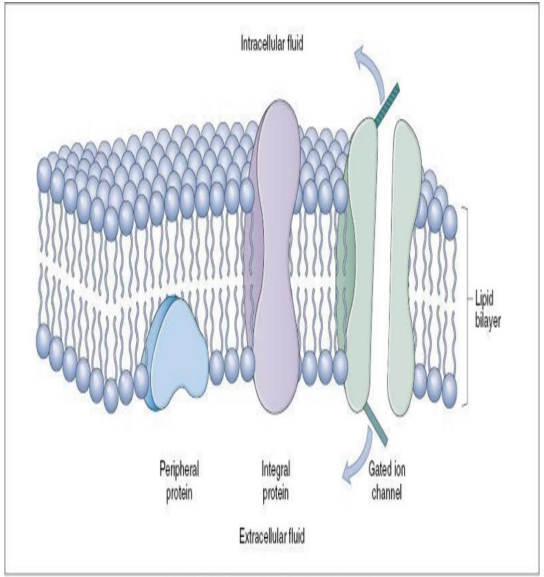
The cell membrane of Proteins:

1- integral proteins : “ Carrier protein “

- span the whole thickness of the membrane
- proteins provide structural channel or pores

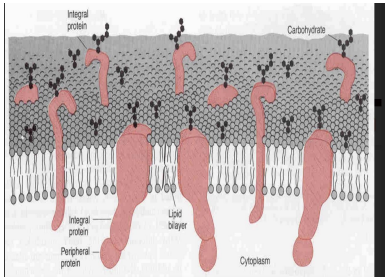
2- Peripheral proteins : “ Carrier proteins”

- Present in on side
- Hormone receptors
- cell surface antigens



The Cell membrane of carbohydrates:

- Glycoproteins : “ most of it “
- Glycolipids
- Proteoglycans : mainly carbohydrates 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 in to immune reactions
- Give most of cells overall -ve surface

Transport Through the cell Membrane:

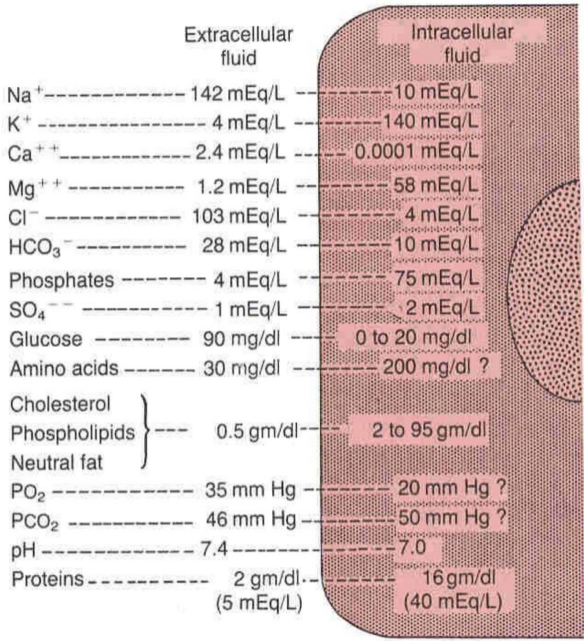
- Cell membrane is selectively permeable
- Through the proteins " water" soluble substances e.g. ions , glucose
- Directly through the bilayer " fat" soluble substances e.g. , O2, CO2 , OH

Types of membrane transport:

1- Diffusion:
- Simple diffusion
- Facilitated diffusion

2- Active transport
- Primary active transport
- Secondary active transport

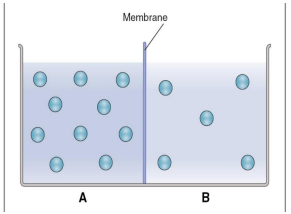
3-Osmosis



What is the diffusion?:

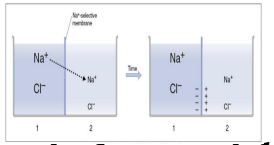
- It is Random movement of substance either through the membrane directly or in combination with carrier protein down an electrochemical gradient

1- Simple diffusion:

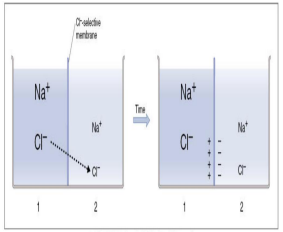


- Non Carrier mediated transport down an electrochemical gradient

- Diffusion of nonelectrolytes " uncharged " from high concentration to low concentration



- Diffusion of electrolytes "charged " depend on both chemical as will as electrical potential difference



Rate of simple diffusion depend on:

1- Amount of substance available

2- The number of opening in the cell membrane for the substance
"selective" ,gating system

3-Chemicals concentration difference net diffusion = P x A(C1-C2)

شرح الرموز فقط

P = permeability coefficient , " temperature, solubility in lipids , size of molecule , thickness of membrane "
A = surface area
C1-C2= gradient difference
" concentration difference , electrical difference, pressure difference "

4- electrical potential difference

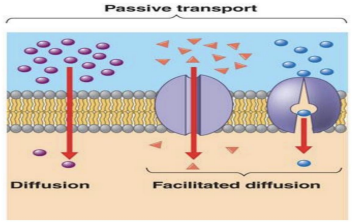
5-molecular size of the substance

6-lipid solubility

7-temperature

Facilitated Diffusion:

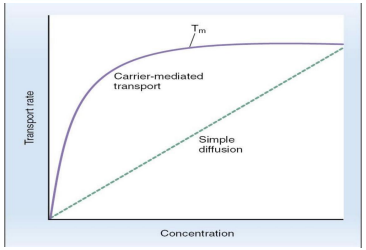
- it is a **carrier mediated** transport **down** an electrochemical gradient



Features of carrier mediated transport:

1-Saturation:

increases concentration ——> increase binding of protein
If all protein is occupied we achieve **full saturation**



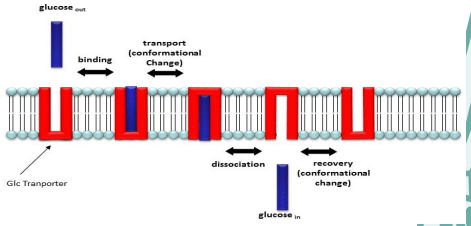
Facilitated Diffusion of Glucose

2-Stereospecificity:

The binding site recognize a specific substance **D-glucose** but <u>not</u> L-glucose

3-Competition :

Chemically similar substance can compete for the same binding site



Substance—> binding site —> substance protein—>complex —> conformational changes release of substance

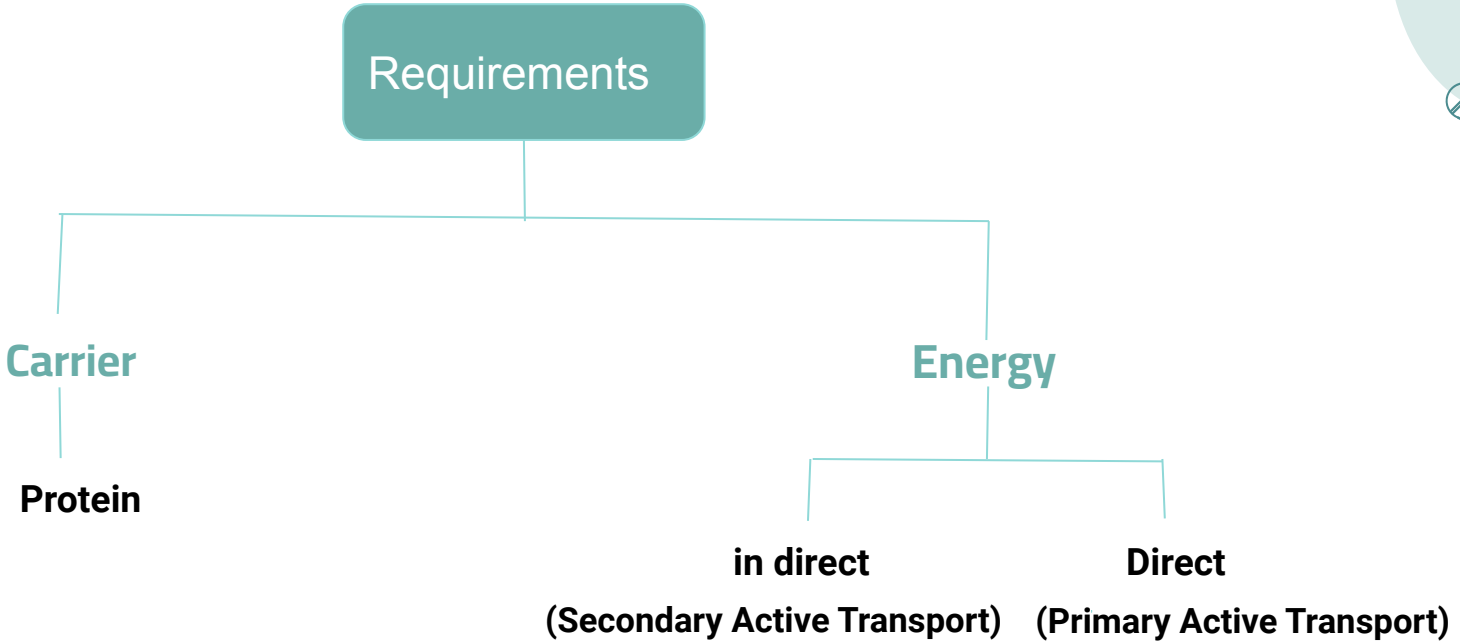
Glucose most of amino acids

Active Transport

It's Transport (uphill) against electrochemical gradient

Active Transport

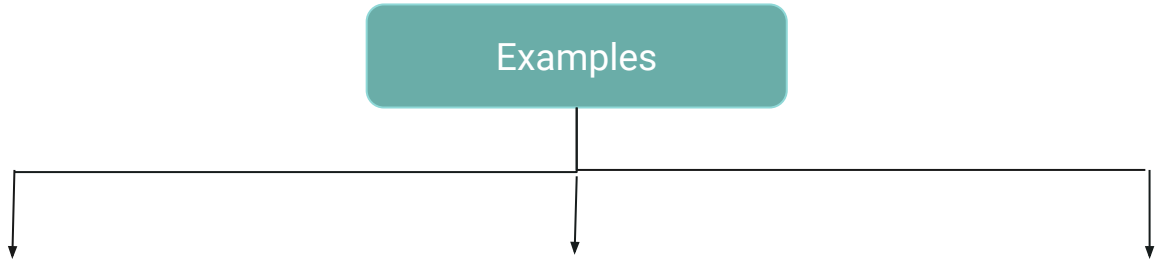
It’s Transport (uphill) against electrochemical gradient



Primary Active Transport

Energy is supplied directly from ATP.

ATP → ADP + P + energy.



hydrogen ions
H+-K+ ATPase.

calcium
(Ca ++ ATPase).

Sodium-Potassium pump
(Na+- K+ pump)

Primary Active Transport

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

- it's present in all cell membranes.
- 3 Na+ in → out.
- 2 K+ out → in.

Characteristic of Na+/K+-ATPase Pump:

1. **Carrier protein is formed from α and β Subunits.**
2. **Binding site for Na inside the cell.**
3. **Binding site for K outside the cell.**
4. **It has ATPase activity.**
5. **3 Na out.**
6. **2 K in.**

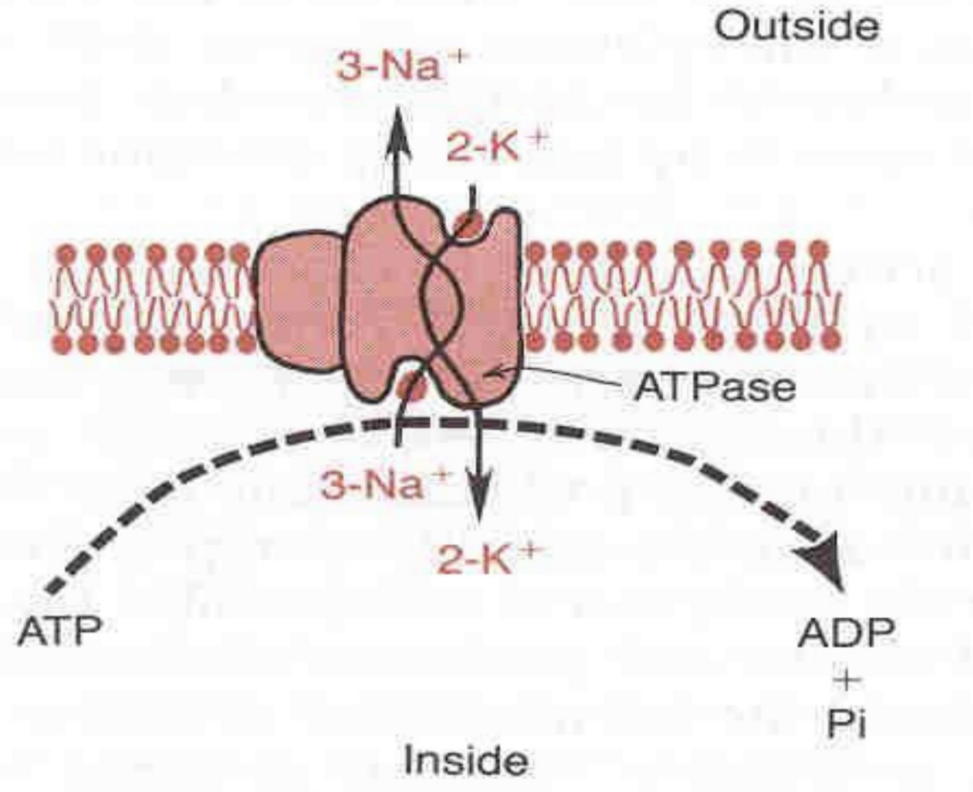
Function of Na+/K+-ATPase Pump:

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

Note:the negative charge inside the cell more than outside

Primary Active Transport

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



Primary Active Transport

B. primary active transport of calcium (Ca ++ ATPase)

Exists in:

- **sarcoplasmic reticulum (SR).**
- **mitochondria.**
- **in some cell membranes.**

Function of calcium (Ca ++ ATPase):

- **Maintaining a low $Ca^{2}+$ concentration inside the Cell**

Primary Active Transport

C. primary active transport of hydrogen ions H+-K+ ATPase.

Exists in:

- **stomach**.
- **kidney**

- pump to the lumen. ⟶

يعمل على اخراج الهيدروجين الى برا وادخال البوتاسيوم ، وينتج عند اخراج الهيدروجين ضخه في تجويف المعدة مما يسبب زيادة الهيدروجين وزيادة الحموضة بالتالي الاصابة بقرحة المعدة

H+-K+ ATPase inhibitors:

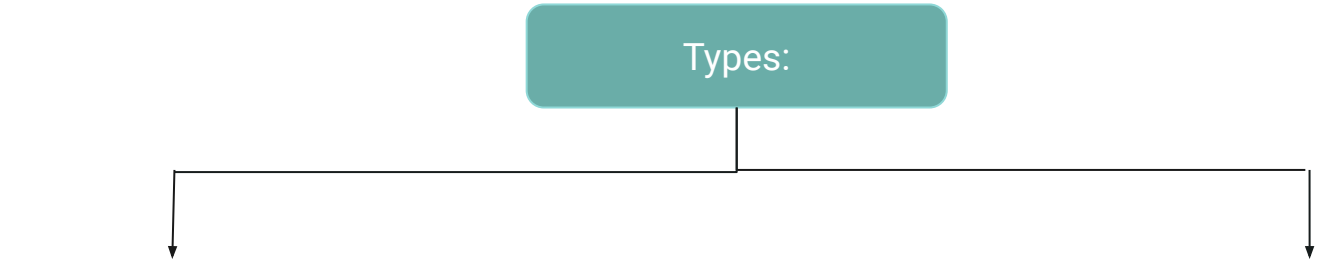
are used to treat ulcers

e.g. for an inhibitor (omeprazole).

Secondary Active Transport

Energy is supplied indirectly from Primary Active Transport

- it's transport of one or more solutes against an electrochemical gradient, coupled with the transport of another solute down an electrochemical gradient.



Note: (Counter) means against each other

Note: (Co) means together

Secondary Active Transport

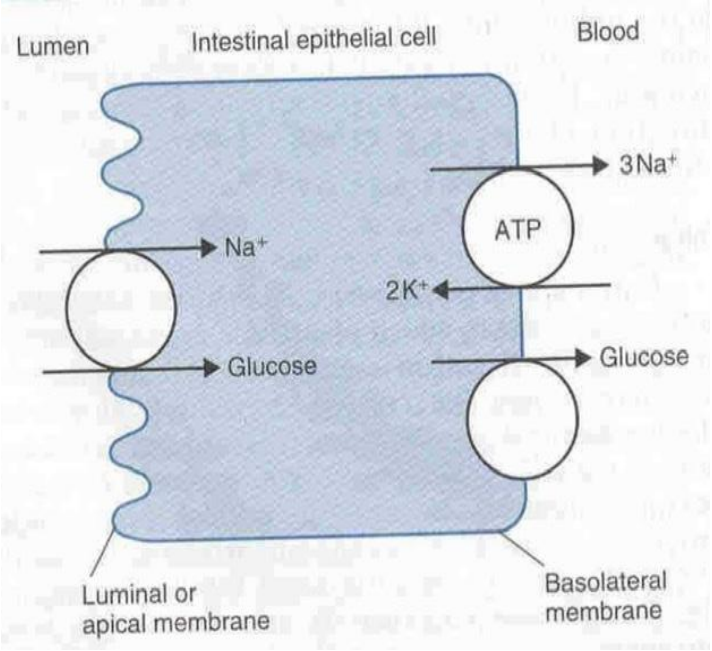
1-Co-transport:

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

-present in the intestinal tract & kidneys.

e.g.
Na+- glucose Co-transport.
Na+- amino acid Co-transport.

-"downhill" solute is Na+



Secondary Active Transport

2-Counter-transport:

- solutes move in against direction " one inside ,one outside cell". —> اتجاهات مختلفة واحد يطلع وواحد يدخل

Na+ is moving to the interior of the cell

causing other substance to move out.

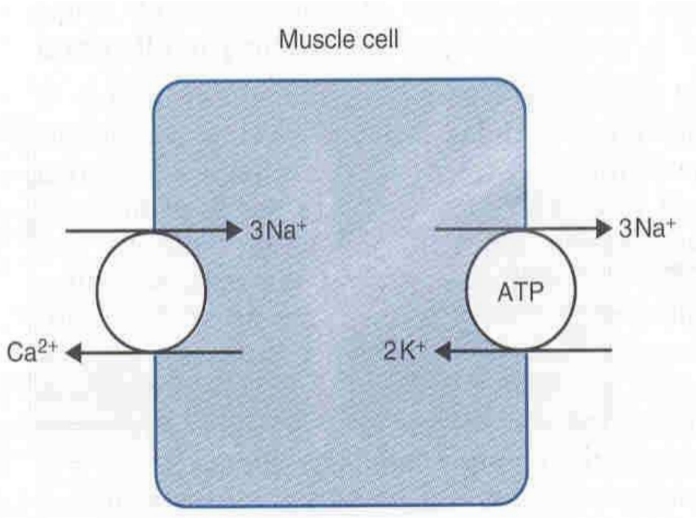
دخول الصوديوم داخل الخلية مع اتجاه التركيز و خروج مواد اخرى لخارج الخلية على عكس التركيز

e.g

-Ca++ - Na+ exchange.

(present in many cell membranes of (muscle cell))

-Na+- H+ exchange in the kidney



Osmosis

Net diffusion of water from a region of high water concentration to region of low water concentration.

Types:

Hypertonic Solution

Net movement of water out of cells

Isotonic Solution

Equal movement of water into and out of cells

Hypotonic Solution

Net movement of water into cells

Osmosis

Osmotic equilibrium is maintained between intracellular and extracellular fluids:

- Small changes in concentration of solutes in the extracellular fluid can cause tremendous change in cell volume.

Intracellular osmolarity = extracellular osmolarity .

- ≈ 300 mosm/L

This is just in girls slides

If environment is:

Hypertonic

- **MORE SOLUTES outside cell**
- **MORE WATER IN CELL**
- **over time, cell loses water**

Hypertonic solution :

- (shrink) more than 0.9%
- out is higher than in

Isotonic

- **same**
- **No change in cell volume**

Isotonic solution :

- (not swell or shrink)
-0.9% solution of sodium chloride or 5% glucose .
- same in and out .

Hypotonic

- **LESS SOLUTES outside cell**
- **LESS WATER IN CELL, more solutes in cell.**
- **over time, cell gains water**

Hypotonic solution :

- (swelling) less than 0.9%
- in is higher than out

This is just in girls slides

MCQ's

Test yourself !

Q1	Which one is classified a hormone receptor:?			
	A: peripheral protein	B: integral protein	C: osmosis	D: all of the above
Q2	What are the soluble substances through protein:?			
	A: O2	B: CO2	C: OH	D: glucose

Q3	Phospholipids are considered:			
	A : hydrophobic	B: Amphipathic	C: hydrophilic	D: none of them

1- A
2- D
3- B

MCQ's

Test yourself !

Q4	H+ __ K ATPase pump Can found in ?			
	A) Both B&C	B) Kidneys	C)Stomach	D) mitochondria

Q5	In Na+/K+-pump, the binding site for Na+ is ..... the cell			
	A) doesn't exist	B) between	C)outside	D) inside

Q6	All solutes move in the same direction '' inside cell''.			
	A) Osmosis	B) Co transport	C) Countertransport	D) Passive transport

4-A
5-D
6-B

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- Omar Alattas
- Khalid Alkanhal
- Nasser Alabdusalam
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