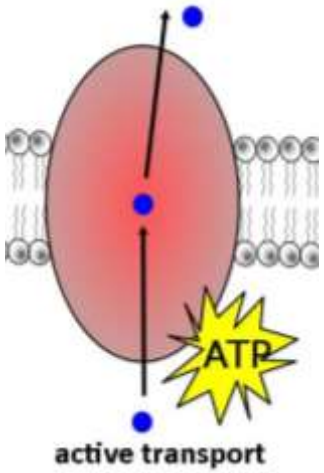
DIFFUSION + ACTIVE TRANSPORT

Transport mechanism : get to the cell membrane or out of the cell membrane according to the energy requirement (kinetic energy)

Kinetic energy : energy obsessed by a subject due to motion

The diffusion occurs as a result of constant motions of particles out and inside the cell



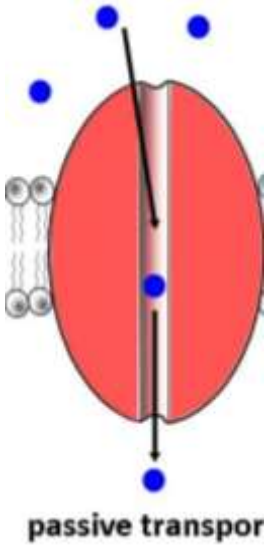
active transport

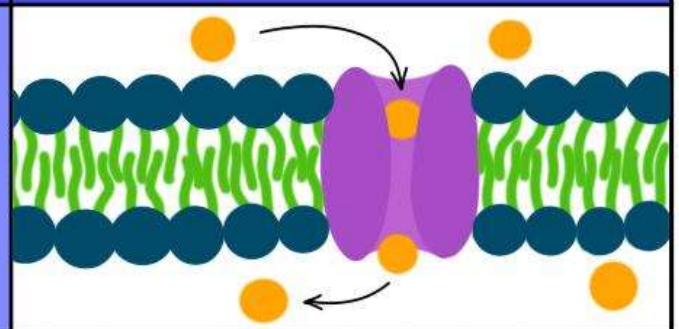
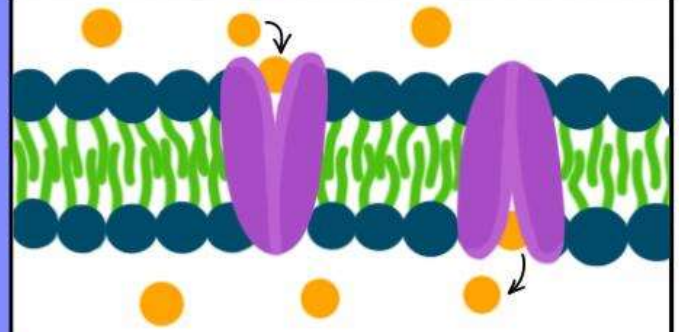
Active transport : kind of transport requires energy (against concentration gradients)(low to high)

1)Primary transport
2) Secondary transport
3)Bulk flow (kind of transport of a large quantity of molecules in or out of the cell)

Passive transport : kind of transport does not require energy (flow of molecules high concentration to low concentration)

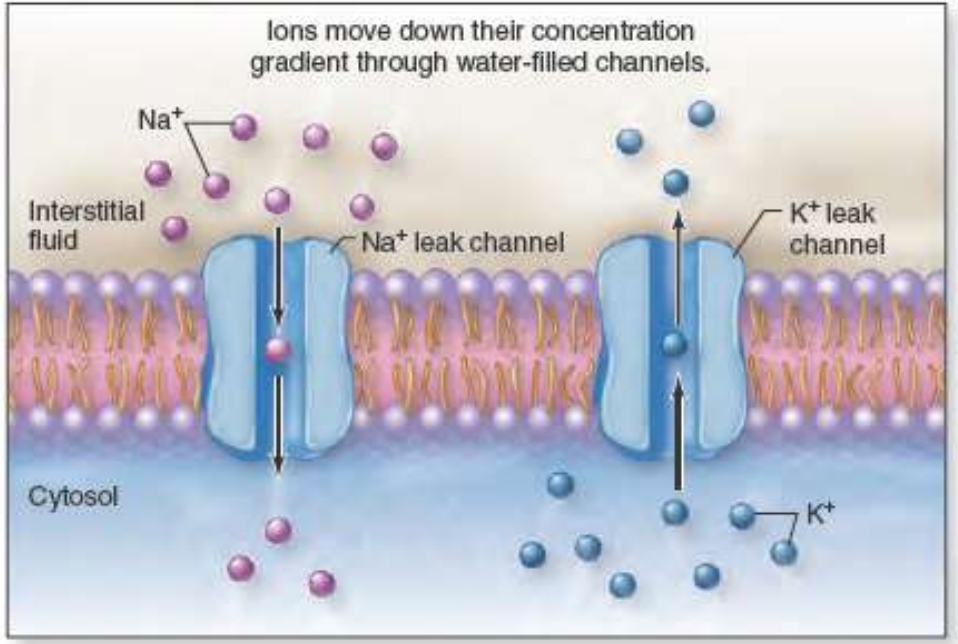
1) Simple diffusion
2) Facilitated diffusion
3) Osmosis
4) Filtration (urinary system)


passive transpor

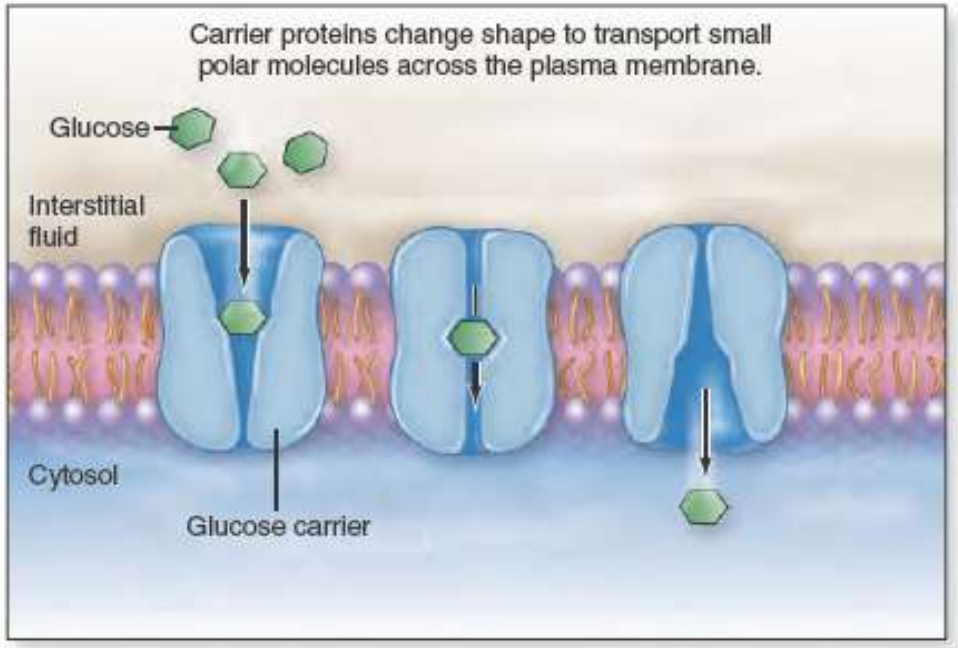
Type of Protein	Description	Structure
Channel protein	Opening in center, can be gated	
Carrier protein	Changes its shape to allow molecules to pass through	

Attention : carrier protein include facilitated diffusion and primary active transport and secondary active transport ….. Small polar molecules

Attention : channel protein include facilitated diffusion ……. Ions and small water soluble compounds



(a) Channel-mediated diffusion



(b) Carrier-mediated diffusion

1) Passive transport :

Cytoplasm, extracellular fluid and cell membrane vary in concentrations and pressure gradients.

There is difference in the concentration of the substance between 2 compartments (cytoplasm and extracellular fluid) and that's create concentration and pressure gradients

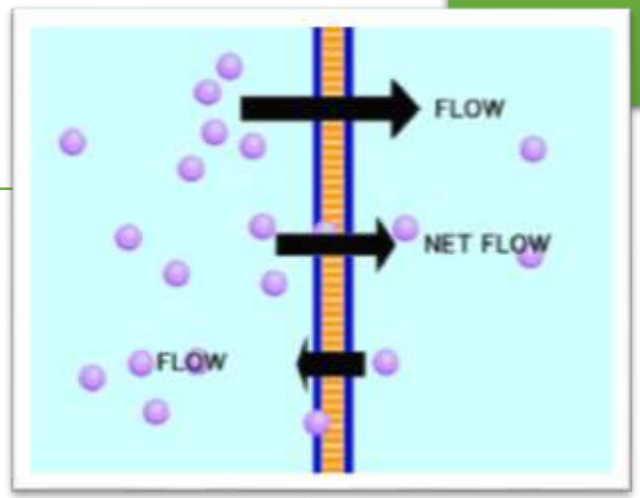
1) What makes the fluid moves in the human body ? The fluid moves because of pressure difference as a result of concentration difference of the solute
2) Concentration gradients : difference of the concentration of the fluids or solutes between 2 medium

Concentration refers to the overall POPULATION of molecules as well as the RATIO in that location compared to another.

Constant movement of substance between 2 compartment

There is a balance between inside and outside the cell, but this does not mean that the values or quantities are equal inside and outside the cell because that depends on the cell's need for example, the water inside the cell may be more than its outside, but it is in a state of equilibrium and this maintains the continuous movement between two compartment

Net Movement



DYNAMIC EQUILIBRIUM

Simple Diffusion

Tendency of molecules of any substance to spread out into the available space. Substances will diffuse down their concentration gradient.

1) The on form of transport that does not carrier mediator
2) Include transport of solute molecules
3) Downhill (high to low)
4) Does not require ATP

Osmosis

The diffusion of water molecules across a selectively permeable membrane.

Hypertonic = solution with higher [conc.] of solutes

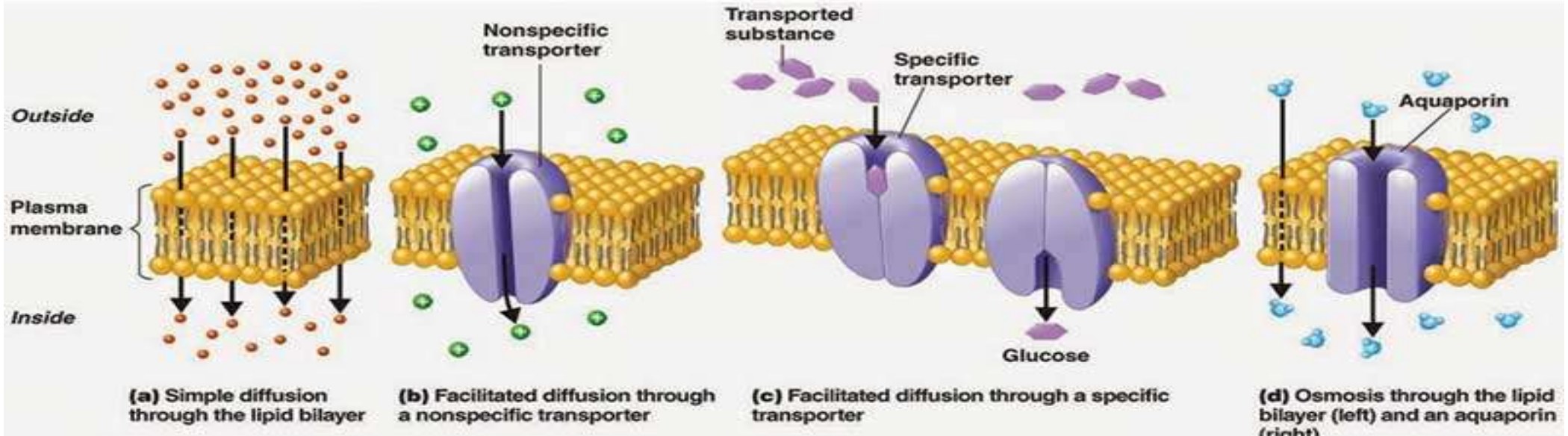
Hypotonic = solution with lower [conc.] of solutes

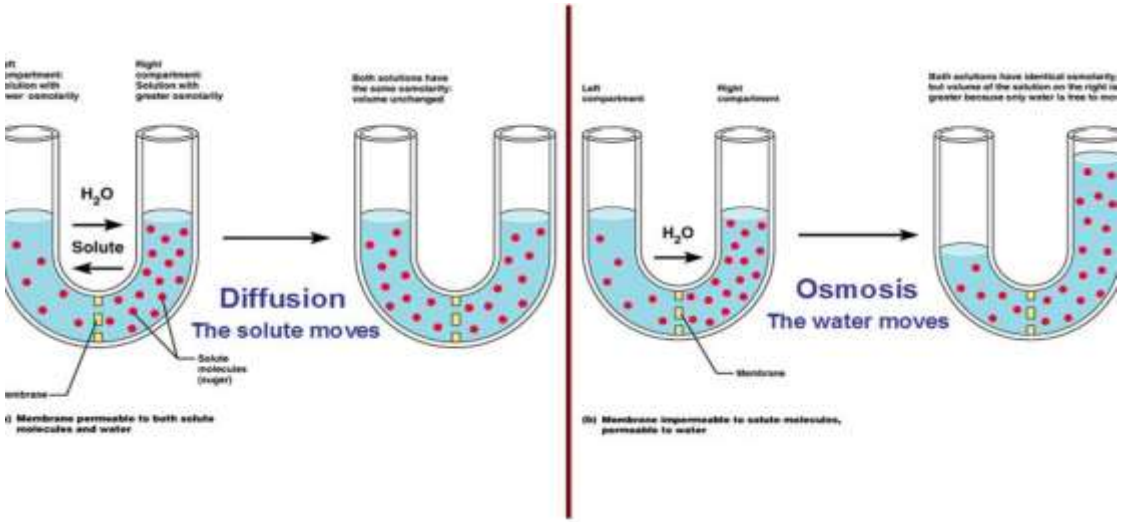
Isotonic = solutions are equal in solute concentration

Facilitative Diffusion

-Transport proteins are helping molecules to cross membrane, but still diffusion (lowering overall free energy) thus doesn't require energy from cell

1) Down hill
2) No ATP
3) Carrier mediator or channel protein
4) Like glucose transport





Osmosis *vs.* Diffusion

Solvent particles migrate across a **semipermeable membrane**.

Solute particles **do not** move across.

Solution concentrations equalized

Solvent/solute particles migrate, concentrations are equalized.

Semipermeable membranes are neither involved nor required.

Factors that Influence Diffusion Rates

- Distance -
  - The shorter the distance, the more quickly [ ] gradients are eliminated
  - Few cells are father than 125 microns from a blood vessel
- Molecular Size
  - Ions and small molecules diffuse more rapidly
- Temperature -
  - ↑ temp., ↑ motion of particles
- Steepness of concentrated gradient -
  - The larger the [ ] gradient, the faster diffusion proceeds
- Membrane surface area -
  - The larger the area, the faster diffusion proceed

FACTORS AFFECTING NET RATE OF DIFFUSION

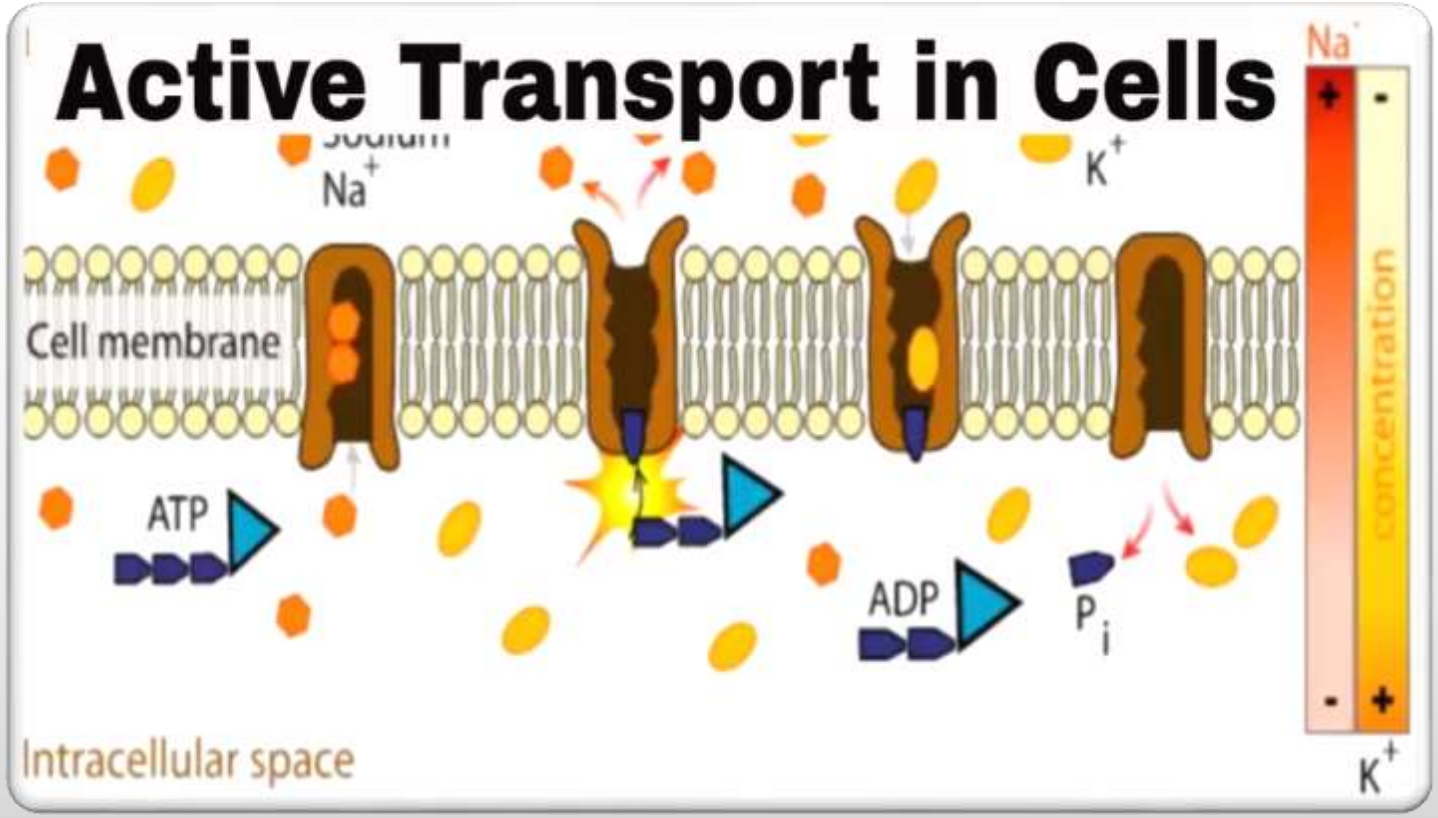
FICK'S LAW OF DIFFUSION:

$$J = -\frac{DA \times (C1-C2)}{T}$$ at particular temperature.

D = Diffusion coefficient.
A = Surface area.
C1&C2 = Concentrations on either sides.

Diffusion Across Membranes

- **Simple Diffusion**
  - Lipophilic substances can enter cells easily because they diffuse through the lipid portion of the membrane
    - Examples are fatty acids, steroids, alcohol, oxygen, carbon dioxide, and urea,
- **Channel-Mediated Diffusion**
  - Membrane channels are transmembrane proteins
  - Used by ions, very small water-soluble compounds
  - Much more complex than simple diffusion



2) ACTIVE TRANSPORT :

- ACTIE TRANSPORT IS THE TRANSPORT OF SUBSTANCES FROM A REGION OF LOWER CONCENTRATION TO HIGHER CONCENTRATION USING ENERGY :
  - DIRECT ENERGY (ATP) LIKE IN PRIMARY ACTIVE TRANSPORT
  - INDIRECT ENERGY LIKE IN SECONDARY ACTIVE TRANSPORT
- EXAMPLES : SODIUM – POTASSIUM PUMP …. CALCIUM PUMP …. POTASSIUM-HYDROGEN PUMP

- Active transport involves the use of carrier proteins, like those of facilitated diffusion, but these carrier proteins act as pumps, using the energy from splitting ATP to pump specific molecules against the concentration gradient

Cell cannot rely solely on passive movement of substances across their membrane

In many substances it is necessary to move substances against their electrical or chemical gradient to maintain the appropriate concentrations inside of the cell or organelle

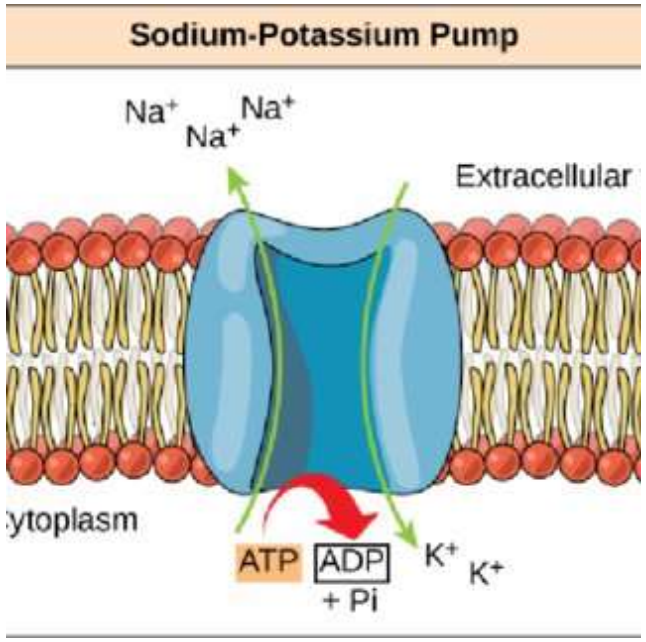
Pumps involved in active transport :

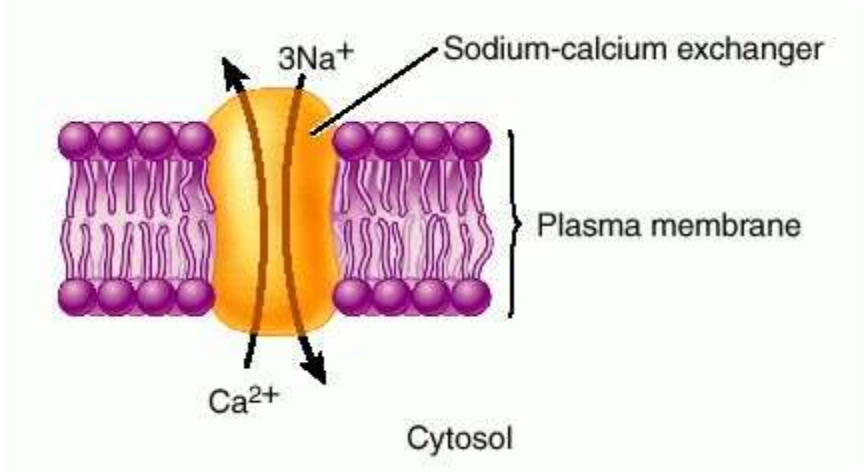
why cell should be more negatively inside from out side ?
Because it is important in actin potential transmission – polarization and depolarization

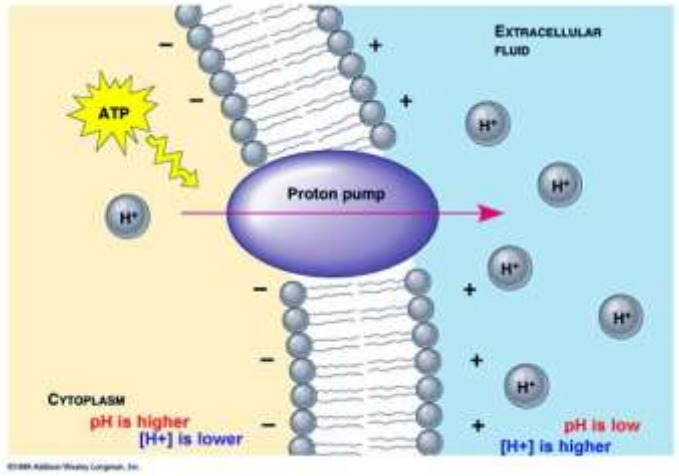
Na-K pump :It is a kind of pump found in many cell of human body that keeps negativity inside the cell by out flow f 3 Na ions and inside flow of 2 K ions

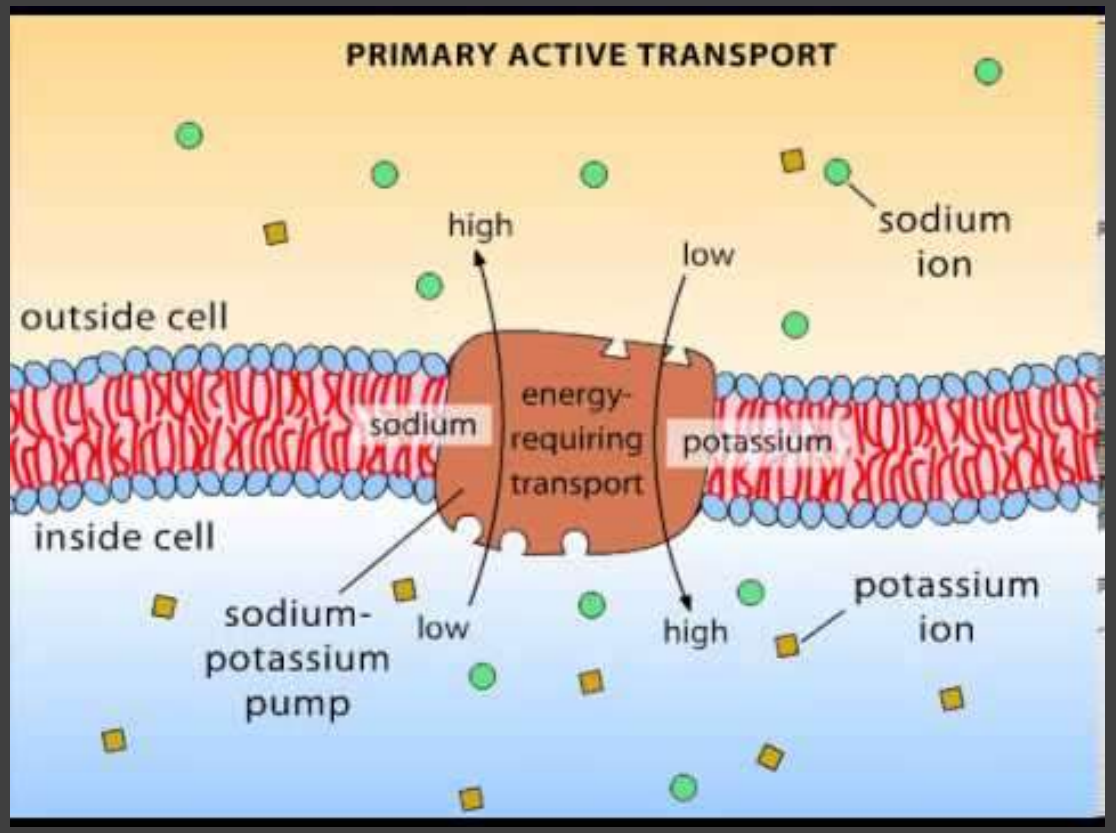
Calcium pump: found in membrane of sarcoplasmic reticulum (contraction and relaxation)

Potassium – hydrogen pump : found in gastrointestinal cell membrane









Primary active transport is the transport of substances uphill using energy (ATP hydrolysis)

It cause a conformational change that results in the transport of the molecule through the protein.

Eg. Na+-K+ pump.

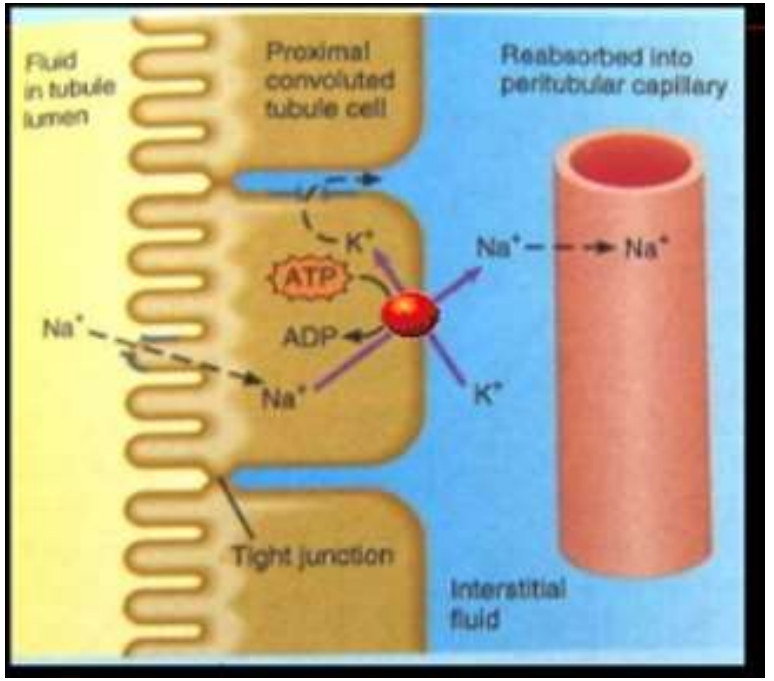
Primary active transport

- **Uphill (against concentration gradients)**
- **Requires direct energy (ATP)**
- **Is carrier mediator**

Functions of Na+K pump

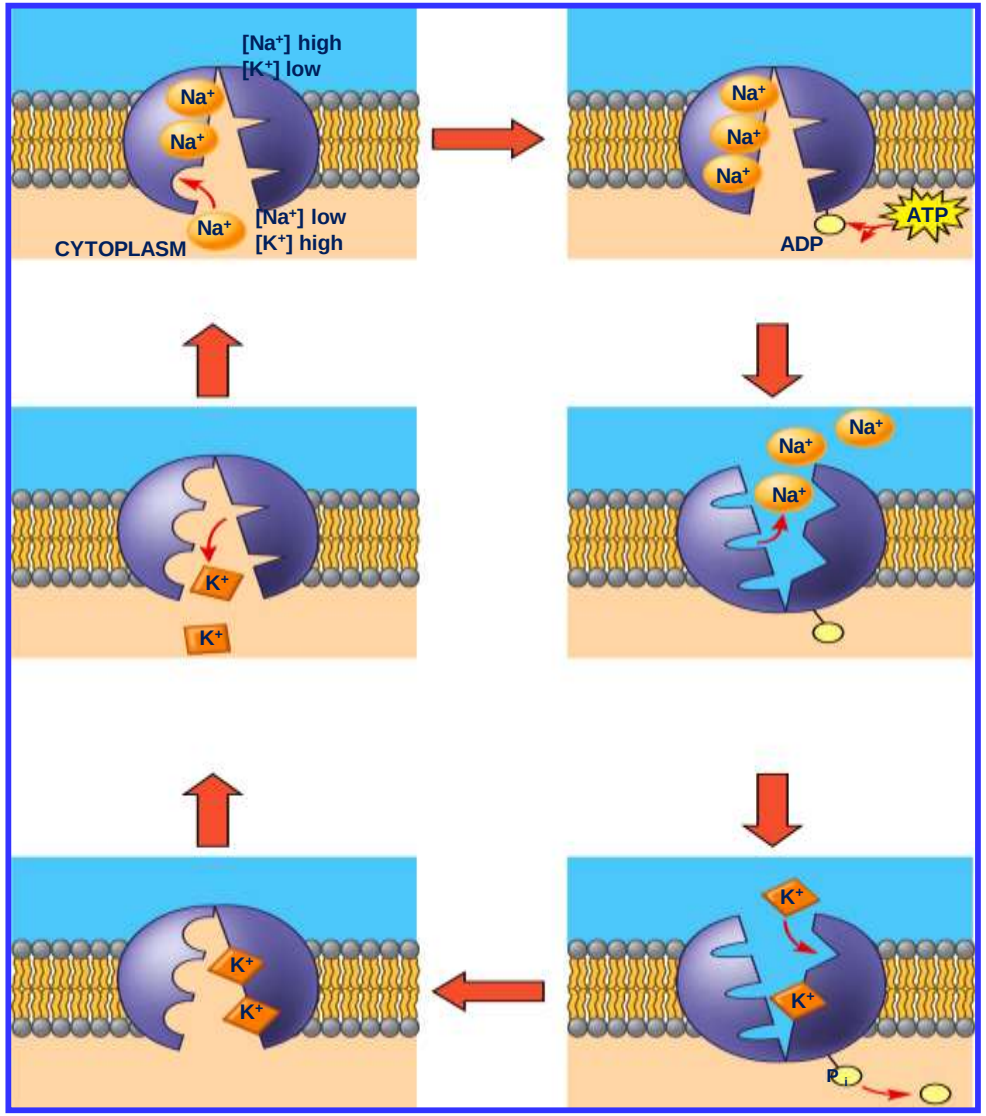
1. It is responsible for maintaining the high K+ and low Na+ concentration inside the cell.
2. It maintains intracellular negativity.
3. Maintains cell volume.
4. Activate the Carrier protein.

That is, it maintains the equilibrium of the amount of solute to the water (solute concentration).



The Sodium-potassium Pump

1. Cytoplasmic Na^+ binds to the sodium-potassium pump.



2. Na+ binding stimulates phosphorylation by ATP.

3. Phosphorylation causes the protein to change its conformation, expelling Na^+ to the outside.

4. Extracellular K^+ binds to the protein, triggering release of the Phosphate group.

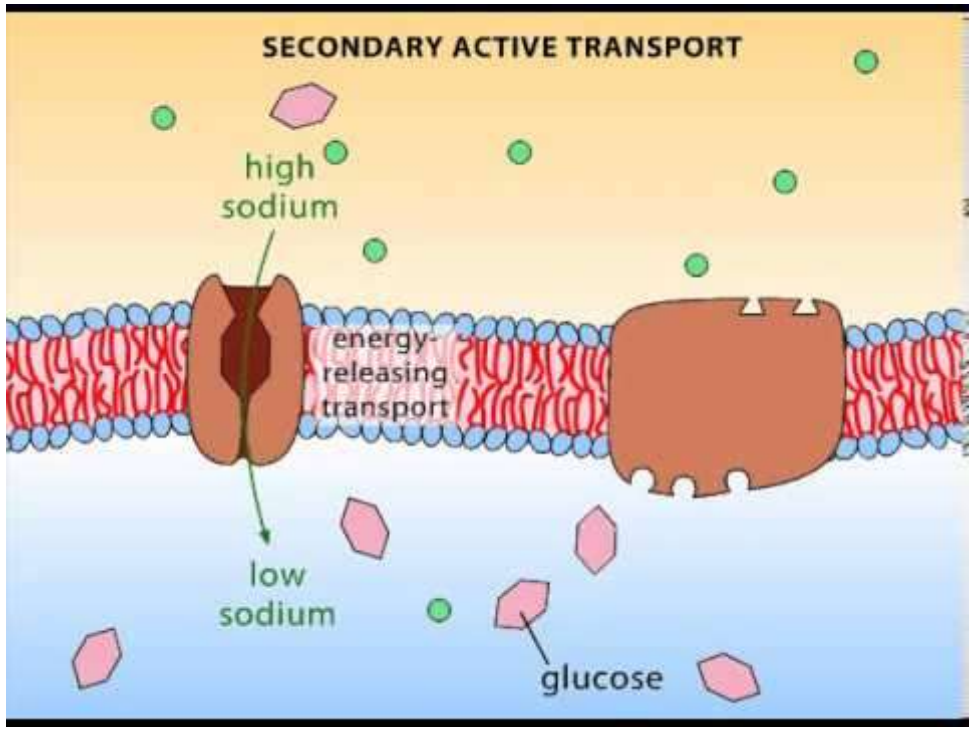
5. Loss of the phosphate restores the protein's original conformation.

6. K^+ is released and Na^+ sites are receptive again;
the cycle repeats.

Secondary active transport

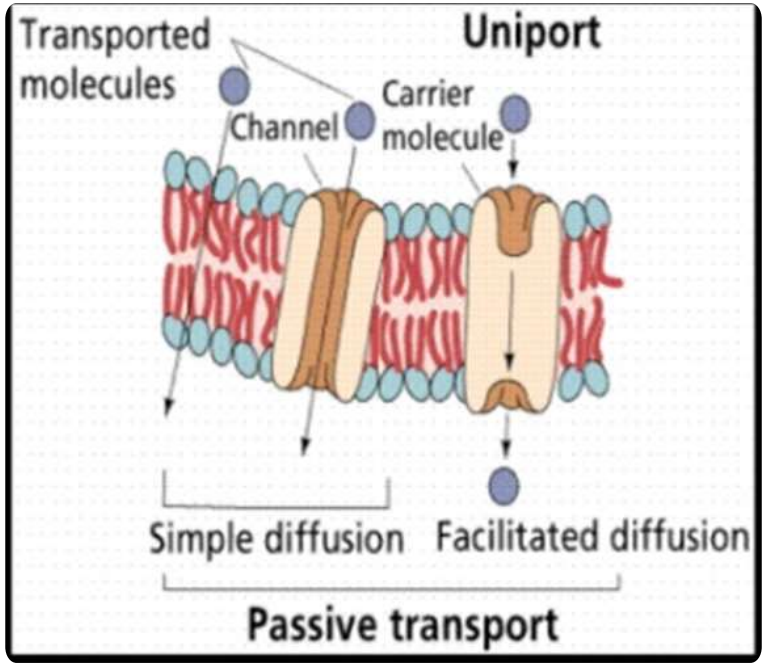
- The transport of substances against a concentration gradient involving energy to establish a gradient across the cell membrane, utilizes the gradient to transport a molecule of interest up its concentration gradient .

- THE TRANSPORT MAY BE
- In the same direction (SYMPORT)
- In the opposite direction (ANTIPORT)



- The transport of 2 or more solute is coupled
- One of the solutes (usually Na) is transported down hill and provides energy for the uphill transport of the other solute
- Energy is provided indirectly from the Na gradient that maintained across the cell membrane

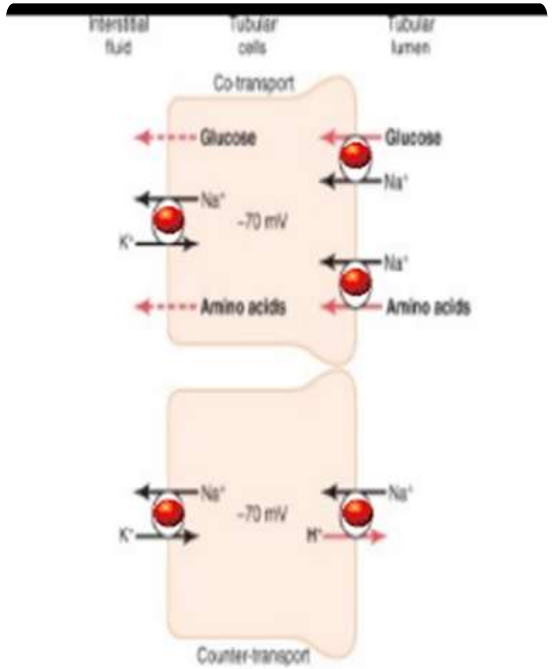
Uniport

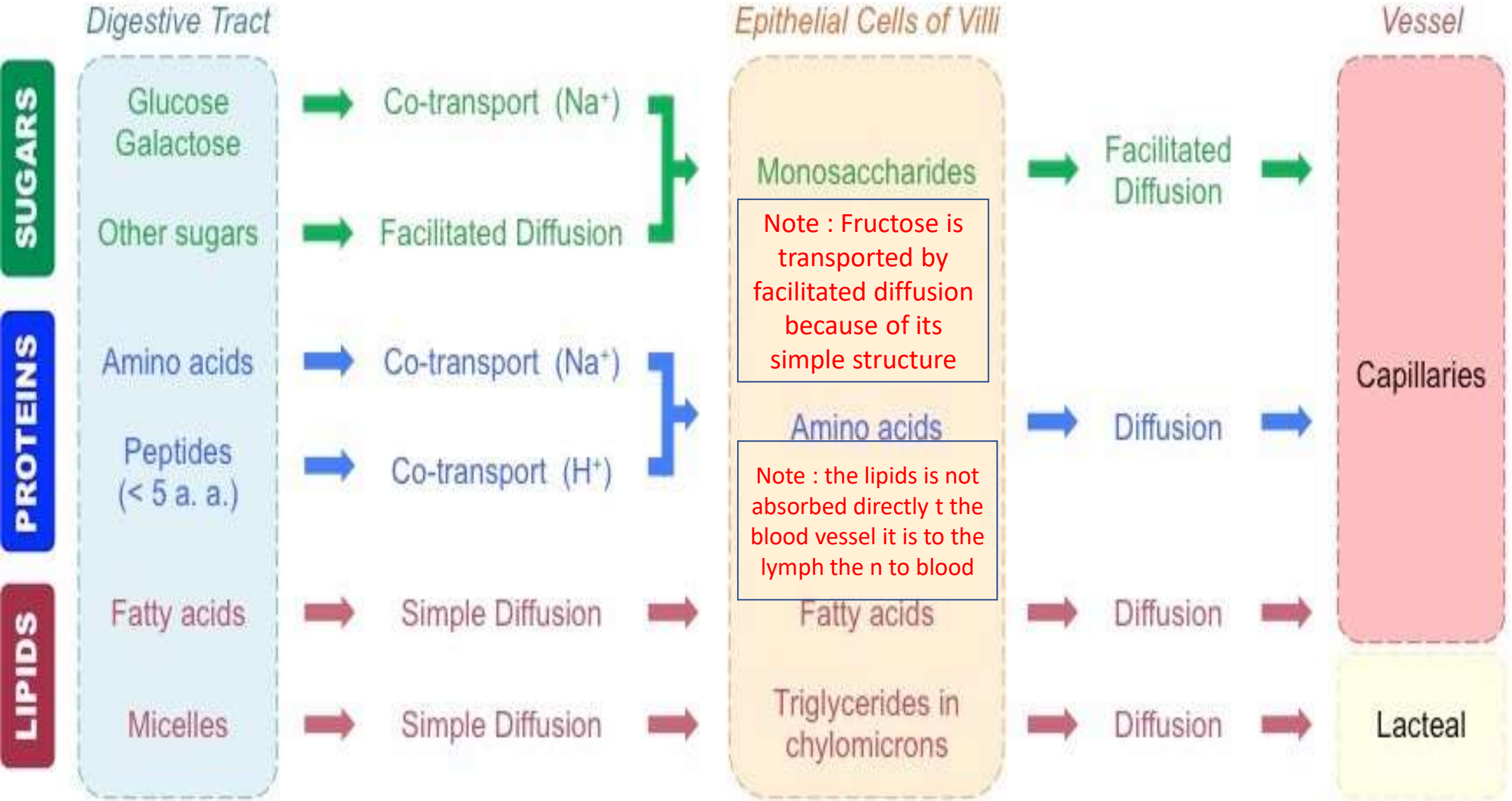


- **The movement of a single Substance.**
- **It requires no energy from the cell.**
- **Examples.**
  - **Simple diffusion.**
  - **Facilitated diffusion.**

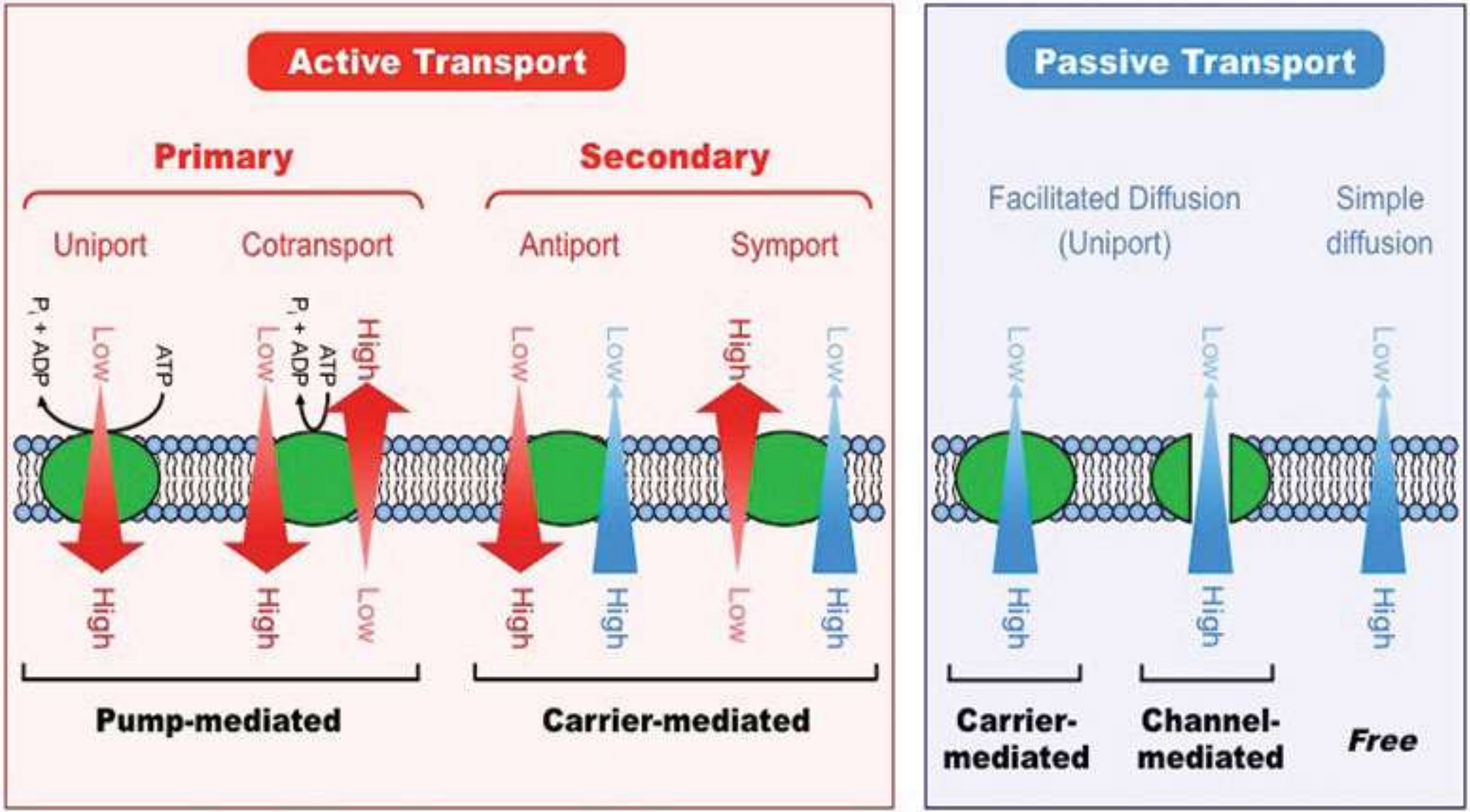
Symport (Co-transport)

- Transport of two substances using the energy produced by concentration difference developed by primary active transport
- Substances are moving in the same direction.
- Example: transport of amino acids, Glucose,



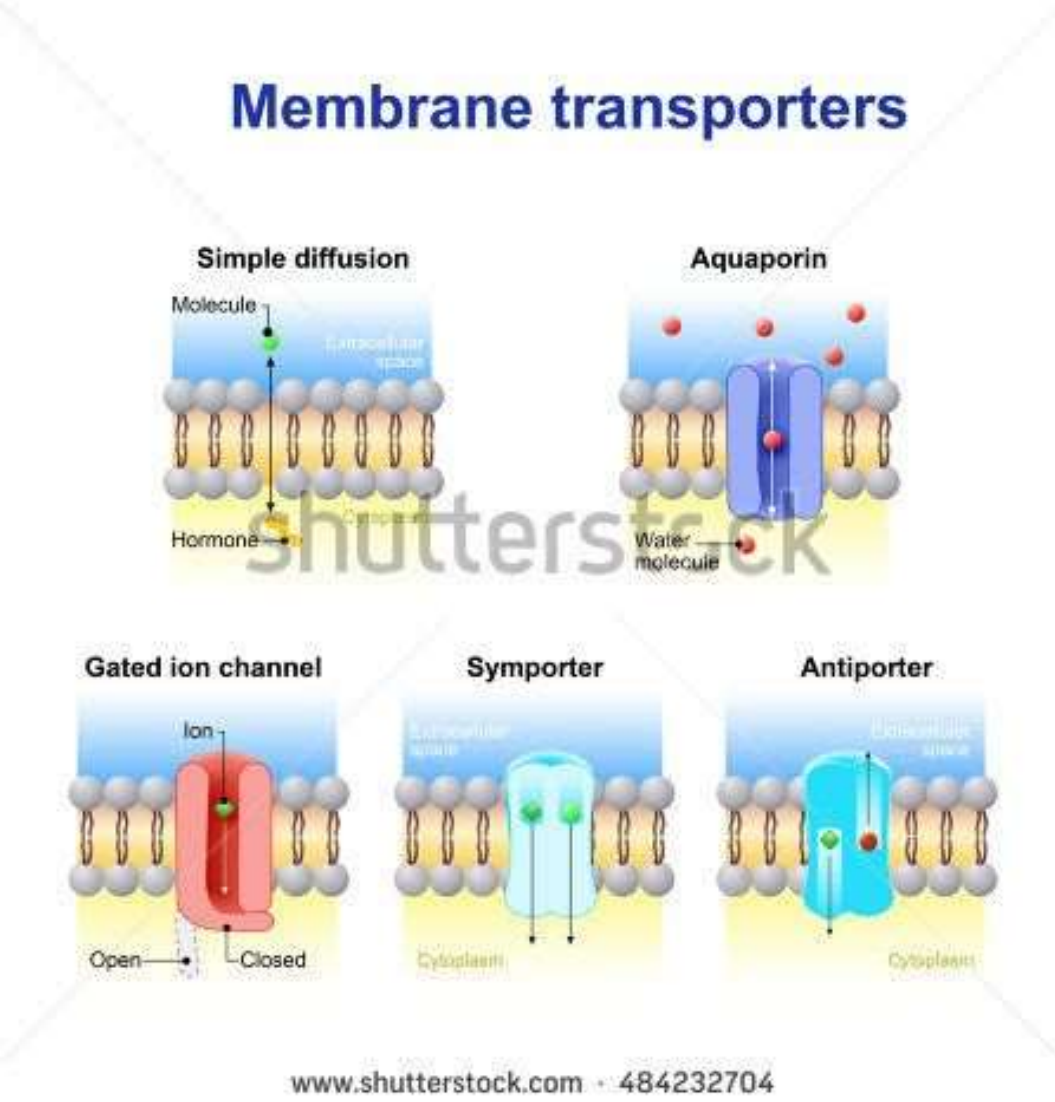

Digestive Tract
Epithelial Cells of Villi
Vessel
SUGARS
PROTEINS
LIPIDS
Glucose
Galactose
Co-transport (Na+)
Other sugars
Facilitated Diffusion
Monosaccharides
Facilitated Diffusion
Note : Fructose is transported by facilitated diffusion because of its simple structure
Amino acids
Co-transport (Na+)
Peptides (< 5 a. a.)
Co-transport (H+)
Amino acids
Diffusion
Capillaries
Note : the lipids is not absorbed directly t the blood vessel it is to the lymph the n to blood
Fatty acids
Simple Diffusion
Fatty acids
Diffusion
Micelles
Simple Diffusion
Triglycerides in chylomicrons
Diffusion
Lacteal

The small intestine is the primary site of amino acid and glucose absorption into the blood. These solutes are transported by three processes: simple diffusion, facilitated diffusion, and "active" transport. Simple diffusion occurs via the paracellular and cellular routes, whereas mediated transport occurs solely through the cell. Transport across the enterocyte involves uptake from the gut across the brush-border membrane, diffusion through the cytoplasm, and exit to the portal blood across the basolateral membrane.


Active Transport
Primary
Secondary
Uniport
Cotransport
Antiport
Symport
P_i + ADP
ATP
Low
High
Pump-mediated
Carrier-mediated
Passive Transport
Facilitated Diffusion
(Uniport)
Simple
diffusion
Carrier-
mediated
Channel-
mediated
Free

Summary :

Type :	Electrochemical gradient	Carrier mediator	Metabolic energy
Simple diffusion	Downhill	No	No
Facilitated diffusion	Downhill	Yes	No
Primary active transport	Uphill	Yes	Yes
Cotransport	Uphill	Yes	Yes (indirect)
counter transport	Uphill	Yes	Yes (indirect)



1) **Which of the following characteristics is shared by simple and facilitated diffusion :**

A. Occurs down an electrochemical gradients

B. Requires metabolic energy

(A)

2)The nephron reabsorbs glucose through a sodium / glucose transporter. What sort of transporter is it :

A. Protein channel

B. Antiporter

C. Sodium pump

D. Symporter

(D)

3. The cell membrane contains channels and pumps that help move materials from one side to the other. What are these channels and pumps made of?

a. Carbohydrates
b. b. lipids
c. c. bilipids
d. d. protein
(D)

4. Diffusion occurs because :

a. molecules are attracted to one another.
b. molecules constantly move and collide with each other.
c. cellular energy forces molecules to collide with each other.
d. cellular energy pumps molecules across the cell membrane.
(B)

5. During diffusion, when the concentration of molecules on both sides of a membrane is the same, the molecules will :

a. move across the membrane to the outside of the cell.
b. stop moving across the membrane.
c. continue to move across the membrane in both directions.
d. move across the membrane to the inside of the cell.
(C)

6. The diffusion of water across a selectively permeable membrane is called :

a. osmotic pressure

. b. osmosis.

c. pinocytosis.

d. active transport.

(B)

7. Which means of particle transport requires input of energy from the cell?

a. diffusion

b. osmosis

c. facilitated diffusion

d. active transport

(D)

8. What are the 2 transport proteins found a cell membrane?

A. Carrier and facilitator proteins

B. Facilitator and channel proteins

C. Carrier and channel proteins

D. Channel and osmotic proteins

(C)

9. What a cell needs to transport particles by active transport?

A. Sun
B. Wind
C. Energy
D. Channels
(C)

10. Which of the following methods does not require any carrier or channel for transport of substances?

A. secondary active transport
B. facilitated diffusion
C. simple diffusion
D. primary active transport
(b)

11. Which substances are transported through facilitated diffusion?

A. galactose
B. urea
C. oxygen
D. Alcohol
(a)

12. Which type of movement occurs when Na/K pump is used?

A. Na ions moves out of the cell and K+ move in
B. K+ ion moves out of cell and Na ion move in
C. both Na and K+ ions move inside the cell
D. both Na and K+ move out of the cell
(a)

13. Which of the following statement is NOT true?

A. chemical changes leads to change in shape of pump
B. symporters are the one which moves substances in diff direction
C. Vitamin K is transported through simple diffusion
D. in passive transport, the substance moves down its concentration gradient
(b)

14. Which substance is transported through secondary active transport?

A. urea
B. water
C. Fatty acids
d. none of the above
(d)

15. What is the source of energy in active transport?

A. from sunlight
B. hydrolysis of ATP
C. energy stored in ionic concentration gradient
D. both A and C
(d)

16. In what case, the transporters are known as antiporters?

A. when 2 substances move in same direction
B. when 2 move in same direction and 1 in opposite
C. when 3 move in same direction
D. when 2 substances move in opposite direction
(d)