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Number

4

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The Plasma Membrane has embedded proteins, and that plasma membrane has certain properties, in addition to its chemical structure, it has the lipid bilayer structure, in addition to proteins which are functional proteins, these proteins carry out several functions, one of these functions is to transport molecules across the plasma membrane.

But is the lipid bilayer structure permeable to all types of particles?

Some particles can pass through the lipid bilayer structure but they have to be lipophilic

(Lipid soluble).

Membrane fluidity:

The plasma membrane is fluid at 37°C, but **What determines the fluidity of the plasma membrane?**

1) The presence of Cholesterol in the plasma membrane.

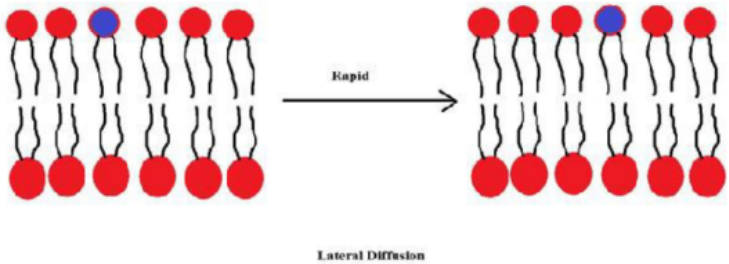
2) The concentration of unsaturated fatty acids. (More concentration of these = more fluid the Plasma Membrane becomes).

Cholesterol in plasma membranes:

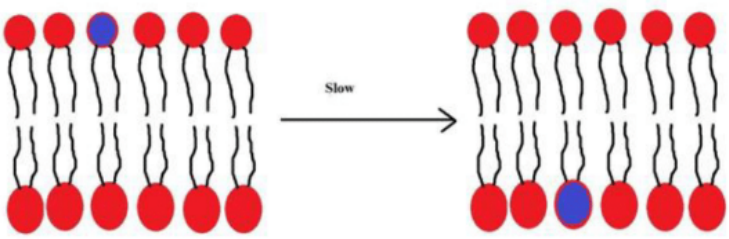
a) Increase firmness and integrity of cell membrane (50% of Cell membrane structure).
b) helps to separate phospholipids, so the fatty acid chains can't come together and crystallize.
c) Helps preventing extremes and maintaining consistency of membrane.

Also, the plasma membrane is **not** static structure, there is movement all the time, and there are 2 kinds of movement:

1. Lateral movement: lateral movement of these phospholipids in the plasma membrane.
2. Flip Flop movement: phospholipids flip from one side to the other.

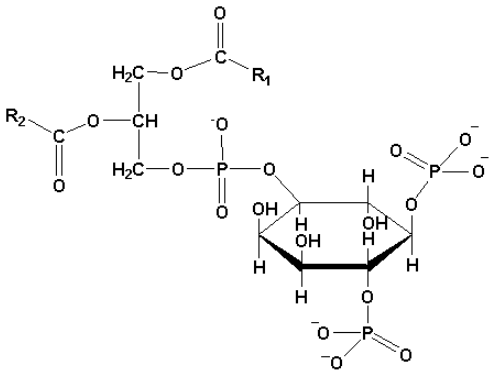


Lateral Diffusion



Flip Flop Diffusion

One of the functional molecules in the Plasma Membrane is the phospholipid PIP_2 (Phosphatidylinositol-4, 5-bisphosphate), it has two chains of fatty acids and a phosphate group bind to the glycerol molecule.



Phosphatidylinositol 4,5-bisphosphate (PIP2)

So, we have the lipid bilayer and a lot of proteins and these proteins perform several functions, some of these functions are:

a) **Ion channels**: These channels are specific channels e.g. (Ca^+ channels, K^+ channels, Na^+ channels) not universal channels.

10:00

b) **Carriers (Transporters)**: they can transport hydrophilic molecules; the carriers are also specific.

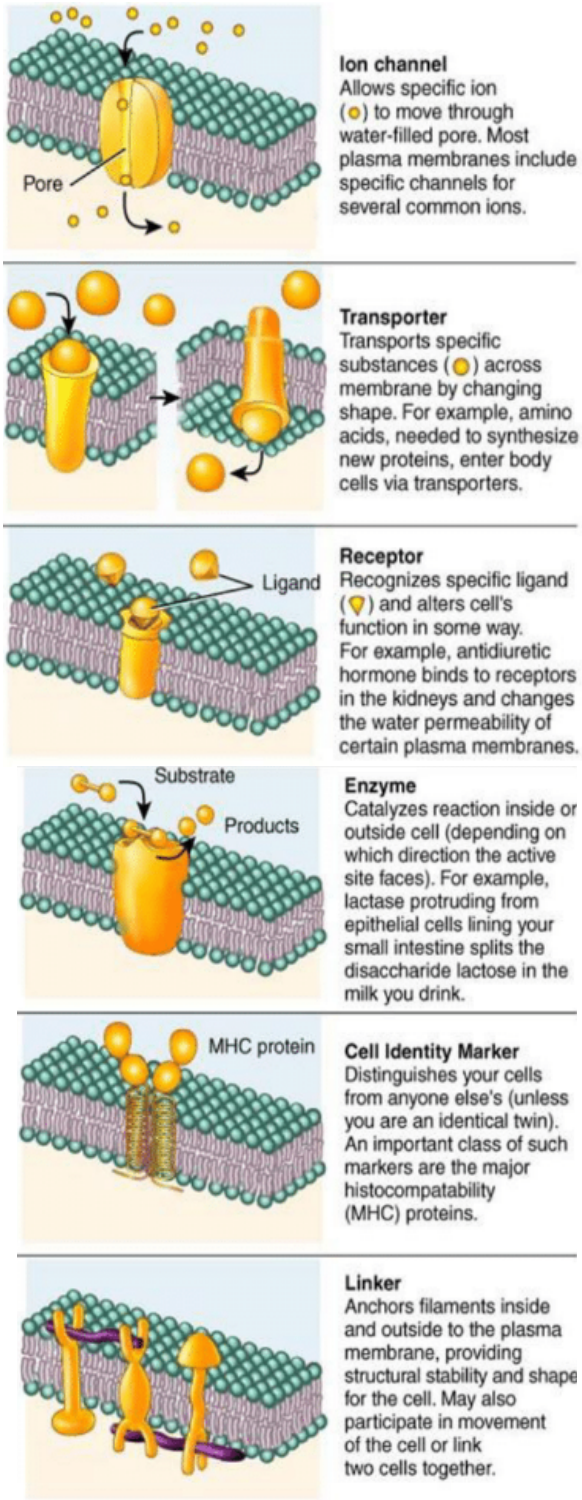
c) **Receptors**: they are specific. The binding molecule is called a ligand, it could be a hormone it could be any substance which can bind to these receptors.

Ligand: an ion or molecule attached to a metal atom by coordinate bonding.

d) **Enzymes**: catalyses reactions, e.g. the enzyme which can split the phospholipid that was mentioned earlier (PIP_2).

e) **Cell Identity Markers**: Formed of proteins injunction with sugars, each one of us has his own unique antigens which are called self-antigens, and these antigens are important for the function of the immune system to recognize the self-antigens from the not-self-antigens (It's like an Id card that immune system cells use to recognise bacteria and destroy it).

f) **Linkers**: joining cells together.



Pumps are also transporters (Primary Active Transport)

Channel Regulation

The question is, **Are the channels open all the time?**

- Sometimes we need them open, sometimes we need them closed, so we have a regulatory system which regulates the activity of the channels.

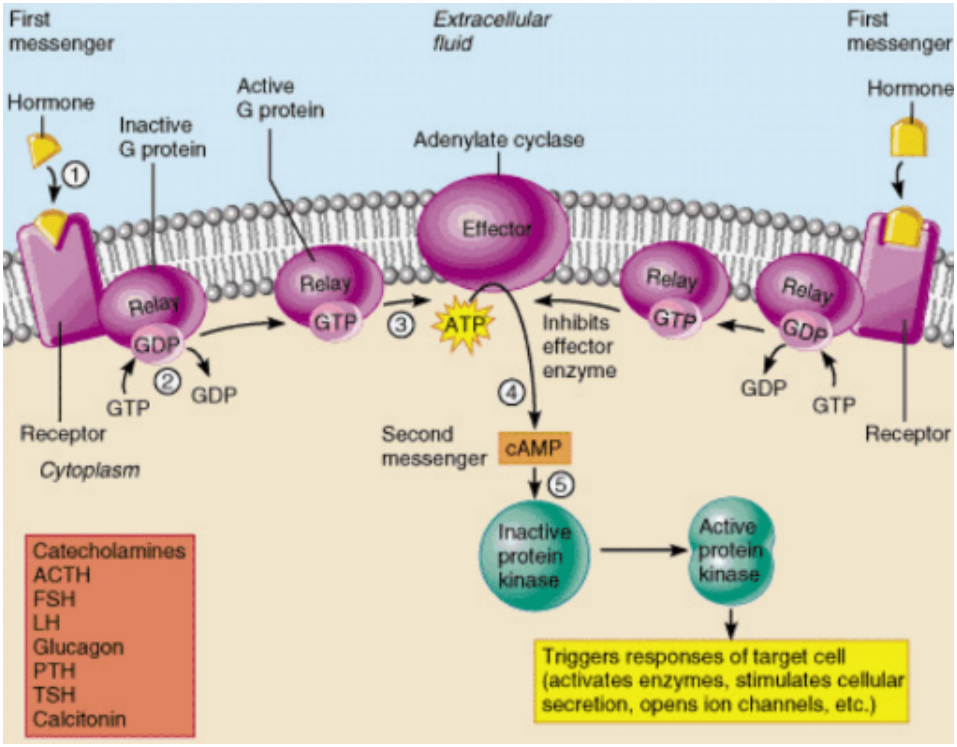
We need regulatory systems in our body to regulate the activities of other cells to reach homeostasis.

Receptors & G-Proteins

The structure of these receptors has many complexes of proteins and subunits.

There are other kinds of protein which are linked to the receptors and they are called G-Proteins (there are many types of G-proteins G-I, G-s, G-q), their function is linking the receptor to an enzyme or linking the receptor to an effector.

e.g. the enzyme Adenylate cyclase.



The hormone binds to the receptor, which activates the G-protein that is linked to that receptor, and that G-protein will activate the mentioned enzyme.

The activation of the enzyme (Adenylate Cyclase) will increase the concentration of **cAMP** inside the cell while consuming **ATP**, the increase of the cAMP concentration inside the cell will activate a specific enzyme inside the cell which will change the activity of the cell.

*They are called **G**-proteins because they consume **G**TP instead of ATP.
By the activation of one enzyme we are getting millions of end products.

Another example of an enzyme is the Phaspholipase C, which splits the PIP_2 (Phosphatidylinositol-4, 5-bisphosphate) to IP_3 (inositol tri-Phosphate) and DG.

$$PIP_2 \xrightarrow{Phaspholipase\ C} IP_3 + DG$$

By removing the phosphate group from the carbon position C of the glycerol, and that will change the activity of the cell.
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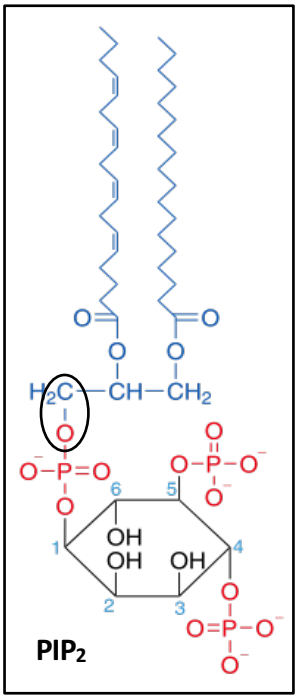
//The splitting happens in the circled area.



The transport mechanisms are very well regulated, so we can have some receptors linked to channels to change the activity of these channels.
E.g.

1. The activation of the ca^{++} channels results in diffusion of ca^{++} from extracellular to intracellular.
2. The activation of K^+ channels results in diffusion of K^+ from intracellular to extracellular.
3. The activation of Na^+ channels results in diffusion of Na^+ from outside to inside.

Linkers

And, we have linkers as protein structures which are linked together.

We have many types of junctions.

1. **Tight Junctions**: cells are tight together, this is found for example at your intestine & stomach, it only has one layer of cells joined together by tight junctions, and by the presence of tight junctions there is no passing of molecules, so the whole layer of cells will be working like one membrane, separating external environment from internal environment.
2. **Gap Junction**: we have this type of junctions at certain types of tissues, the importance of these junctions is the communication between two nearby cells. These gap junctions are like channels between two nearby cells.
3. **Desmosome (Adhering Junction)**: allows the cells to remain anchored together.

Transport

Passive Transport Mechanisms

We know that the rate of diffusion depends on the concentration gradient and the permeability of the plasma membrane, to say that the membrane is highly permeable for this specific ion, so all channels are open.

What is the relation between the concentration gradient and the rate of diffusion? Linear relation.

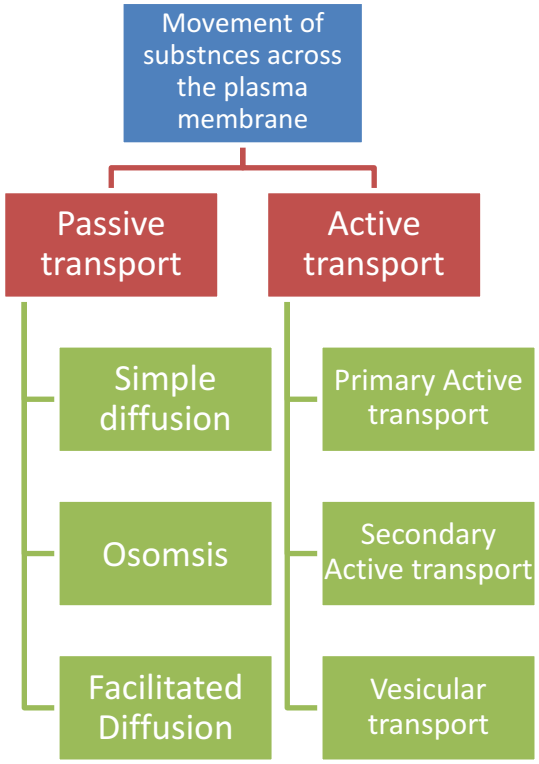
Is the transport through channels considered simple diffusion or facilitated diffusion? Transport through channels is considered either simple diffusion or facilitated diffusion.

30:00

Some people consider it as simple diffusion; because the relation between the concentration gradient and the rate of diffusion is linear.

While others consider it facilitated diffusion; because there are protein structures that has helped Na^+ channels move Na^+ from higher concentration region to lower concentration region.

So, it remains up to you what you would like to consider it whether facilitated diffusion or simple diffusion.



Recap

V-max in facilitated diffusion means **Maximum Velocity**, so you are reaching a point even when you increase the concentration, no increase happens to the rate of diffusion; because we have limited number of carriers in a certain area of the plasma membrane.

What is the difference between osmolality and osmolarity? Osmolality is the number of osmoles of solute in a kilogram of solvent, while osmolarity is the number of osmoles of solute in a litre of solution. An osmole is one mole of any non-dissociable substance. It will contain 6.02×10^{23} particles.

What is the relationship between the thickness of the membrane and the rate of diffusion? Inversely proportional.

Filtration

Movement of water and solutes through a semipermeable membrane (either through the plasma membrane or between cells) from a region of higher hydrostatic pressure to a region of lower hydrostatic pressure, that is, along a pressure gradient.

Hydrostatic vs Osmotic pressure

Hydrostatic pressure: The pressure of a fluid.
Osmotic pressure: The point at which the hydrostatic pressure prevents the natural movement of water.

Conclusion of Passive Transport Mechanisms.

1. **Simple diffusion**: transport through lipid bilayer, transport through channels, Fick's law of diffusion.
2. **Facilitated diffusion**: by carriers (Differences in diffusion Kinetics between the previous modalities) Equivalent Concentration of particles.
3. **Osmosis**: concept of osmotic pressure (Van 't Hoff's law), Oncotic (Colloid-osmotic) pressure. Osmolarity, Osmolality Hydrostatic pressure and filtration.

Active Transport Mechanisms

ATP is consumed to phosphorylate the pump, by phosphorylation of that pump you are getting the function of the whole pump structure and the function of the whole pump structure is resulting in transport of the ions from the lower concentration to the higher concentration.

What is the difference between primary active transport and secondary active transport?

- **Primary Active Transport**: consumes ATP directly to phosphorylate the structure e.g. (ATP-ase carriers or Pumps) (functions of pumps: Na^+/K^+ pump, H^+ pump, H^+/K^+ pump, Ca^{++} pump).
  Ca^{++} pumps transport Ca^{++} from inside the cell to outside the cell, (from low concentration to high concentration). But Ca^{++} channels transport Ca^{++} from outside to inside (from high concentration to low concentration).

- **Secondary Active Transport**: consumes ATP indirectly.

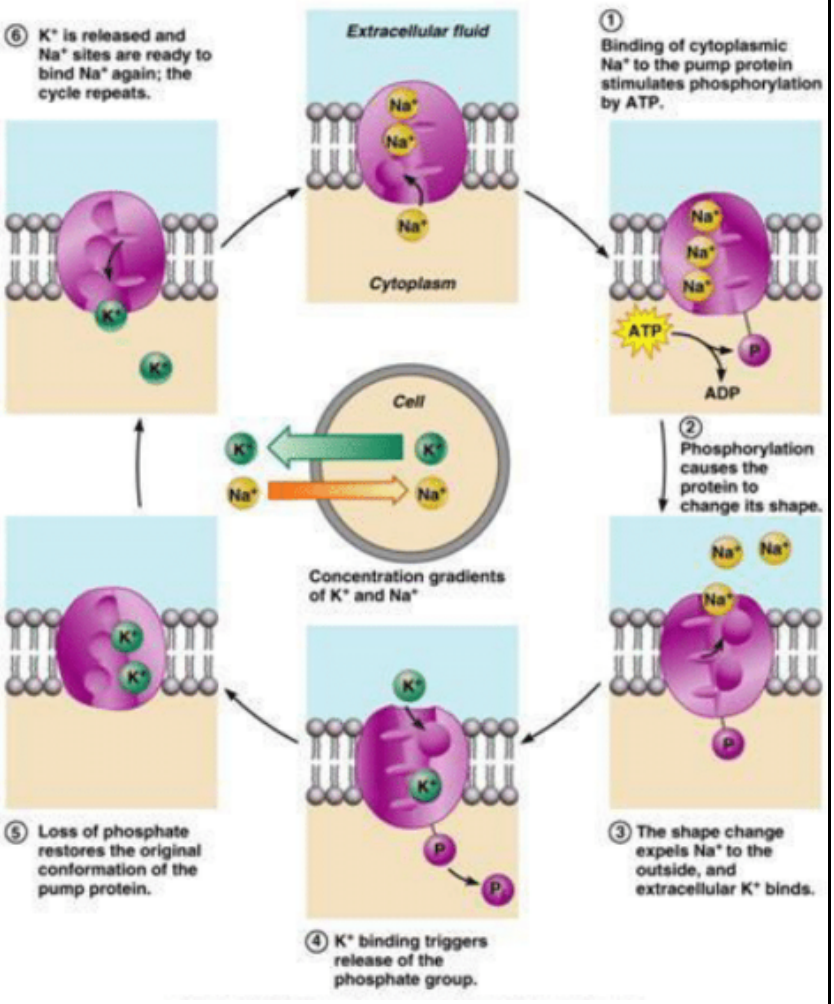
Na^+/K^+ pump

It transports 3 Na^+ from inside to outside, while transporting 2 K^+ from outside to inside.

40:00

So, the pumps work by phosphorylation.

But when that pump isn't functioning (for example it doesn't transport sodium, It only transports 2 potassium ions from outside toward the inside), the sodium will diffuse from outside toward the inside down the concentration gradient by other means of transport (channels), with time the concentration gradient for sodium inside the cell will increase (the osmolarity inside increases), that increase of osmolarity will lead to osmosis and water will move from outside toward the inside ,and the cell will swell (lysis).



*The pump is important at keeping the cell isotonic.

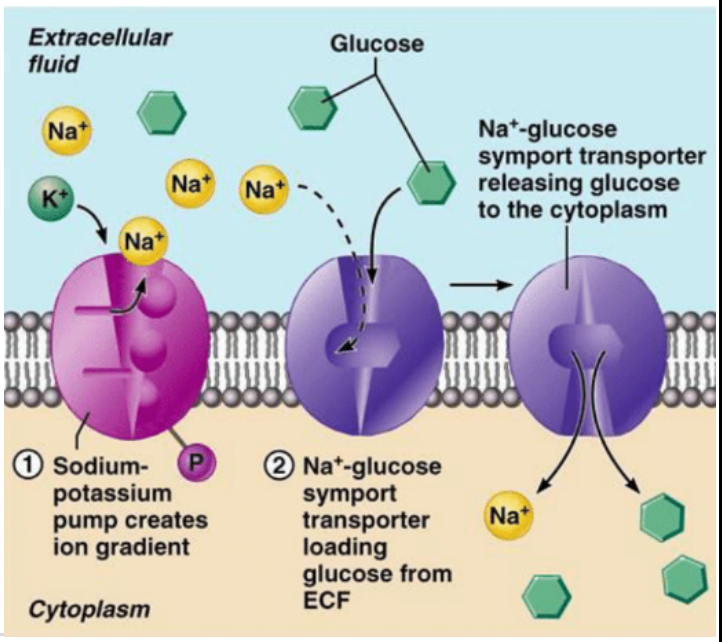
Secondary Active Transport

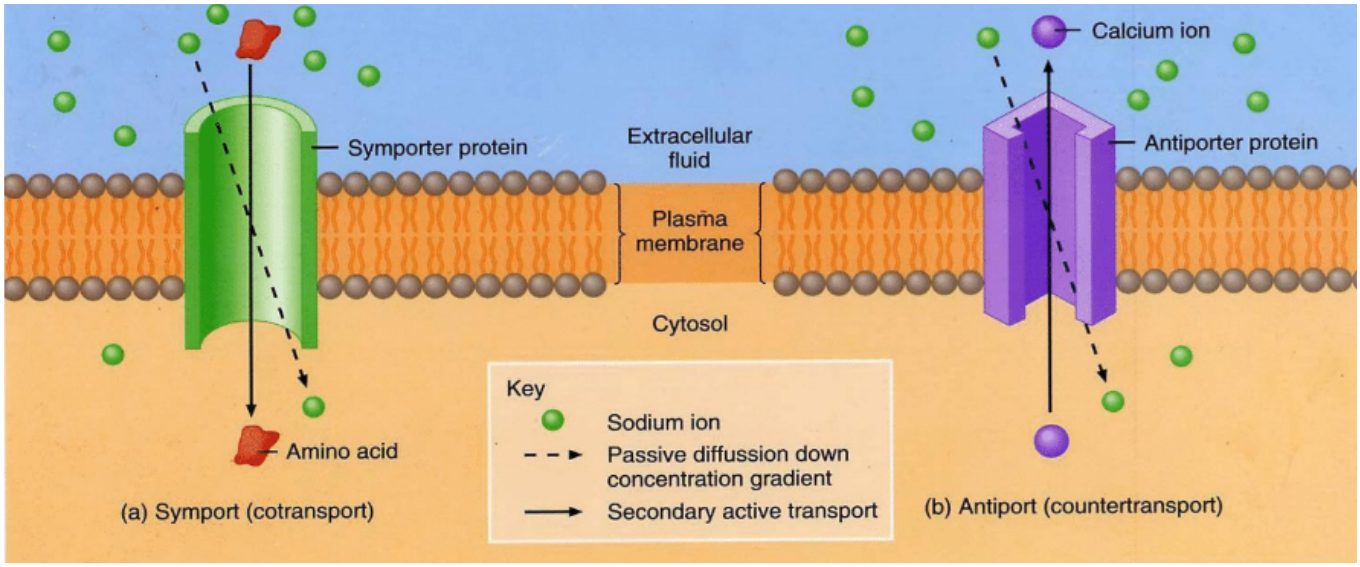
We have already mentioned that secondary active transport uses ATP indirectly, but **how?**

1. Na^+/K^+ pump creates Na^+ concentration gradient. (uses ATP)
2. Na^+-Glucose symport transporter, (Has 2 binding sites) uses the force of the concentration gradient of Na^+ to move another substance (here it's glucose) from the low concentration to the high concentration.

   This is the indirect use of ATP.

   (this type exists in the epithelial layer of the gastric tract)





Types of secondary active transport

1. **Co-transport** (symport) e.g. (Na^+-Glucose symport transporter). The two substances are transported in the same direction.
2. **Counter transport** (antiport) the two substances are transported in the opposite direction to each other examples: sodium -calcium counter transport and sodium- hydrogen counter transport.

47:00