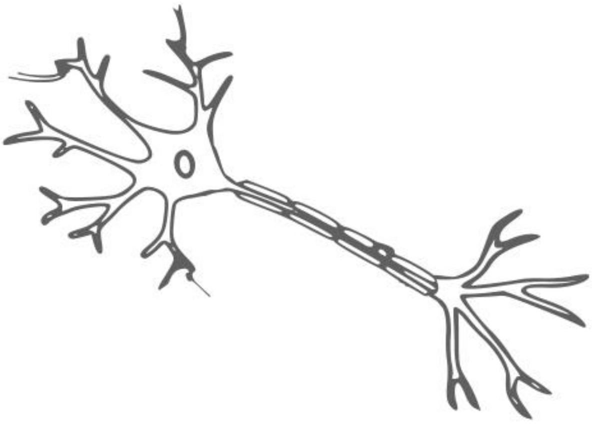
Sheet no. **4**

Physiology



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Active transport

Active Transport is the movement of particles through the plasma membrane from the low concentration to the high concentration using ATP.
(ATP dependent)

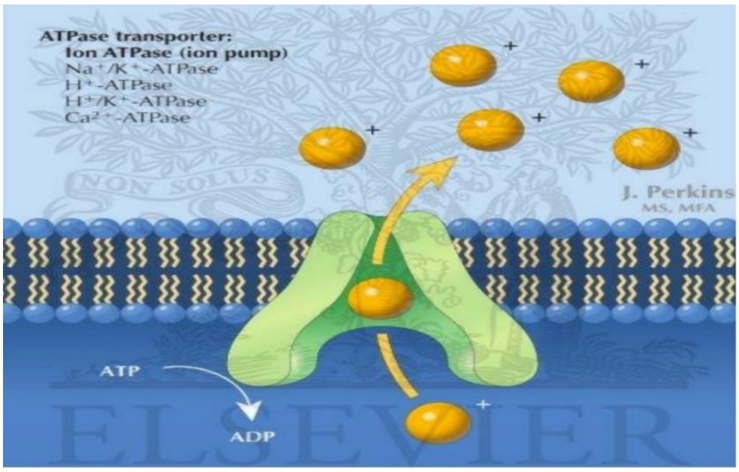
Active Transport has three Mechanisms

- **A-** **Primary Active Transport** (ATP- ase carrier or pump)
- **B-** **Secondary active transport** (Na+ dependent carriers)
- **C-** **Vesicular transport** (endocytosis, phagocytosis, transcytosis, pinocytosis)

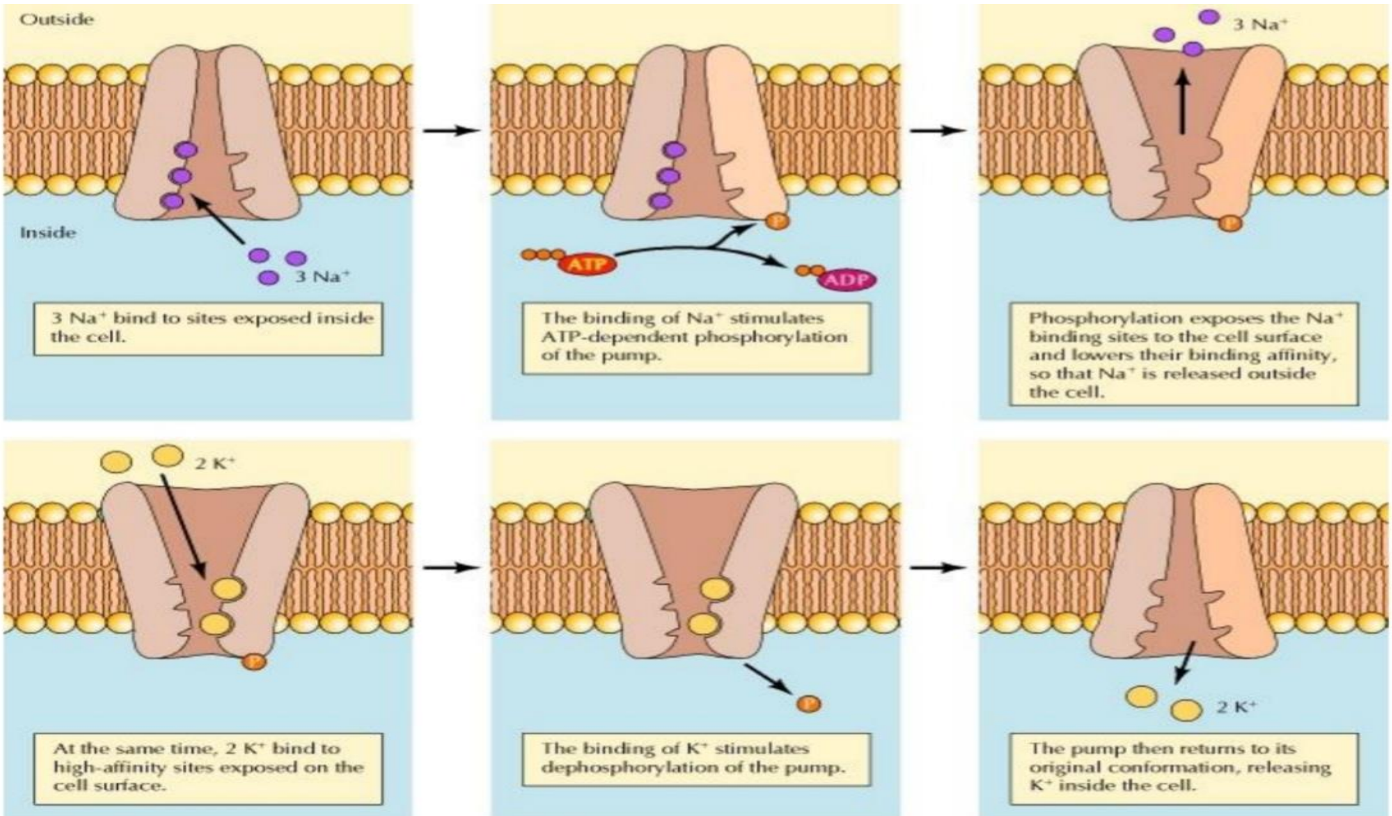
// Primary Active Transport

NOTE // This pumps require energy because substances are moving against concentration gradient. They hydrolyze the ATP directly

- Examples of primary active transport pumps and their function

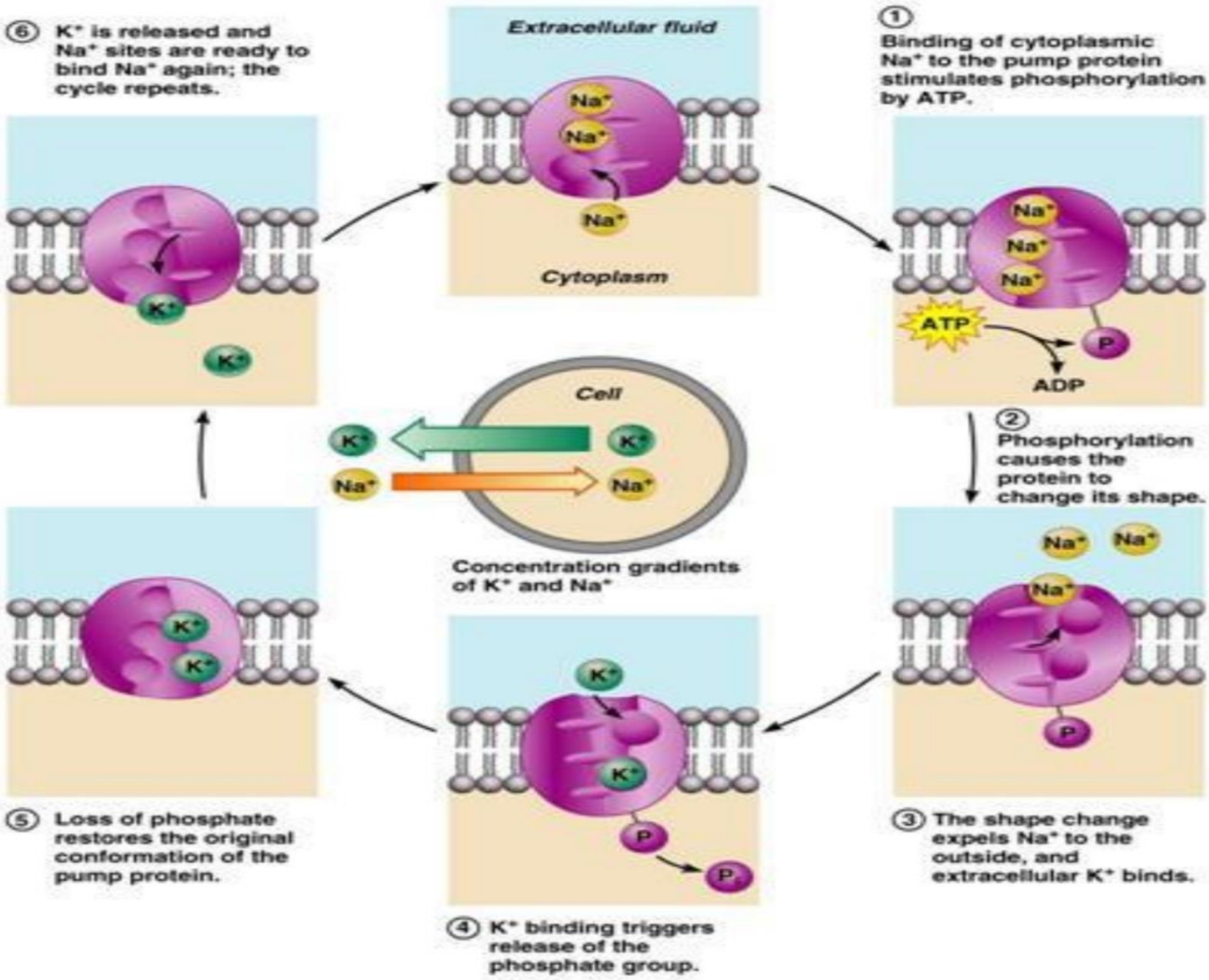


1- -Na+/K+ pump: They pump 3 Na from inside to outside and 2 K inside form outside ,It hydrolyses ATP that's why it's called ATPase .. The pump helps maintaing resting potential, affects transport, and regulates cellular volume, It also functions as a signal transducer, and keeps cells alive



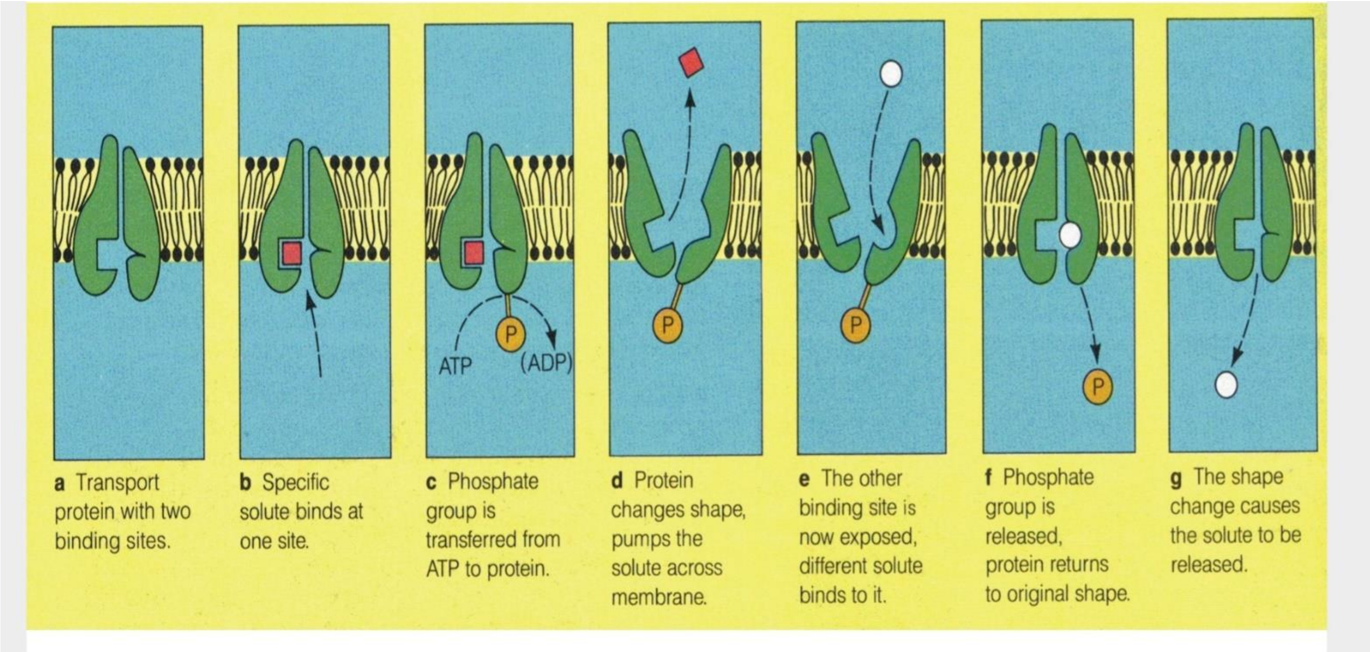
---Na-K pump

It has three binding sites for sodium ions on the portion of the protein that protrudes to the inside of the cell. It has two binding sites for potassium ions on the outside . The inside portion of this protein near the sodium binding sites has adenosine triphosphatase (ATPase) activity. When two potassium ions bind on the outside of the carrier protein and three sodium ions bind on the inside, the ATPase function of the protein becomes activated. Activation of the ATPase function leads to cleavage of one molecule of ATP, splitting it to adenosine diphosphate (ADP) and liberating a high-energy phosphate bond of energy. This liberated energy is then believed to cause a chemical and conformational change in the protein carrier molecule, extruding the three sodium ions to the outside and the two potassium ions to the inside .



2- H+ pump : (in the stomach) pumps hydrogen into the stomach against the concentration gradient (that's why the stomach pH is 2)

3- H+/K+ pump: the proton pump of the stomach that lowers the pH of the stomach for digestion (Stomach has a high concentration of H+, So the protons go inside it by primary active transport)



4- Ca++ pump: Ca2+has many important roles as an intracellular messenger. The release of a large amount of free Ca++ can trigger a fertilized egg to , skeletal_muscle cells to contract, secretion by secretory cells and interactions with Ca++, responsive proteins like calmodulin, after the contraction of the smooth muscles of the heart finishes Ca++ ions will move out of the cell by active transport through this pumps

// Secondary active transport

In this type of movement,, A particle moving down its concentration gradient will carry Another particle to move against its concentration gradient , it is called secondary active transport because of the energy that is used to generate the driving force of the first molecule's concentration gradient , using ATP ***So ATP is used indirectly***

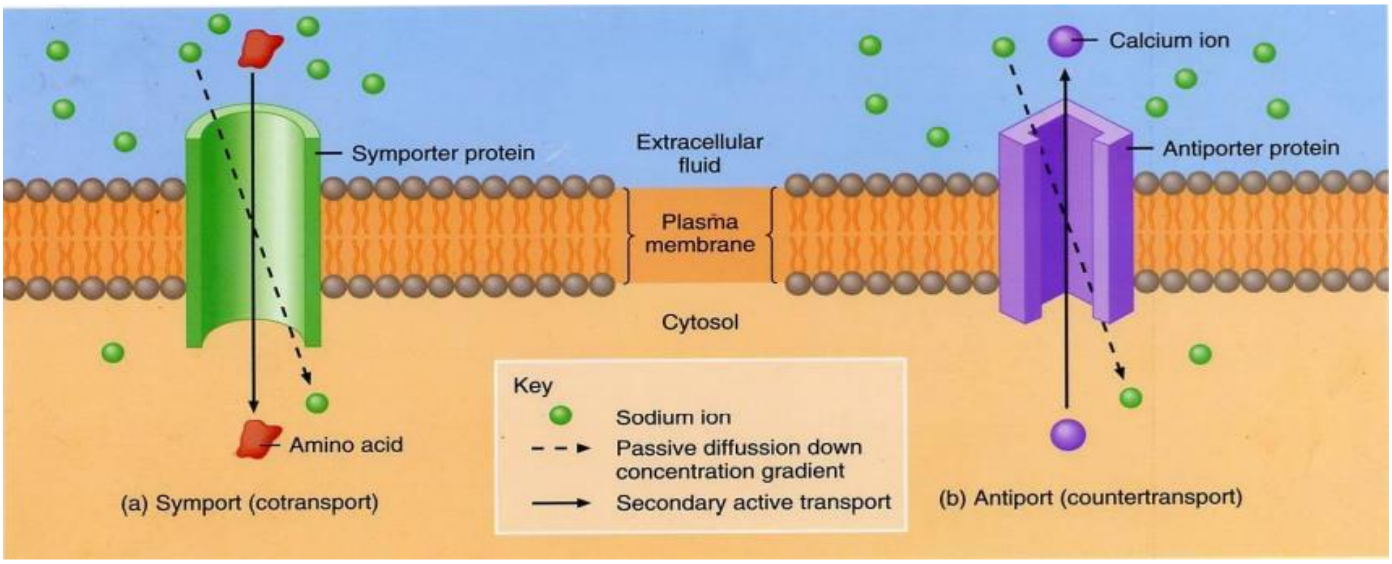
There are two types of secondary active transport:

Co-transport (SYMPORT): transporting both molecules in the same direction

Ex: In the left part of the figure below we can see that the amino acid moves in the same direction as the sodium ion, The sodium ion moves down it is cone-gradient and carrying the amino acid with it , so the amino acid is Co-transported with the sodium

Counter-transport (ANTIPORT): transporting molecules in the opposite direction

Ex: in the right part of the figure below we can see that the calcium ion moves in the opposite direction of the sodium ion, so calcium is counter transported



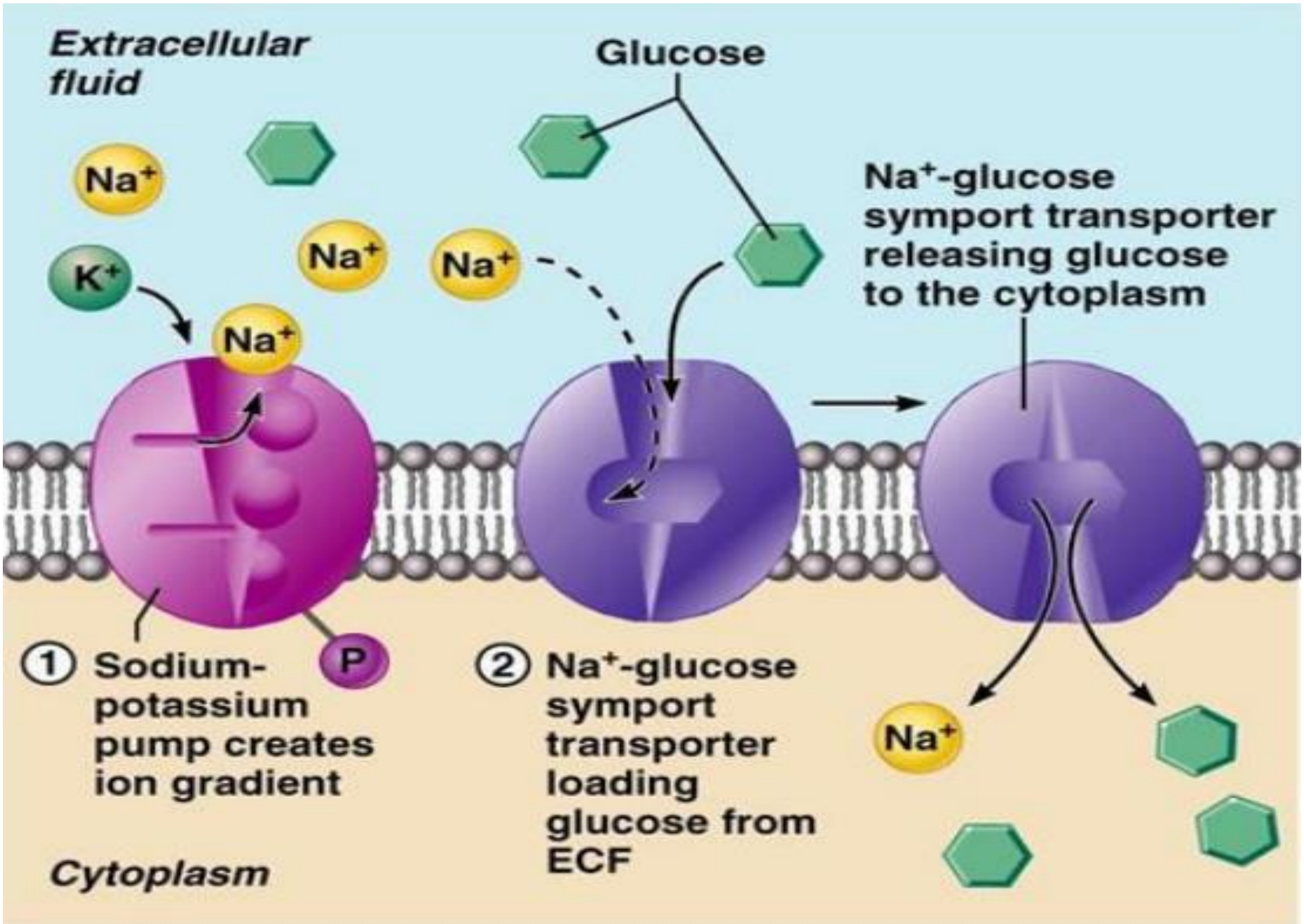
Example of Co-transporter: Na+/glucose symport (figure below)

Steps:

1) Na+/Glucose symport transporter moves Na+ with the concentration gradient

2) Na+ Carries glucose molecule with it and transport it against the concentration gradient

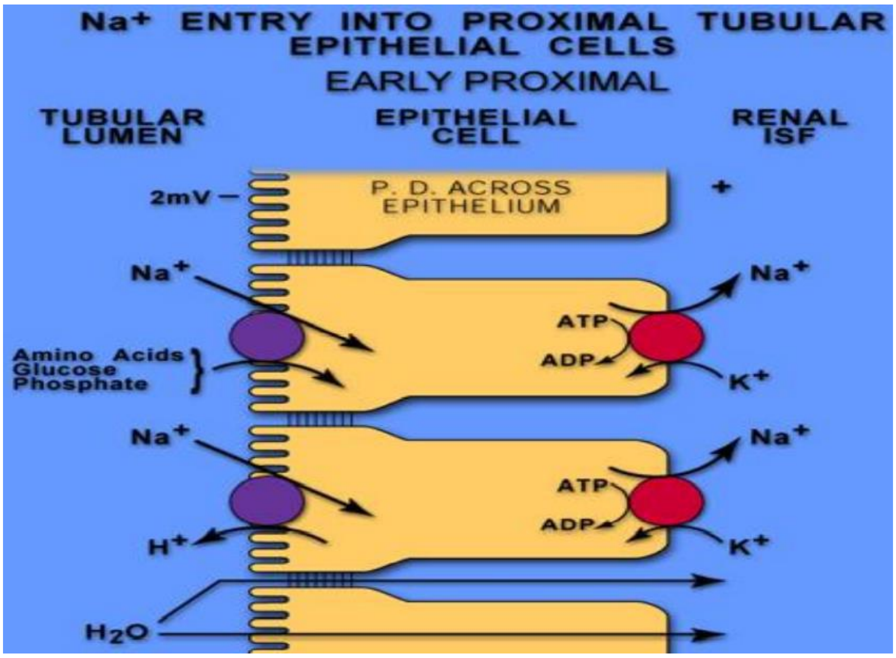
3) This process will lead to increase sodium concentration inside the cell, so NA+/K+ ATPase will restore the concentration gradient using ATP



Example of Counter-transport: (figure in the right)

Note: The part where H+ go outside the cell represents a counter transport mechanism

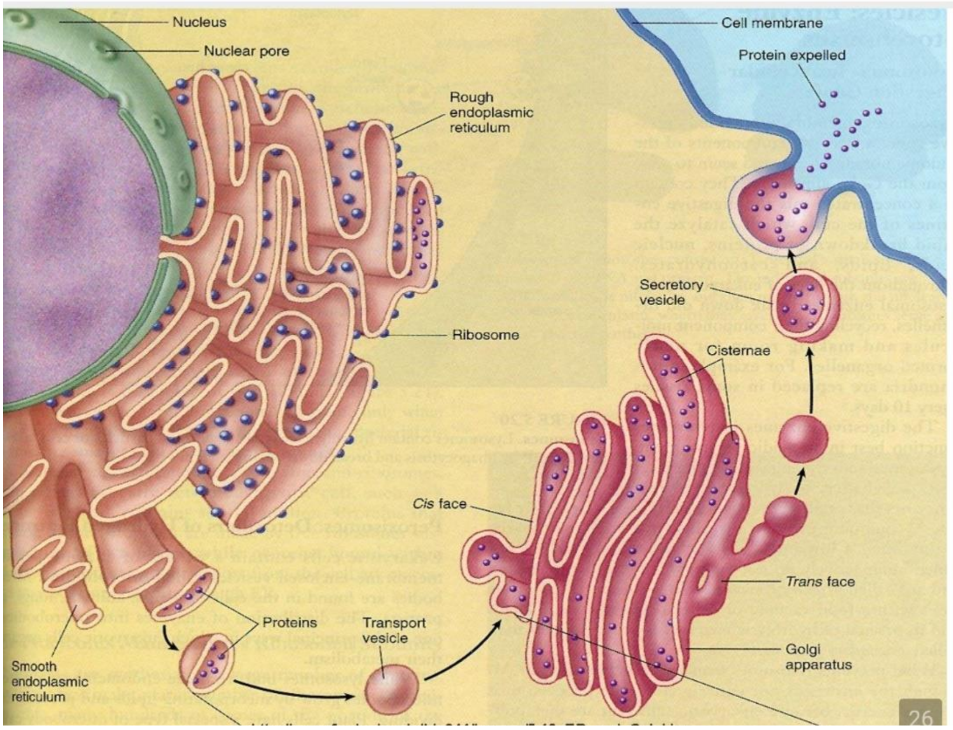
But the parts where (amino acid/glucose/phosphate) go inside the cell represent the co-transport mechanism



ON SHORT // secondary active transport: It also moves substances against their concentration gradient. Energy is also used but it is used INDIRECTLY ,can be (Co-transport /Counter transport) For example, it moves Na outside to inside in exchange for from inside to moving Ca2+ outside. (antiport or counter transport) *Ca+2 outside is more than inside (remember the Ca+2 pump) If it keeps working the Na equal on both sides, and if it equal then the pump stops. different on What keeps the Na+ both sides is the sodium potassium pump (indirect transport).

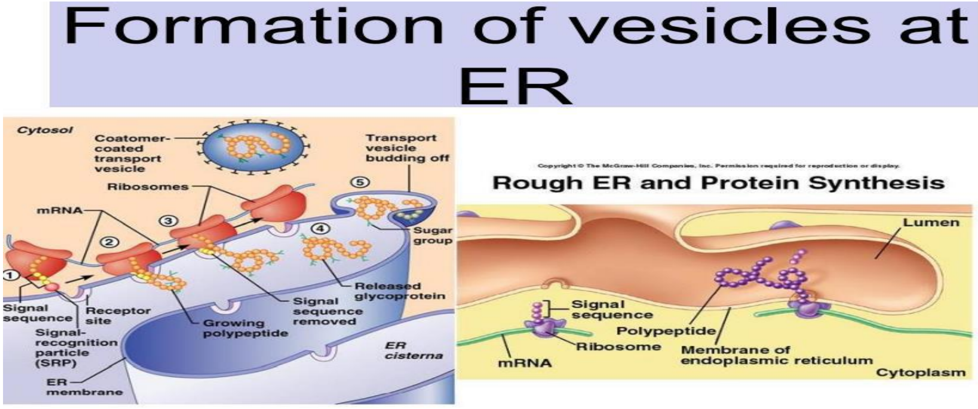
// Vesicular transport

- Vesicles can transport inside cells and go outside them to transport substances (e.g. proteases) by fusion through membranes, vesicles moves through cell on microtubules as they use them as streets and they are carried by carrier proteins

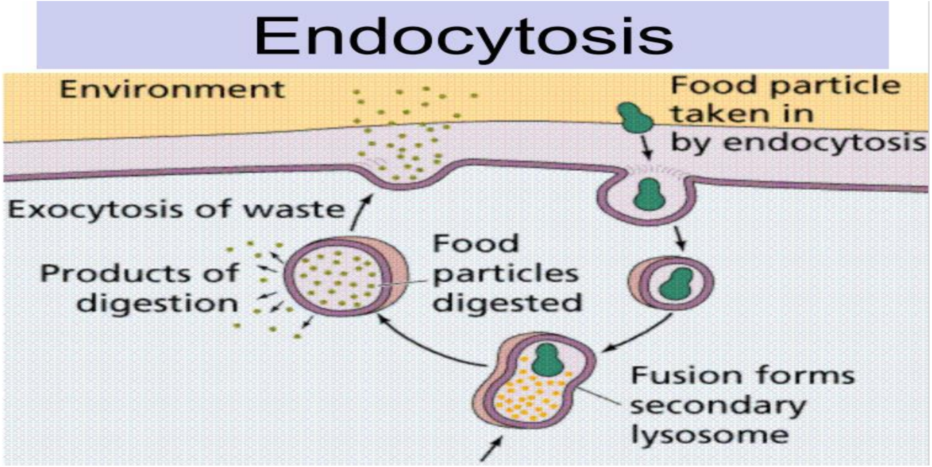


NOTE // vesicles move in the cell on the cytoskeleton (microtubules) by motor proteins that use ATP

1) Formation of vesicles at ER: for transporting them to Golgi for further modification of proteins



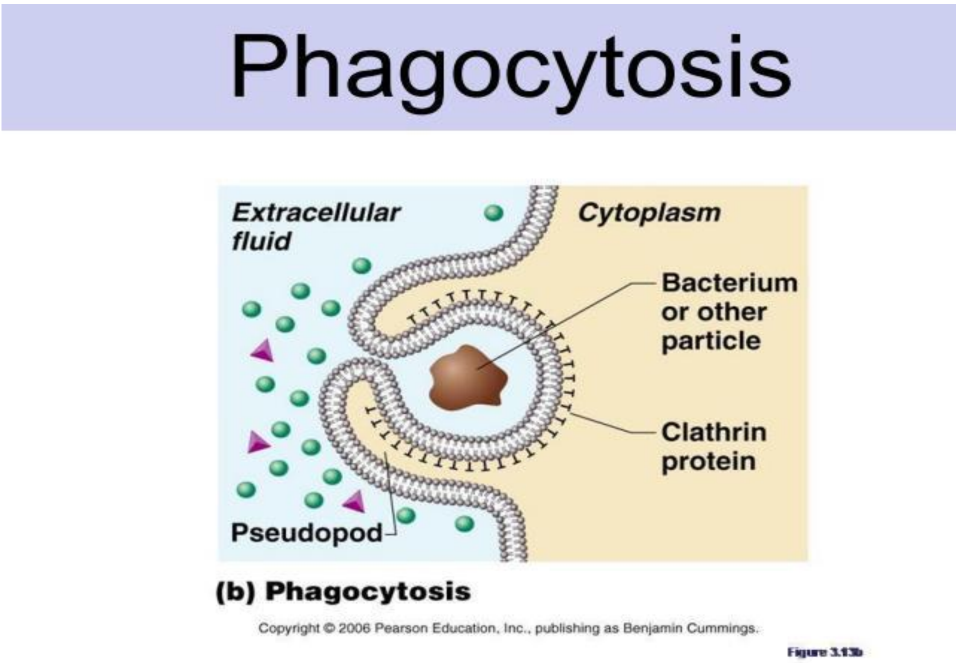
2) Endocytosis: Moving of substances (food) into cells in vesicles, then these vesicles typically fuse with lysosomes to be digested



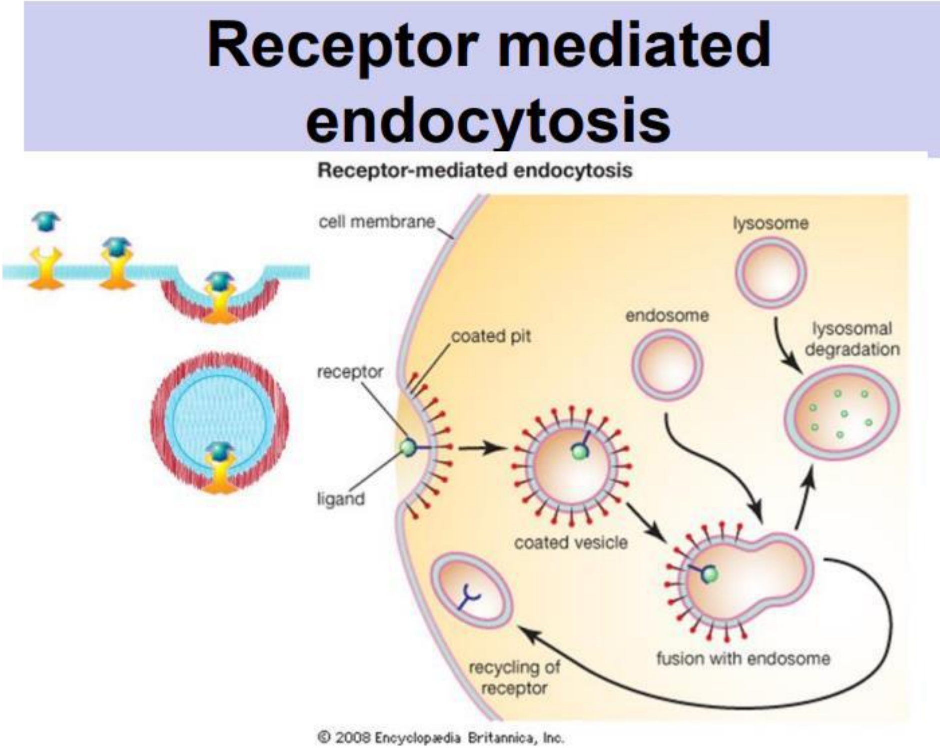
3) **Exocytosis**: Moving of substances (e.g. secretory proteins and waste) outside cells after fusing the vesicle in the plasma membrane

NOTE // Proteins are made in rough endoplasmic reticulum then go to Golgi apparatus to be modified then budding in vesicles and go outside the cells to be secreted via . exocytosis :Such as secretion of hormones,When hormones are synthesized then altered, it has to move in a vesicle to leave the cell, and the vesicle requires energy to move through the cell.

4) **Phagocytosis**:(Cell eating) Moving of large molecules into cells after forming pseudopods (usually done by phagocytes)

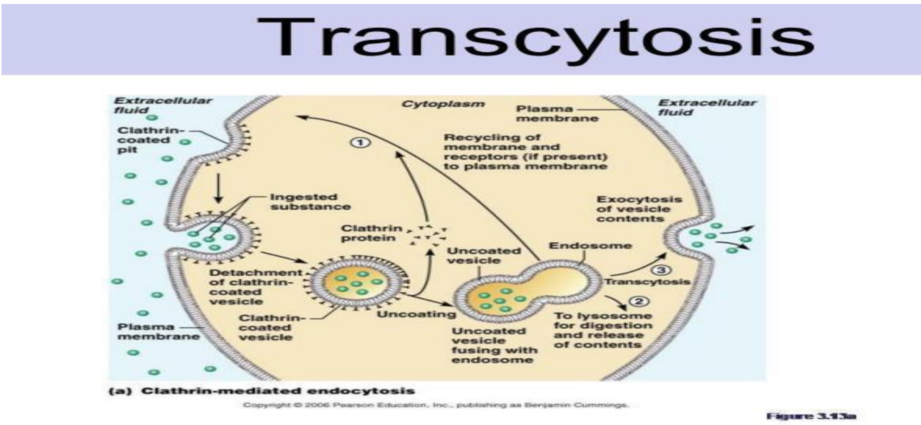


4) **Receptor-mediated endocytosis**: endocytosis that occurs after the internalized substance (ligand) bind to a receptor, Then these vesicles fuse with other vesicles (for example lysosomes) and the ligand will be digested then after that the receptor is recycled, and it usually returns to the surface, cholesterol enters the cell by receptor mediated endocytosis



NOTE // The substance is captured by pseudopods Then the vesicle is punched in it will fuse with the lysosome and then will Be digested..

6) **Transcytosis**: Passing of particles through the whole cell from outside on one side to outside on the other side, these particles go outside the cell by exocytosis process



NOTE // the substance enters the cell from one side then leaves from the other side.

7)Pinocytosis: (cell drinking) movement of extracellular fluids into a cell by infolding of the plasma membrane to form a pinocytic vesicle

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Active Transport	Transport in which cell expends energy to move a substance across the membrane against its concentration gradient through transmembrane proteins that act as transporters; maximum transport rate is limited by number of available transporters.	Polar or charged solutes.
Primary active transport	Transport of a substance across the membrane against its concentration gradient by pumps; transmembrane proteins that use energy supplied by hydrolysis of ATP.	Na^+, K^+, Ca^{2+}, H^+, I^-, Cl^-, and other ions.
Secondary active transport	Coupled transport of two substances across the membrane using energy supplied by a Na^+ or H^+ concentration gradient maintained by primary active transport pumps. Antiporters move Na^+ (or H^+) and another substance in opposite directions across the membrane; symporters move Na^+ (or H^+) and another substance in the same direction across the membrane.	Antiport: Ca^{2+}, H^+ out of cells. Symport: glucose, amino acids into cells.
Transport In Vesicles	Movement of substances into or out of a cell in vesicles that bud from the plasma membrane; requires energy supplied by ATP.	
Endocytosis	Movement of substances into a cell in vesicles.	
Receptor-mediated endocytosis	Ligand-receptor complexes trigger infolding of a clathrin-coated pit that forms a vesicle containing ligands.	Ligands: transferrin, low-density lipoproteins (LDLs), some vitamins, certain hormones, and antibodies.
Phagocytosis	"Cell eating"; movement of a solid particle into a cell after pseudopods engulf it to form a phagosome.	Bacteria, viruses, and aged or dead cells.
Pinocytosis	"Cell drinking"; movement of extracellular fluid into a cell by infolding of plasma membrane to form a pinocytic vesicle.	Solutes in extracellular fluid.
Exocytosis	Movement of substances out of a cell in secretory vesicles that fuse with the plasma membrane and release their contents into the extracellular fluid.	Neurotransmitters, hormones, and digestive enzymes.

regulation of exocytosis

– an example of regulated exocytosis: the synaptic transmission between two neurons

1) change of presynaptic membrane permeability to calcium ion (Ca+2)

2) increase in calcium concentr2ation in axon terminal (Assuming that the vesicles and the axon membrane are both negative; repulsion will occur, but as the Ca+2 concentration increases inside , then the repulsion will decrease and more exocytosis, because vesicles will dock and diffusion on the plasma membrane.)

3) more exocytosis by increasing the release of neurotransmitters

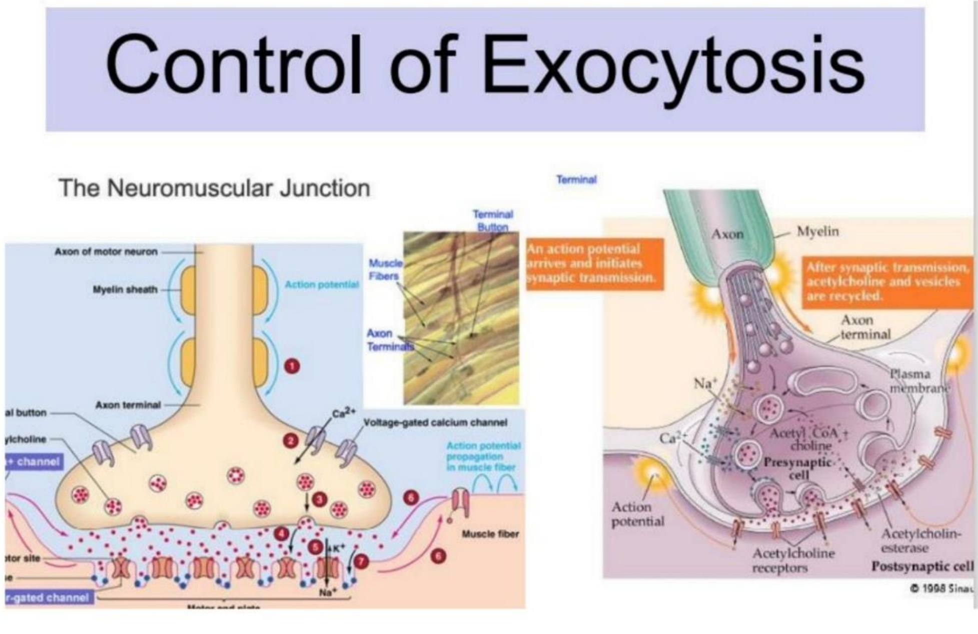
Control of Transport

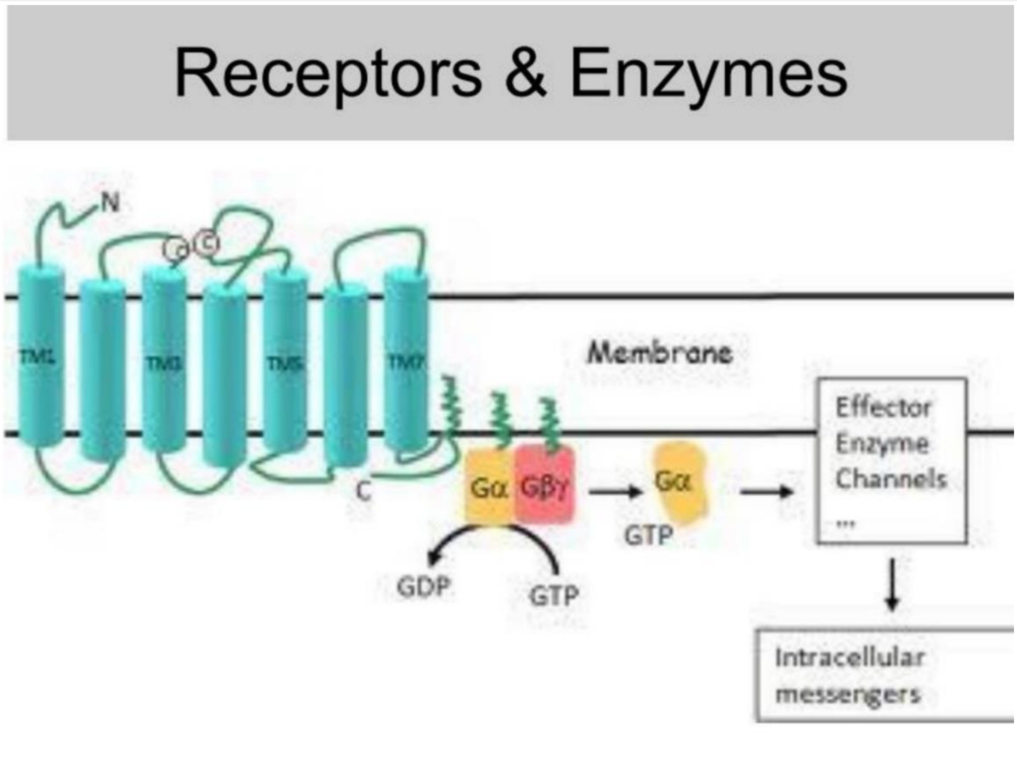
Controlled by //

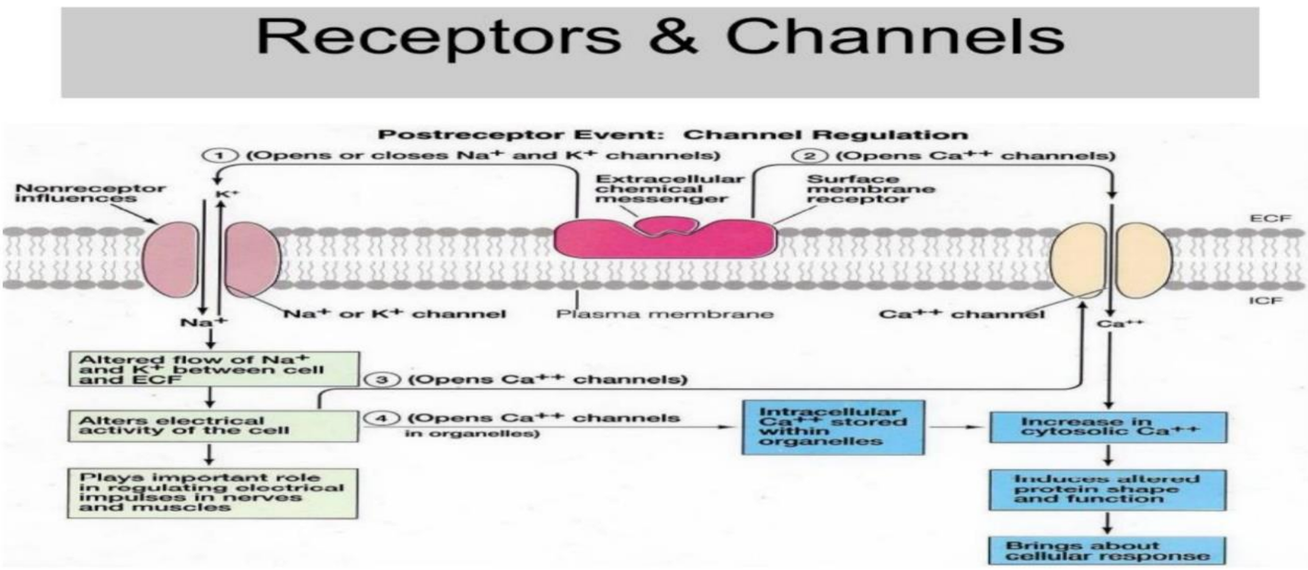
1) Receptors: control ligand gated channels, also called chemical gated channels (there are voltage gated channel as well)

2) Enzymes and second messengers can control Receptors as well

3) Some ions such as calcium can control the exocytosis of vesicles in neurons







GOOD LUCK