Working System of Sodium - Potassium Pump.

In Biological System the Cation Sodium (i.e Na^+) and Cation Potassium (i.e K^+) Can not pass through the lipid layer (i.e a lipid layer is made up with double wall's of Protein Cell membrane.

Now such encapsulation of metal ions like Na^+ & K^+ facilitates their transport through the enclosed cations present in an organic lipid soluble surface which is called Cavitands, then it can pass through the cell membrane.

In the animal cells the concentration of (Na^+) Cation Sodium is 5-15 mM and Cation Potassium (K^+) is 100-140 mM.

But in the extra cellular space the statement is reversed.

i.e In extra cellular space the concentration of Na^+ (Sodium ion) is 100-140 mM and concentration of Potassium ion (K^+) is 5-15 mM.

This is essentially needed for the survival of the cell and many other physiological functions which are metioned below

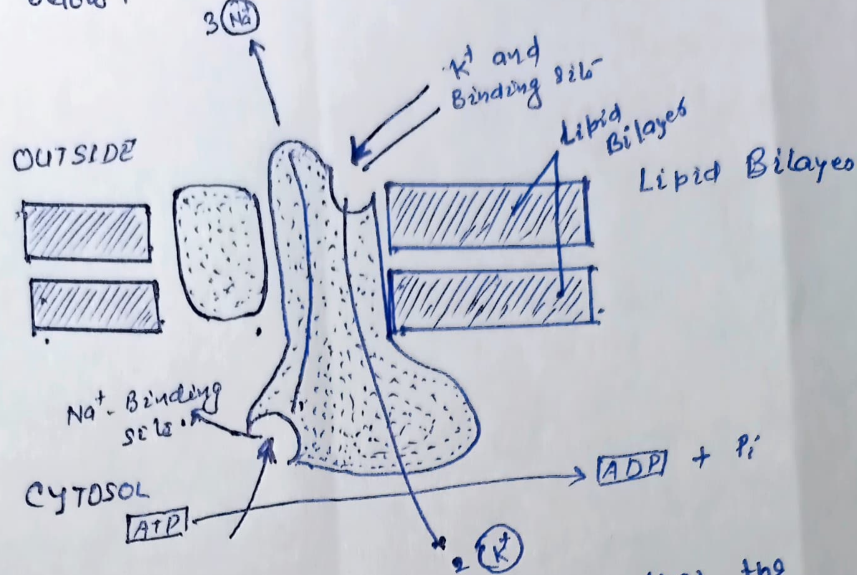
(a) They help in transport of amino acids, along with sugar, nucleotides and other essential substances.

(b) Sodium ion (Na^+) Potassium ion (K^+) and other gradients are required for the transmission of nerve impulse.

(c) They also regulate the cell volume and cell shape.

(d) High cellular K^+ ion concentration is required for the optimal glycolysis and protein synthesis.

The figure for working of $Na^+ - K^+$ Pump in biological system is given below.



It is Obvious from the above figure that the $Na^+ - K^+$ ATPhase Pump for transport of three Na^+ ion Out of a cell for every two K^+ into a cell against their gradients.

Now the metabolic energy upto 20-40% of the total metabolic energy of the cell is consumed in the maintenance of these ion ingredients, this energy consumption reaches up to 70% in neutral tissues.

The energy is needed to maintain high K^+ ion Concentration and low Na^+ ion Concentration in a Cytosol is provided by a protein in the cell membrane and this is called Na^+, K^+, ATPase or Na^+/K^+ Pump.

The energy derived from ATPase Causes the transport of Na^+, K^+ ion from lower Concentration to higher Concentration. This is known as active transport or active Pump.

Principle of working:-

The $Na^+ - K^+$ ATPase or Na^+/K^+ Pump Consists of two α, β Subunits possessing Cytoplasmic and Extra-Cellular domains respectively.

Each ATPase enzyme molecule binds Sodium ion (N and hydrolyses ATP to ADP on the Cytoplasmic Side of the membrane to Pump out three (03) Na^+ ions out of

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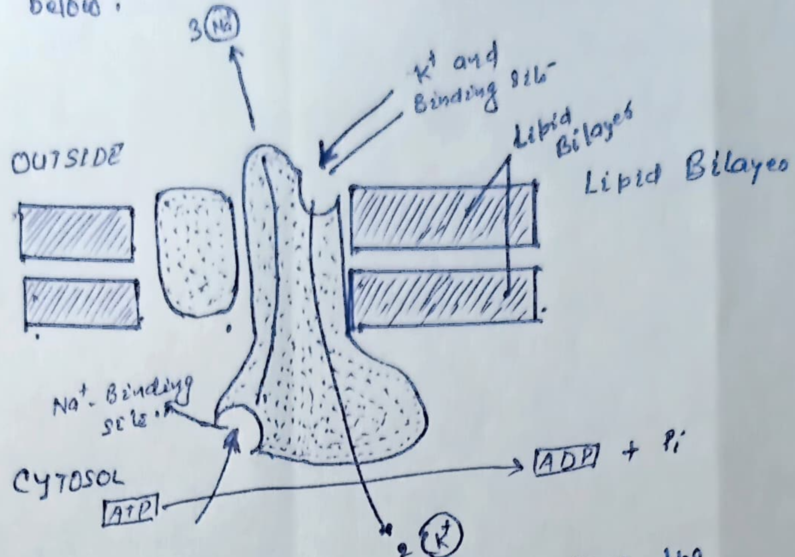

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Each ATPase enzyme molecule binds sodium ion (Na^+) and hydrolyses ATP to ADP on the cytoplasmic side of the membrane to pump out three (03) Na^+ ions out of the cell and two (02) K^+ ions are transported into the cell.

In the above activity we find there is net movement of one positive charge out-ward per cycle hence the Na^+/K^+ pump is considered electrogenic in nature.

The net process can be represented as follows

$$ATP + H_2O + 3Na^+ \text{(inside)} + 2K^+ \text{(outside)}$$

$$\downarrow$$

$$ADP + P_i + H_2O + 3Na^+ \text{(outside)} + 2K^+ \text{(inside)}$$

The enzyme ATPase exists in two forms E_1 and E_2. The E_1 form has affinity for Na^+ and ATP, it readily gets phosphorylated in presence of Mg^{2+} to form E_1-P carrying three occluded Na^+ ions, E_1-P changes to E_2-P, having low affinity for Na^+ ion but high affinity for K^+. E_2-P, therefore, release 3 Na^+ ions and binds $2K^+$ ions on the outside of the cell giving rise to E_2-2K^+, which releases $2K^+$ ions in the interior of the cell.

It has been shown that Na^+-K^+ ATPase, in its E_2-P state is used by cardiac glycosides for binding, forming a stable E_2-P (cardiac glycosides) complex. This inhibits the function of Na^+-K^+ ATPase resulting in inhibition of sodium pump. This situation leads to accumulation of Na^+ ions in these cells, encouraging endosmosis thus leading to swelling and bursting of cells and consequent narrowing of blood vessels creating hypertension.