Active Transport

Transportation is an essential, natural and the physiological process which occurs in all the higher organisms including plants, animals, and humans. In order to sustain life, this process is important as it functions by constantly transporting, different essential materials to and from all parts of the body including cells, tissues, and organs.

"Active Transport is defined as a process that involves the movement of molecules from a region of lower concentration to a region of higher concentration against a gradient or an obstacle with the use of external energy."

During the process of active transport, a protein pump makes use of stored energy in the form of ATP, to move molecules.

Types of Active transport : Active transport is of two types – Primary active transport and secondary active transport.

Primary active transport: In this process of transportation, the energy is utilized by the breakdown of the ATP to transport molecules across the membrane against a concentration gradient. Therefore, all the groups of ATP powered pumps contain one or more binding sites for the ATP molecules, which are present on the cytosolic face of the membrane. Basically, the primary active transport uses external chemical energy such as the ATP.

Sodium-potassium pump, the most important pump in the animal cell is considered as an example of primary active transport. In this process of transportation, the sodium ions are moved to the outside of the cell and potassium ions are moved to the inside of the cell.

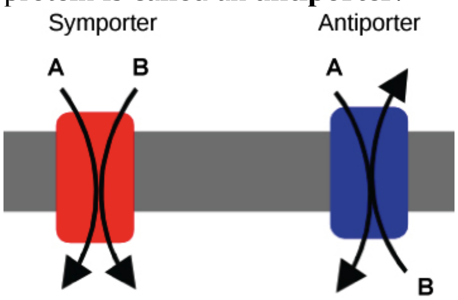
Mechanism of primary (carrier-mediated) active transport:

1. The protein is initially open to the cell interior, allowing sodium ions to adhere to the high-affinity pump.
2. Binding of sodium induces the phosphorylation of the pump via ATP hydrolysis.
3. This chemical modification to the pump causes it to undergo a conformational change so that it is instead open to the cell exterior. In this new conformation, the pump now has a low affinity towards sodium, causing those ions to get released into the extracellular space.
4. The shape change also creates a high-affinity environment for potassium ions on the pump, so potassium ions can thus bind, causing the release of the attached phosphate group.
5. Removal of that phosphate group returns the pump to its starting conformation, i.e., facing the cell's inside.
6. Again, the pump reverses its affinity from potassium to sodium, so the potassium ions detach as the sodium ions did on the outside. Now, the pump can bind to sodium as before and repeat the process.

Secondary active transport: The electrochemical gradients set up by primary active transport store energy, which can be released as the ions move back down their gradients. Secondary active transport uses the energy stored in these gradients to move other substances against their own gradients.

As an example, let's suppose we have a high concentration of sodium ions in the extracellular space. If a route such as a channel or carrier protein is open, sodium ions will move down their concentration gradient and return to the interior of the cell. In secondary active transport, the movement of the sodium ions down their gradient is coupled to the uphill transport of other substances by a shared carrier protein (a **co-transporter**). For instance, in the figure below, a carrier protein lets sodium ions move down their gradient, but simultaneously brings a glucose molecule up its gradient and into the cell. The carrier protein uses the energy of the sodium gradient to drive the transport of glucose molecules.

In secondary active transport, the two molecules being transported may move either in the same direction (i.e., both into the cell), or in opposite directions (i.e., one into and one out of the cell). When they move in the same direction, the protein that transports them is called a **symporter**, while if they move in opposite directions, the protein is called an **antiporter**.



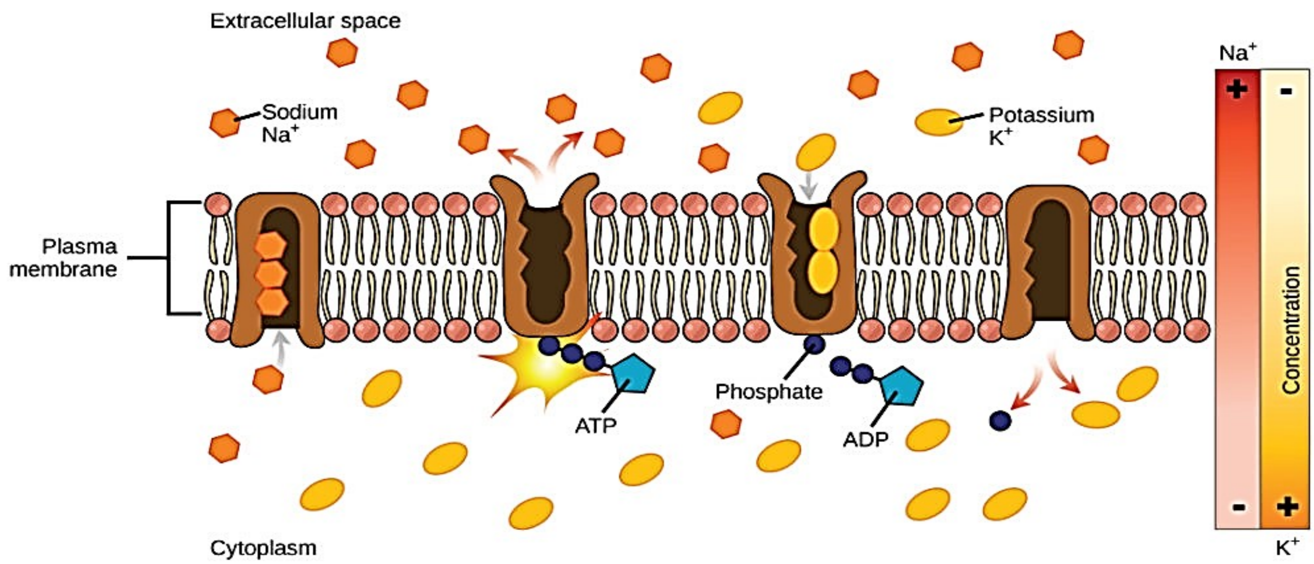


Figure1 . The sodium-potassium pump move potassium and sodium ions across the plasma membrane.

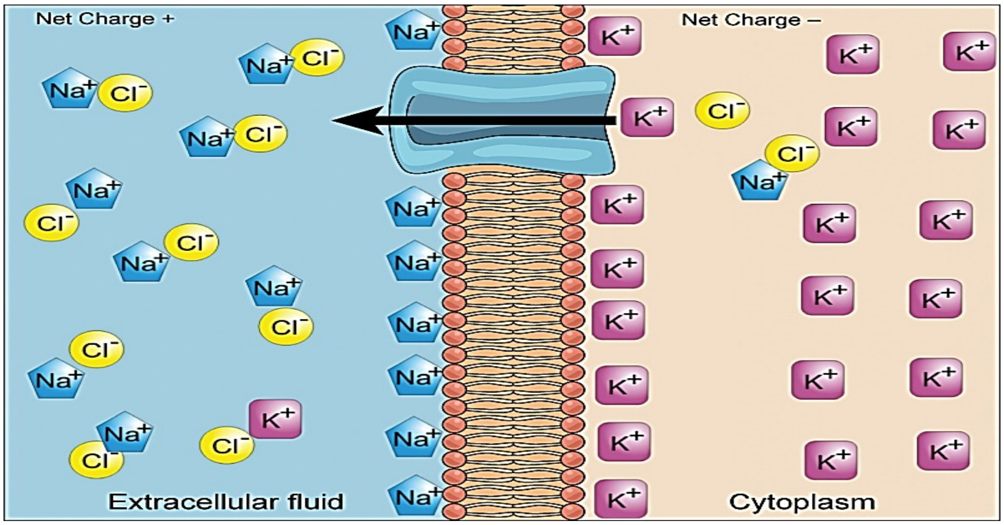


Figure 2. Electrochemical gradients arise from the combined effects of concentration gradients and electrical gradients.