Primary and Secondary Active Transport

The active transport of molecules across cell membranes is one of the major factors on molecular level for keeping homeostasis within the body. This kind of transport requires energy as they transport molecules against their concentration gradient. It is divided into two types according to the source of energy used, called primary active transport and secondary active transport. In primary active transport, the energy is derived directly from the breakdown of ATP. In the secondary active transport, the energy is derived secondarily from energy that has been stored in the form of ionic concentration differences between the two sides of a membrane.

Cell Membrane

The cell membrane consists of a lipid bilayer including a large amount of protein molecules. These are considered as integral or peripheral membrane proteins. The lipid bilayer constitutes a barrier for the movement of different substances. However, some substances, especially lipid-soluble substances, are still able to pass this lipid bilayer through diffusion. The membrane proteins show different properties for the transport of substances. Their molecular structures interrupt the continuity of the lipid bilayer and thereby constitute an alternative pathway through the cell membrane. Hence the vast majority of the membrane proteins are regarded as transport proteins. They play a crucial role in keeping the ion concentration intracellular and extracellular on a physiological level. The way how transportation is achieved differs among three groups of transport proteins.

- Large pores, consisting of several protein subunits, that allow the bulk flow of water, ions and larger molecules down their chemical concentration gradients (facilitated diffusion). **No** additional metabolic activity is required hereby.
- ATP-dependent ion pumps is the usage of direct or indirect metabolic energy to move molecules against its electrochemical gradient.
- Specialized ion channels that only allow the passage of particular ions across the membrane.

The substances that are transported across the membrane can cross alone, along with other molecules or in exchange:

- Uniporters, that move one type of molecule in one direction
- Symporters, that move several molecules in one direction
- Antiporters, that move different molecules in opposite directions.

Primary Active Transport

For more information see Primary Active Transport.

Primary active transport utilizes energy in form of ATP to transport molecules across a membrane against their concentration gradient. Therefore, all groups of ATP-powered pumps contain one or more binding sites for ATP, which are always present on the cytosolic face of the membrane.

Based on the transport mechanism as well as genetic and structural homology, there are considered four classes of ATP-dependent ion pumps:

- P-class pumps
- F-class pumps
- V-class pumps
- ABC superfamily

The P-, F- and V-classes only transport ions, while the ABC superfamily also transports small molecules.

The energy expended by cells to maintain the concentration gradients of some ions across the plasma and intracellular membranes is considerable:

- In kidney cells, up to 25 % of the ATP produced by the cell is used for ion transport;
- In electrically active nerve cells, 60-70 % of the cells' energy requirement may be devoted to pumping Na+ out of the cell and K+ into the cell.

Example: Na^+/K^+ pump

Secondary Active Transport

For more information see Secondary Active Transport.

Secondary active transport, is transport of molecules across the cell membrane utilizing energy in other forms than ATP. This energy comes from the electrochemical gradient created by pumping ions out of the cell. This Co-Transport can be either via antiport or symport.

Example : Na+ / glucose co-transporter

The formation of the electrochemical gradient, which enables the co-transport, is made by the primary active transport of Na+. Na+ is actively transported out of the cell, creating a much higher concentration extracellularly than intracellularly. This gradient becomes energy as the excess Sodium is constantly trying to diffuse to the interior. This mechanism provides the energy needed for the co-transport of other ions and substances. This is evident in co-transporters such as the Sodium-glucose co-transporter. The Na+ gradient created by the Na+/K+ ATPase is used by the Na+/Glucose co-transporter to transport glucose and Na+ back into the cell.

Links

Related articles

Bibliography

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