TRANSPORT ACROSS CELL MEMBRANE

Two types of transport process occur across the membrane.

1. Non-mediated transport
2. Mediated transport

Non-mediated transport occurs through the simple diffusion process and the driving force for the transport of a substance through a medium depends on its chemical potential gradient. Whereas mediated transport requires specific carrier proteins. Thus, the substance diffuses in the direction that eliminates its concentration gradient; at a rate proportional to the magnitude of this gradient and also depends on its solubility in the membrane's non-polar core.

Mediated transport is classified into two categories depending on the thermodynamics of the system:

1. Passive-mediated transport or **facilitated diffusion:** In this type of process a specific molecule flows from high concentration to low concentration.
2. Active transport: In this type of process a specific molecule is transported from low concentration to high concentration, that is, against its concentration gradient.

Passive mediated transport:

Substances that are too large or polar diffuse across the lipid bilayer on their own through membrane proteins called carriers, permeases, channels and transporters. Unlike active transport, this process does not involve chemical energy. So the passive mediated transport is totally dependent upon the permeability nature of cell membrane, which in turn, is function of organization and characteristics of membrane lipids and proteins.

Types of passive transport:

1. Diffusion: The process of the net movement of solutes from a region of high concentration to a region of low concentration is known as diffusion. The differences of concentration between the two regions are termed as concentration gradient and the diffusion continues till the gradient has been vanished. Diffusion occurs down the concentration gradient.

2. Facilitated diffusion: The process of the movement of molecules across the cell membrane via special transport proteins that are embedded within the cellular membrane is known as facilitated diffusion or called carrier-mediated diffusion. Many large molecules, such as glucose, are insoluble in lipids and too large to fit into the porins, therefore, it will bind with its specific carrier proteins, and the complex will then be bonded to a receptor site and moved through the cellular membrane.

3. Filtration: Filtration is the process of the movement of water and solute molecules across the cell membrane due to hydrostatic pressure generated by the system. Depending on the size of the membrane pores, only solutes of a certain size may pass through it. The membrane

pores of the Bowman's capsule in the kidneys are very small, and only albumins (smallest of the proteins) can filter through. On the other hand, the membrane pores of liver cells are extremely large, to allow a variety of solutes to pass through and be metabolized.

4. Osmosis: Osmosis is the type of diffusion of water molecules across a semi- permeable membrane, from a solution of high water potential to a region of low water potential. A cell with a less negative water potential will draw in water but this depends on other factors as well such as solute potential (pressure in the cell e.g. solute molecules) and pressure potential (external pressure e.g. cell wall).

Active transport: Active transport is the movement of a substance against its concentration gradient (i.e. from low to high concentration). It is an endergonic process that, in most cases, is coupled to the hydrolysis of ATP.

Types of active transport:

1. Primary active transport: Primary active transport, also called direct active transport, directly uses energy to transport molecules across a membrane. Example: Sodium-potassium pump, which helps to maintain the cell potential.

2. **Secondary active transport:** Secondary active transport or co-transport, also uses energy to transport molecules across a membrane; however, in contrast to primary active transport, there is no direct coupling of ATP; instead, the electrochemical potential difference created by pumping ions out of the cell is instrumental. The two main forms of active transport are antiport and symport.

(a) Antiport: In antiport two species of ion or solutes are pumped in opposite directions across a membrane. One of these species is allowed to flow from high to low concentration which yields the entropic energy to drive the transport of the other solute from a low concentration region to a high one. Example: the sodium-calcium exchanger or antiporter, which allows three sodium ions into the cell to transport one calcium out.

(b) Symport: Symport uses the downhill movement of one solute species from high to low concentration to move another molecule uphill from low concentration to high concentration (against its electrochemical gradient). Example: glucose symporter SGLT1, which co-transports one glucose (or galactose) molecule into the cell for every two sodium ions it imports into the cell.

Endocytosis and Exocytosis

Endocytosis: Endocytosis is the process by which cells absorb larger molecules and particles from the surrounding by engulfing them. It is used by most of the cells because large and polar molecules cannot cross the plasma membrane. The material to be internalized is surrounded by plasma membrane, which then buds off inside the cell to form vesicles containing ingested material.

Phagocytosis or "cell eating," is a mechanism whereby the cell can ingest solid particles. Phagocytosis is the process by which certain living cells called phagocytes engulf larger solid particles such as bacteria, debris or intact cells. Certain unicellular organisms, such as the

protists, use this particular process as means of feeding. It provides them part or all of their nourishment. This mode of nutrition is known as phagotrophic nutrition. In amoeba, phagocytosis takes place by engulfing the nutrient with the help of pseudopods, that are present all over the cell, whereas, in ciliates, a specialized groove or chamber, known as the cytostome, is present, where the process takes place.

When the solid particle binds to the receptor on the surface of the phagocytic cell such as amoeba, then the pseudopodia extends and later surrounds the particle. Then their membrane fuses to form a large intracellular vesicle called phagosome. These phagosomes fuse with the lysosome, forming phagolysosomes in which ingested material is digested by the action of lysosomal enzymes. During its maturation, some of the internalized membrane is recycled to plasma membrane by receptor mediated endocytosis.

Pinocytosis, or "cell drinking," allows the cell to consume solutions. An infant's intestinal lining ingests breast milk by pinocytosis, allowing the mother's protective antibodies to enter the baby's bloodstream.

Exocytosis: The process by which the cells direct the contents of secretory vesicles out of the cell membrane is known as exocytosis. These vesicles contain soluble proteins to be secreted to the extracellular environment, as well as membrane proteins and lipids that are sent to become components of the cell membrane. It is the final step in the secretory pathway that typically begins in the endoplasmic reticulum (ER), passes through the Golgi apparatus, and ends at the outside of the cell. Some of the examples include secretion of proteins like enzymes, peptide hormones and antibodies from cells and release of neurotransmitter from presynaptic neurons.

Types of exocytosis: Exocytosis are of two types. Constitutive exocytosis and Regulated exocytosis

1. Constitutive exocytosis: Secretory materials are continuously released without requirement of any specific kind of signal.

2. **Regulated exocytosis:** Regulated exocytosis requires an external signal, a specific sorting signal on the vesicles for release of components. It contains a class of secretory vesicles that fuse with plasma membrane following cell activation in presence of signal. Examples of regulated exocytosis are secretion of neurotransmitter, hormones and many other molecules.