The Cytoplasmic membrane strcture and functions

Cytoplasmic membrane:

The cytoplasmic membrane surrounds the cell's protoplasm, and is chemically composed mainly of proteins (60-70%) and phospholipids (20-30%). The thickness of this membrane is approximately 7.5 nanometers and is characterized by selective permeability. The structure of this membrane is very similar to the structure of the cytoplasmic membrane in eukaryotic cells, but the most important difference between them is that the bacterial membrane does not contain sterols in its composition. In addition, we find that the bacterial membrane is richer in protein materials than that found in eukaryotic organisms, and this is related and largely consistent with its role and the many different functions that this membrane performs in bacteria, as it performs some vital processes to break down sugars and produce energy due to the fact that it contains respiratory enzymes.

The main function of the plasma membrane is to protect the cell from its surrounding environment and is semi-permeable and regulates the substances that enter and exit it. The most important functions of the plasma membrane is:

1- Selective Permeability and Nutrient Transmission:

This membrane has the property of selective permeability, meaning that it allows nutrients to enter the bacterial cell and waste to exit it. While at the same time preventing large molecules and toxic substances from entering the cell.

2- Many enzymes are concentrated in the structure of this membrane, which enables it to perform various vital functions such as respiration and photosynthesis. For example, mesosomes are folds of the membrane into the cell that perform the respiration process instead of mitochondria due to the presence of respiratory chain enzymes. Chromatophores are also tiny tubes that fill the cytoplasm and perform photosynthesis. They are found in photosynthetic bacteria and are also derived from the cytoplasmic membrane and contain pigments, enzymes and electron carriers that enable them to perform photosynthesis instead of plastids in eukaryotic plant cells.

3- Secretion of hydrolytic enzymes:

Gram-positive bacteria secrete hydrolytic enzymes into the external environment, while Gram-negative bacteria secrete them into the space between the peptidoglycan and the plasma membrane, called the periplasmic space. These enzymes dissolve large molecules to facilitate their movement across the membrane.

4- Synthetic functions:

This membrane contributes effectively to the formation of the outer cell wall, where the sugar peptide molecules that enter into the composition of the wall are manufactured, as the cytoplasmic membrane contains the enzymes involved in the creation of the cell wall. It also contains the lipid carriers at which the units that make up the cell wall are attached. It also contains the enzymes responsible for the synthesis of phospholipids.

5- This membrane participates in bacterial reproduction, as it contributes to the transfer of DNA to the new cell during the process of cellular replication.

6- It contains **chemotactic sites**.

Transport of materials across membranes

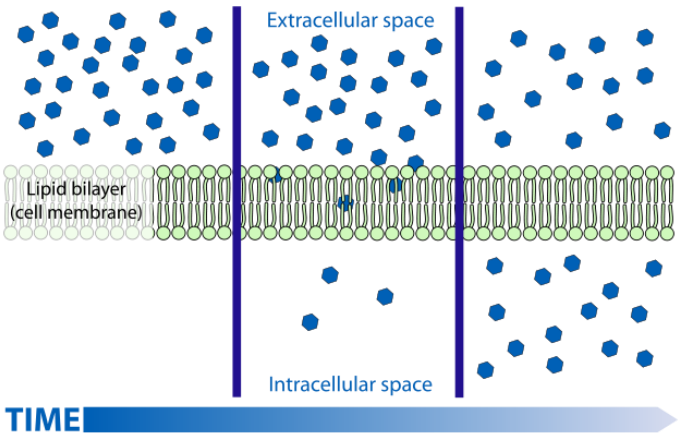
Materials move across the plasma membranes of both prokaryotic and eukaryotic organisms through two types of processes, passive and active.

In passive processes, materials pass through the membranes from an area of high concentration to an area of low concentration (i.e., move along the concentration gradient) without the cell using any energy.

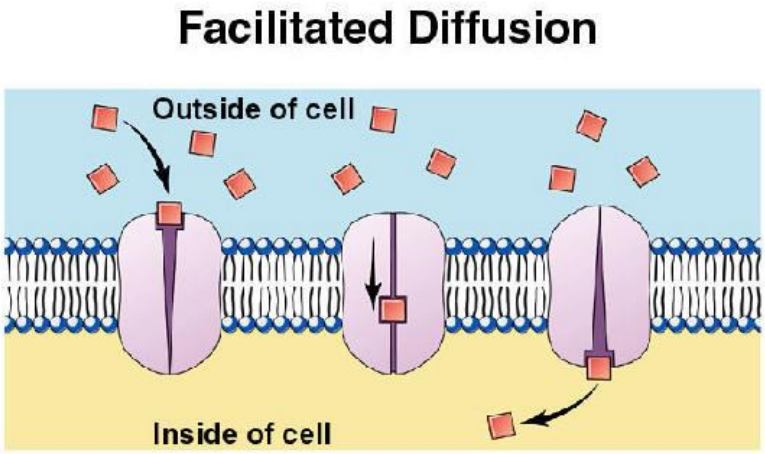
In active processes, the cell must use energy to move materials from areas of low concentration to areas of high concentration (against the concentration gradient).

First/ Passive processes: They include of :

1. **Simple diffusion:** which is the movement of molecules or ions from an area of high concentration to an area of low concentration. The movement continues until the distribution of molecules or ions is equal in both directions. The stage in which the distribution of particles is equal in all areas is called equilibrium. Cells use simple diffusion to transport small molecules such as oxygen and carbon dioxide across their membranes.



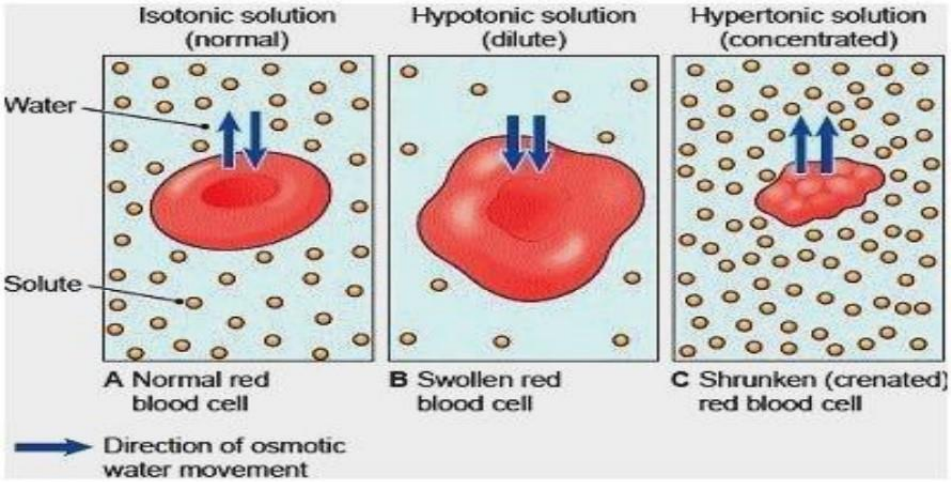
2. **Facilitated diffusion:** It occurs through the presence of special structures that facilitate the passage of materials across membranes. These structures are the membrane's intercellular proteins that act as channels that facilitate the movement of ions or large molecules across the plasma membrane. In this case, this type of intercellular proteins is called transport proteins (i.e. the penetration of materials and their passage through membranes).



Both types are similar in that no energy is consumed by the cell when they occur, because the substance moves from the region of high concentration to the region of low concentration. The difference between the two processes lies in the use of protein transporters in the second type. Some transporters allow the passage of small inorganic ions that are hydrophilic (and are so hydrophilic that they cannot penetrate the nonpolar interior of the lipid bilayer of the plasma membrane). These transporters are more common in prokaryotes and are not specialized to transport specific types of molecules or ions, but rather allow a variety of ions or small molecules to pass through the protein channels embedded in the membrane. There are other transporters common in eukaryotes that are specialized, that is, specific to a specific type of substance, and the transported molecules are usually larger in size, such as simple sugars and vitamins.

3. **Osmosis:** is the movement of water molecules across a selectively permeable membrane from an area of high water concentration (low concentration of dissolved

molecules) to an area of low water concentration (high concentration of dissolved molecules). Water molecules may cross plasma membranes by moving through the lipid bilayer by simple diffusion or through membrane proteins called aquaporins that act as water transporter.

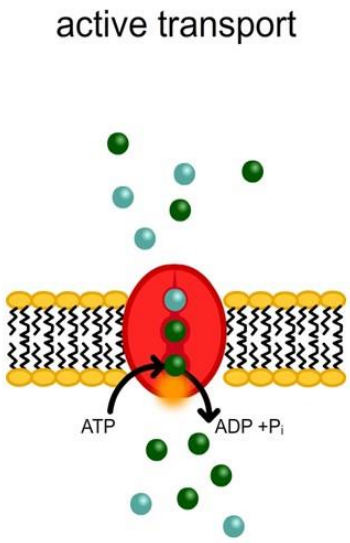


Second/ Active processes:

Both simple diffusion and facilitated diffusion are mechanisms for transporting materials into cells when their concentration is higher outside the cell. However, when a bacterial cell is in an environment containing nutrients at a low concentration (lower than their concentration inside the cell), the cell must use active mechanisms (in which energy is consumed) such as active transport in order to transport or collect the necessary materials into the cell.

A- **Active transport:** In this process, the cell uses energy in the form of ATP to transport materials across the plasma membrane. Among the materials that are transported are ions such as (sodium, potassium, calcium, and chloride), amino acids, and simple sugars. Although these materials can also be transported by passive processes, cells transport them by active transport against the concentration gradient, which allows the cell to collect the materials it needs. The transfer of materials by active transport is from the outside to the inside, even though the concentration is much higher inside it. Active transport depends on the carrier proteins present in the plasma membrane. There is a specific carrier for each material or for each group of similar materials.

Active transport allows microbes to move materials across the membrane at a constant speed even if there is a shortage of the transported material.



B- **Group translocation:** It is a special form of active transport that occurs only in prokaryotes. In this type, the chemical substance changes while crossing the membrane. Once the substance changes and crosses into the cell, the plasma membrane becomes impermeable to it, so the substance remains trapped inside the cell. This type requires energy, which is also provided by high-energy phosphate compounds such as (phosphoenolpyruvate PEP).