**Movement of substances across the plasma membrane**

In order for the cell cytoplasm to communicate with the external environment, materials must be able to move through the plasma membrane, which is act as semi –permeable barrier that allow some substances to pass the membrane but not others.

Substances can pass across the membrane depends not only on the particles of substances themselves but also on additional consideration like how much of substance is already on each side of the membrane (concentration gradient), or on the availability of energy to support the process because some transport mechanism require energy to be provided by the cell in order for certain types of substances to be moved from one side of the membrane to the other.

There are two types of transport mechanism by which molecules traverse membrane:

1-**passive transport** is the movement of molecules or ions from an area of higher to lower concentration; mechanism does not require energy from cells (metabolic energy). The four main kinds of passive transport are like simple diffusion, facilitated diffusion, filtration and osmosis.

Passive transports can happen through three different channels:

a- lipid bilayer

b-pore/channel protein

c-carrier protein (integral proteins have receptors that bind with specific molecules to pass through P.M.)

2-Other **transport mechanism** that require energy from cells like active transport and bulk transport mechanisms.

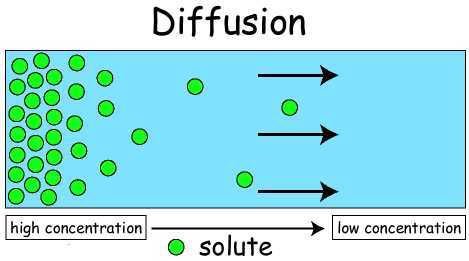
**1-Passive transport mechanism**

**A-Diffusion**: also called (simple or passive diffusion) is the net movement of material from an area of high concentration to an area with lower concentration and no membrane proteins are involved. The energy used in the process of diffusion is supplied by the particles themselves for example the rate of diffusion increase with increase in temperature.

**Particles that Move through the Plasma Membrane through Diffusion**

Substances soluble in fat: fatty acid, glycerol, some vitamins (A ,D ,E ,K)

Neutral particles: water, oxygen, carbon dioxide

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**Factors that affect the RATE of diffusion**

1. Difference in concentration between the inside and outside of the cell.  The bigger the difference between concentrations, the diffusion will be faster.

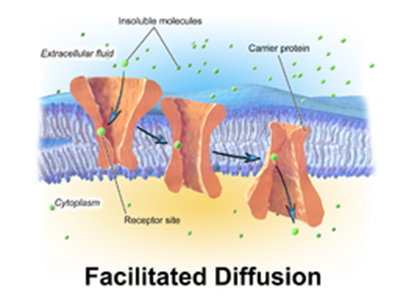
2. The size of the chemical substance.  O2 is two atoms. Glucose is 24 atoms big.  Protein is massive.  Oxygen can easily diffuse across a cell membrane.  Sugar can kind of, that’s why it’s assisted by a transporter protein to facilitate it.  The proteins don’t move at all.

3. Temperature. Higher temps = molecules move faster.

4. Whether the chemical substance is water-soluble or lipid soluble.  The lipid soluble goes faster because the cell membrane is phospholipids and can easily diffuse through a fatty membrane.

**b- Facilitated diffusion** is the movement of molecules across the cell membrane via special transport proteins that are embedded within the cellular membrane (integral proteins) so it differs from passive diffusion in that molecules do not dissolve in phospholipids bilayer but their passage is mediated by proteins and this process requires no energy.

Large, insoluble molecules, such as glucose (very essential elements for life and it represents the main source of energy for cells) and proteins require a carrier molecule to move through the plasma membrane. 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.



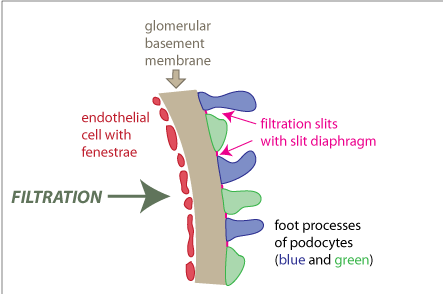
**There are two classes of proteins mediate facilitated diffusion**

**1-carrier proteins** are specific, each one or type can transport with only a certain type of molecule or ion, which is then transported through the membrane. For example, various sugar molecules of identical size might be present inside or outside the cell, but glucose can cross the membrane hundreds times faster than the other sugars. For that reason the membrane can be called differentially permeable.

**2-channel proteins** form unblocked pores that allow speciﬁc substances to enter or leave the cell. Water can pass through phospholipid bilayers by simple diffusion or by facilitated diffusion through special channel proteins called **aquaporin's**.

**c- Filtration**

Filtration is the movement of water and solute molecules across the cell membrane due to hydrostatic [pressure](https://en.wikipedia.org/wiki/Pressure) .Depending on the size of the membrane pores, only solutes of a certain size may pass through it. For example, the membrane pores of the [Bowman's capsule](https://en.wikipedia.org/wiki/Bowman%27s_capsule) in the kidneys are very small, and only [albumins](https://en.wikipedia.org/wiki/Albumins), the smallest of the proteins, have any chance of being filtered through.



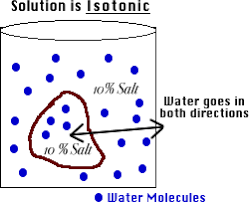
**Filtration process in kidney glomeruli.**

**d- Osmosis**: is the movement of water [molecules](https://en.wikipedia.org/wiki/Molecules) across a selectively permeable membrane.

There are three types of Osmosis solutions:

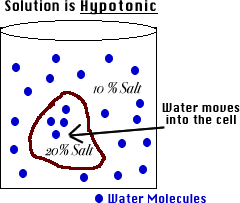
**1-Isotonic solution**

Isotonic solution is when the extracellular solute concentration is balanced with the concentration inside the cell. In the Isotonic solution, the water molecules still moves between the solutions, but the rates are the same from both directions, thus the water movement is balanced between the inside of the cell as well as the outside of the cell. Tissue ﬂuids and blood plasma are isotonic for body cells.



**2- Hypotonic solutions**

Hypotonic is a solution that is less concentrated than the intracellular ﬂuid, so the water moves into the cell and that can cause the cell to swell up and explode. When the cell is in danger of bursting, organelles called contractile vacuoles will pump water out of the cell to prevent this.

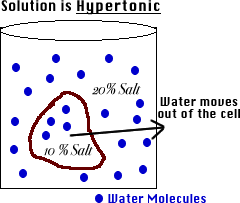
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**3- Hypertonic solution**

Hypertonic solution is when the solute concentration outside the cell is higher than the concentration inside the cell.

In hypertonic solutions, water diffuses out of the cell due to osmosis and the cell shrinks in a process termed **crenation.**

Thus, the animal cell has always to be surrounded by an isotonic solution.



**2-Transport mechanisms (requiring energy from cells)**

The cell needs to transport molecules against their concentration gradient (from low to high concentration) and that needs energy which provide by ATP hydrolysis.

There are many types of mechanisms that require energy to transport different material across P.M.:

**A- Active transport** is the movement of substances like ions against its concentration gradient (from low to high concentration).

Both carrier proteins and energy are needed to transport molecules against their concentration gradient. In this case, chemical energy (ATP) is required for the carrier proteins to combine with the substance to be transported.

For example the kidney cells have a large number of mitochondria (to create energy) near membranes where active transport is occurring.

**B- Bulk transport** is the movement of substances or macromolecules across membrane within a small vacuole that's means that the large molecules and particles move through membrane enclosed by vesicles formed by parts of cell membrane.

These processes are grouped according to whether materials are moved into or out of the cells in which both needs energy as follows:

**1-Endocytosis**

Cells uptake molecules and particles from surrounding media through plasma membrane to inside the cytoplasm in which material a cross through plasma membrane invigilates to inside the cell to form vesicle containing ingested material. Endocytosis occurs in one of three ways

**a-Phagocytosis (cell eating)**

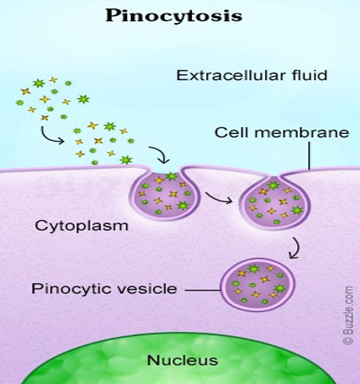
Occurs when the materials enter the cell in which cells engulf large particles like bacteria and debris. Cytoplasmic process (pseudopodia) of the cell is extended and surrounds the particles and form vesicle called **phagosome.** Phagosomesthen fuse with lysosome to form phagolysosome. Lysosomal enzymes digest the content and the indigested particles are retained within vacuoles which termed residual bodies

Certain white blood cells like neutrophil and macrophage are specialized for engulfing and removing particles like bacteria and dead cells.

**b-Pinocytosis (cell drinking)**

Occurs when the plasma membrane folds inward to form a channel allowing dissolved substances to enter the cell.

When the channel is closed, the liquid is encircled within a pinocytic vesicle, which then fuse with lysosomes to hydrolyze (break down) the particles. These vesicles then fuse with plasma membrane to release their and release their contents outside the cell. This process is termed transcytosis and requires energy in the form of adenosine triphosphate (ATP).



**2-Exocytosis**

Exocytosis is the opposite of endocytosis (in which substances are taken into cells), like waste products or molecules for export like hormones and proteins.

In exocytosis, membrane-bound vesicles containing large amount of cellular molecules are transported to the [cell membrane](https://www.thoughtco.com/cell-membrane-373364). The vesicles fuse with the cell membrane and expel their contents to the exterior of the cell.

Both endocytosis and exocytosis are used by all cells because the important molecules for the cells are large molecules and cannot pass through passive transport so they needs energy to transport this molecules across plasma membrane and making a form of bulk transport.

