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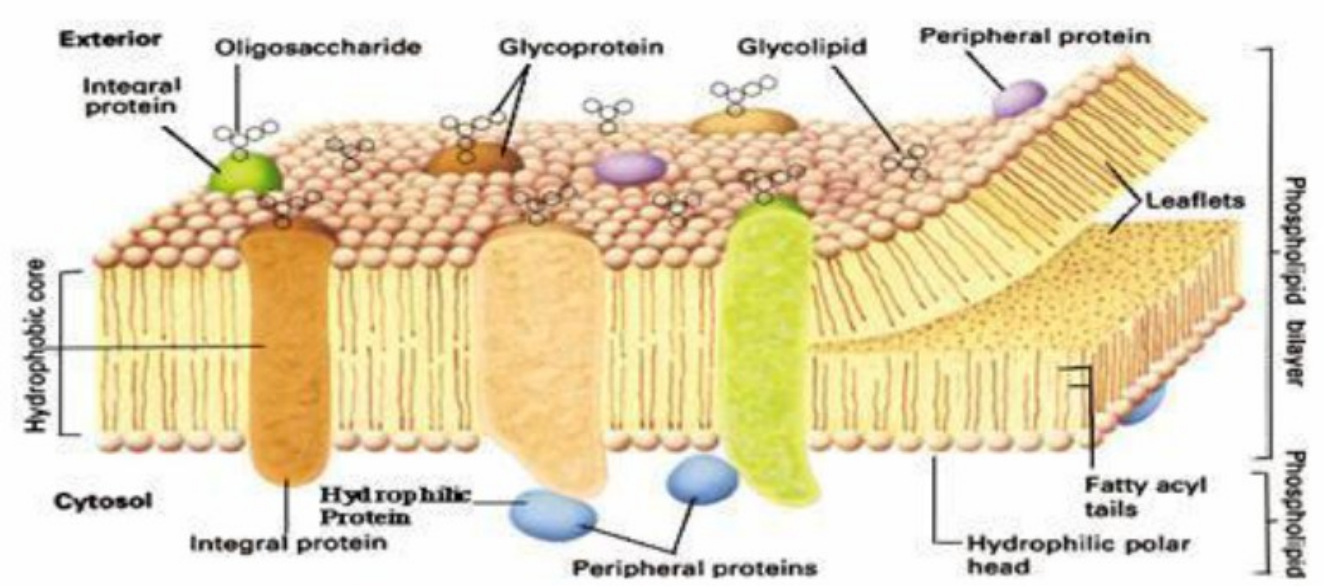
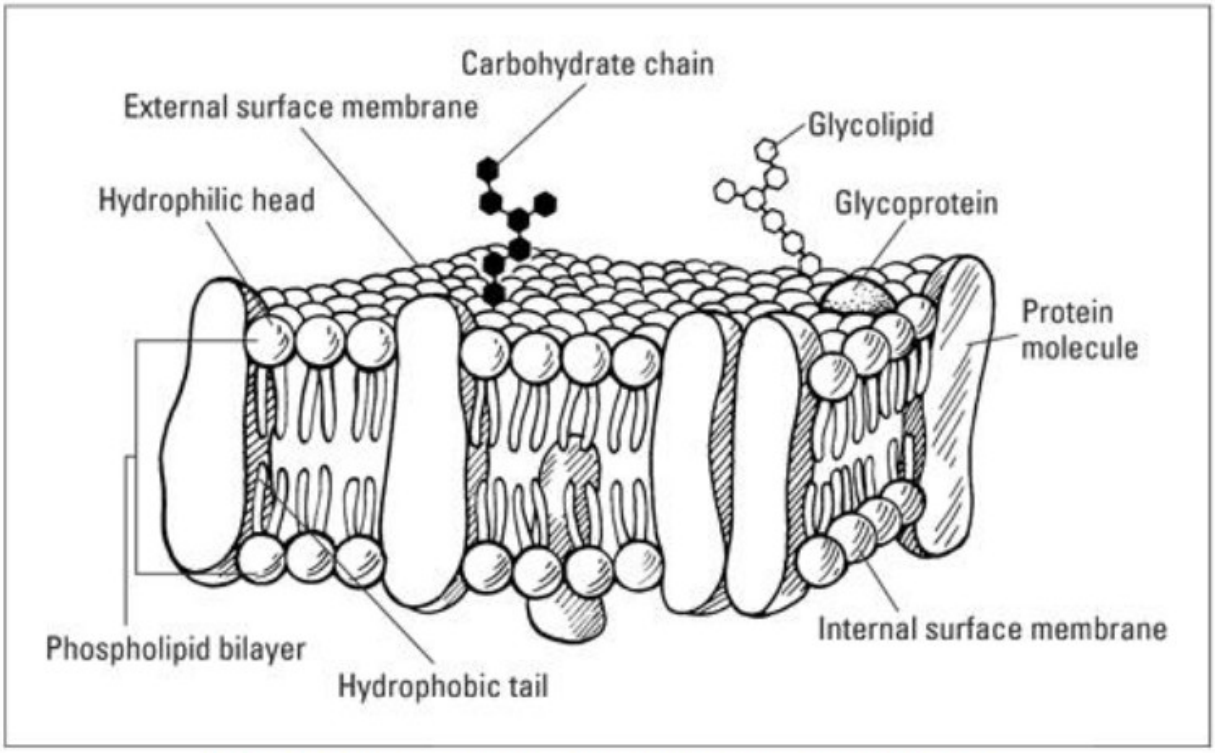
Fluid Mosaic Model:

1972 Singer and Nicolson proposed a model for explaining the membrane structure, taking into account all the known facts. According to this model, cell membrane consists of a highly viscous fluid matrix of a bilayer of phospholipids having globular proteins associated with them. This model came to be known as fluid mosaic model. The phospholipid molecules in the cell membrane have their polar, **hydrophilic heads** towards outer surface and the nonpolar, **hydrophobic tails** towards inner surface. This arrangement forms a water resistant barrier through which only lipid soluble substances can pass through. The proteins in cell membrane are of two kinds. Peripheral protein some of the proteins are found at the periphery, partly projecting out of the lipid layer. These are the extrinsic proteins. These proteins can be easily extracted. Integral proteins some of the protein molecules are found totally embedded in the phospholipid matrix. Those are the intrinsic, which represent nearly 70% of the membrane proteins. These proteins cannot be extracted. Some of the integral proteins have very large molecules that extend throughout the phospholipid matrix,

projecting out on both surfaces. These proteins are called tunnel proteins or transmembrane proteins.

They are believed to have channels for the passage of water-soluble substances. The scattered arrangement of protein molecules in the phospholipid matrix gives the appearance of a mosaic pattern. Hence , the name to the model. A few molecules of oligosaccharides are found attached to the free ends of protein molecules on the outer surface of the membrane is called glycoprotein. Sometimes they are also found attached to phospholipid layer is called glycolipid.





The fluid-mosaic model of plasma membranes.

The phospholipid bi-layer and associated proteins is called the fluid mosaic model of the membrane's structure. 'Fluid' because the positions of the constituents are always changing and 'mosaic' because the membrane is made from different types of molecules.

Types of Cellular Transport

The membrane is selectively permeable and able to regulate what enters and exits the cell. The movement of substances across the membrane can be :

1-Passive Transport

A. Simple diffusion.

B. Facilitated diffusion (diffusion with the help of transport proteins).

C. Osmosis (diffusion of water).

- Cell uses no energy ,- molecules move randomly,- Molecules spread out from an area of high concentration to an area of low concentration.

2-Active Transport (cell does use energy)

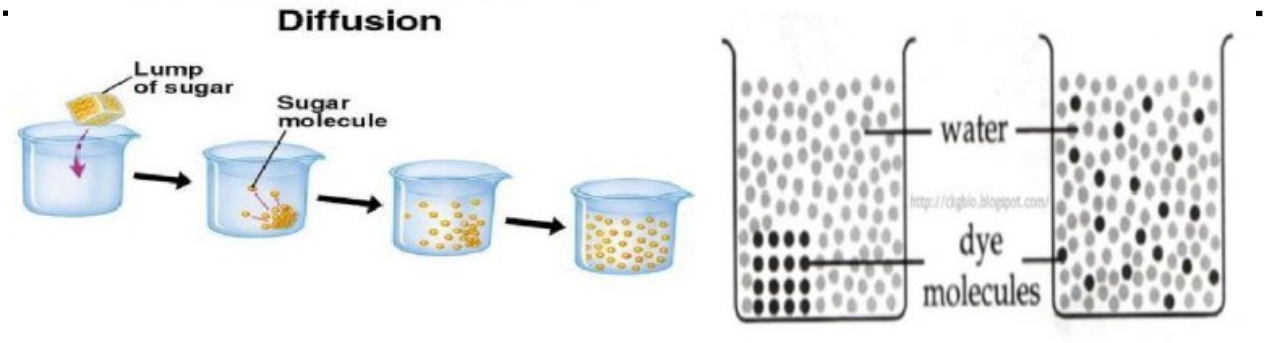
Protein Pumps b. Endocytosis c. Exocytosis

✓**Passive Transport:-**

1. **Simple diffusion**

Simple diffusion is the random movement of particles (molecules) from a region of high concentration to a region of low concentration, no energy required, This process will continue until a dynamic equilibrium reached.

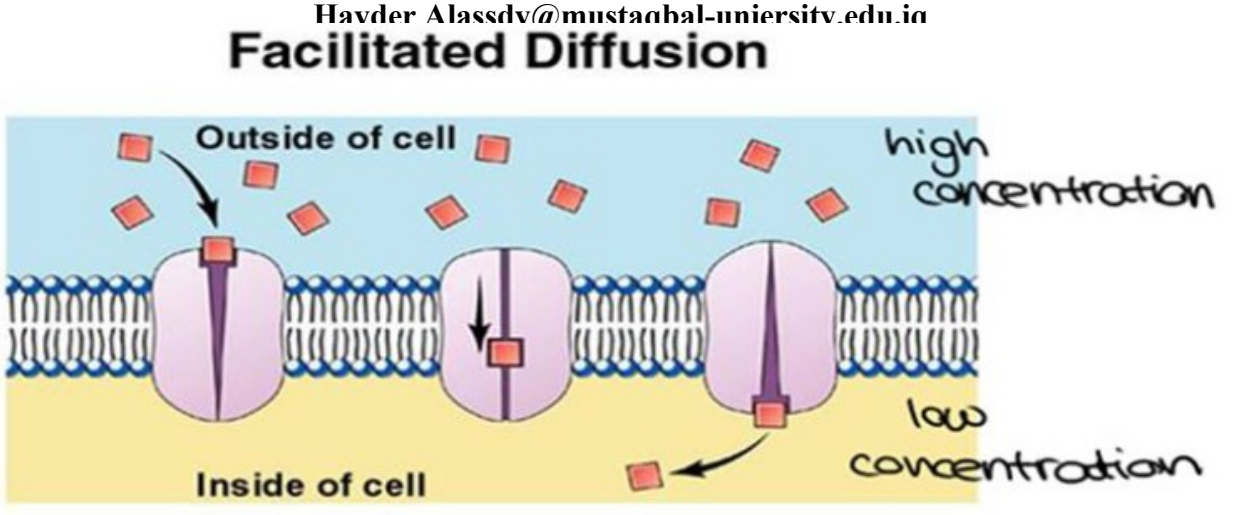
Example – Oxygen diffuses from the blood cells in the blood stream into muscles .



2-Facilitated diffusion (diffusion with the help of transport proteins)

- Facilitated diffusion is the passive movement of molecules or ions down a concentration gradient (high concentration to an area of low concentration)
- It is utilized by molecules that are unable to freely cross the phospholipid bilayer (e.g. large, polar molecules and ions)
- This process is mediated by two types of transport proteins – channel proteins and carrier proteins in the plasma membrane
- This process don't required energy

example- the absorption of glucose and amino acid from the villi into the blood capillaries.



Facilitated diffusion through a carrier protein in the plasma membrane.

3. Osmosis (diffusion of water)

- Define osmosis : The diffusion of water across a selectively permeable membrane:-
  - The random movement of water molecules.
  - From a region of high concentration of water molecules to a region of low concentration of water molecules.
  - Through a partially permeable membrane.
- Define selectively permeable membrane : a membrane that allows only certain materials to cross it.

Materials pass through pores in the membrane

Example – the reabsorption of water molecules from the nephrons into the blood capillaries.

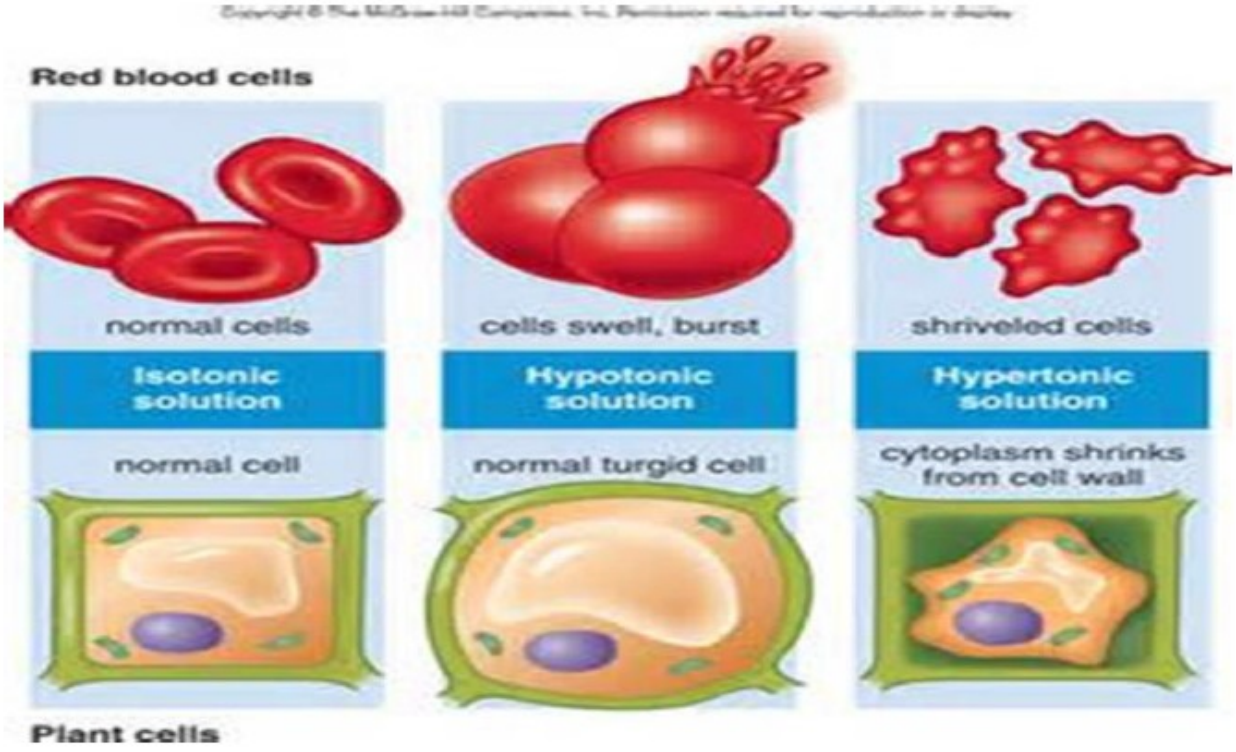
How Does Osmosis Affect Cells?

Osmosis allows cells to regulate the balance of water inside the cells.

The (concentration of solutes outside the cells determines) whether a cell is isotonic, hypotonic, or hypertonic.

- **Isotonic** : cells that are in an isotonic solution reside in a solution which has the same concentration of the solute as the cells inside its membrane . There is net flow of water across the plasma membrane. Animal cells are in their normal state in isotonic solution, while plant cells are flaccid.
- **Hypertonic**: cells that are in a hypertonic solution reside in a solution which has the higher concentration of the solute outside of the cell. This concentration gradient results in a net flow of water out the cell .animal cells shrivel in a hypertonic solution, as water has left the cell, causing the cell to die .but plant cells are plasmolyzed, meaning that the cell has lost water inside its membrane, resulting in it pulling away from the side of its cell wall.

- **Hypotonic** : cells that are in a hypotonic solution reside in a solution which has the lower concentration of the solute outside of the cell. This concentration gradient results in a net flow of water into the cell. Animal cells lyse, or burst, in hypotonic solutions as the cell cannot contain so much water .plant cells are in their healthy state in hypotonic solution, as the cell pushes against the cell wall, giving the cell its structure as the cell wall doesn't allow the plant cell to burst as the animal cell does.



✓ Active Transport:-

Process that moves materials across the plasma membrane requires energy from the cell in the form of ATP, Materials move against the concentration gradient:

Low concentration high concentration

Three types of active transport: a. protein Pumps b. Endocytosis c. Exocytosis

1-Active Transport protein Pumps

1-An ATP molecule breaks down into ADP, releasing a phosphate group and a whole lot of energy.

2-The phosphate group attaches to a protein pump, causing it to change its shape so that it can move a small molecule or ion across the plasma membrane.

3-The protein changes shape again so that the molecule can be released on the other side.

There are many types of carrier proteins and they only carry specific molecules across the plasma membrane.

Example of active transport: sodium-potassium pump in nerve cells

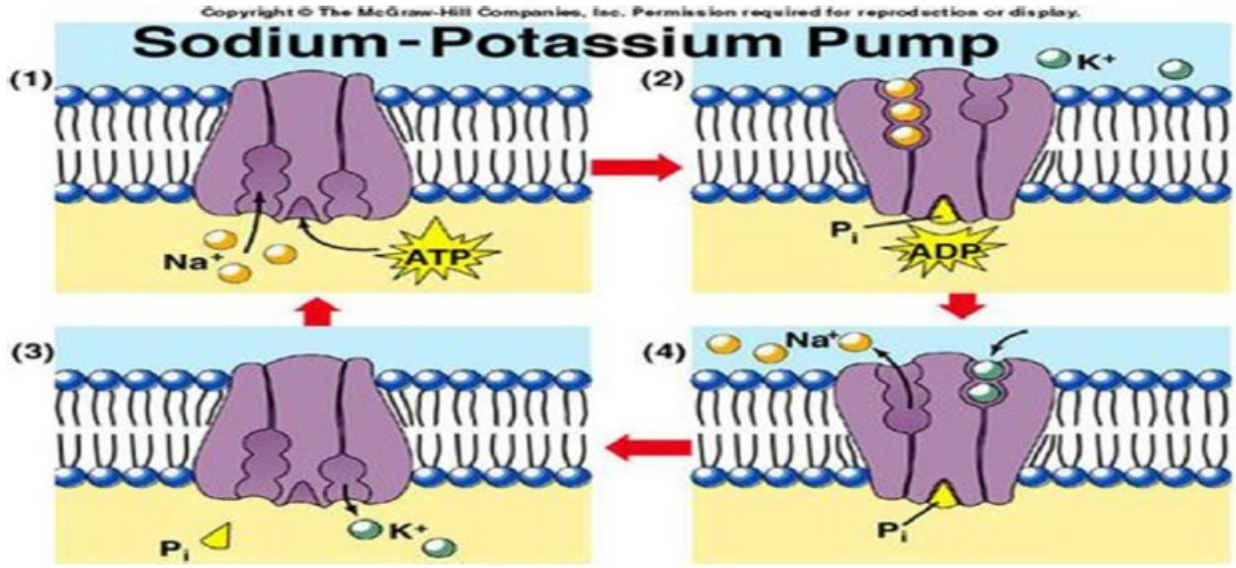
~~Sodium ions are kept at low concentrations inside the cell and~~ potassium ions are at higher concentrations outside the cell,

1- 3 Na+ and 1 ATP bind to the protein "pump."

2- ADP is released, causing a change in the pump's shape.

3- 3 Na+ are released as 2 K+ bind to the pump.

4- Pi is released, causing the pump's shape to change, and releasing 2 K+ .



The Sodium-Potassium Pump

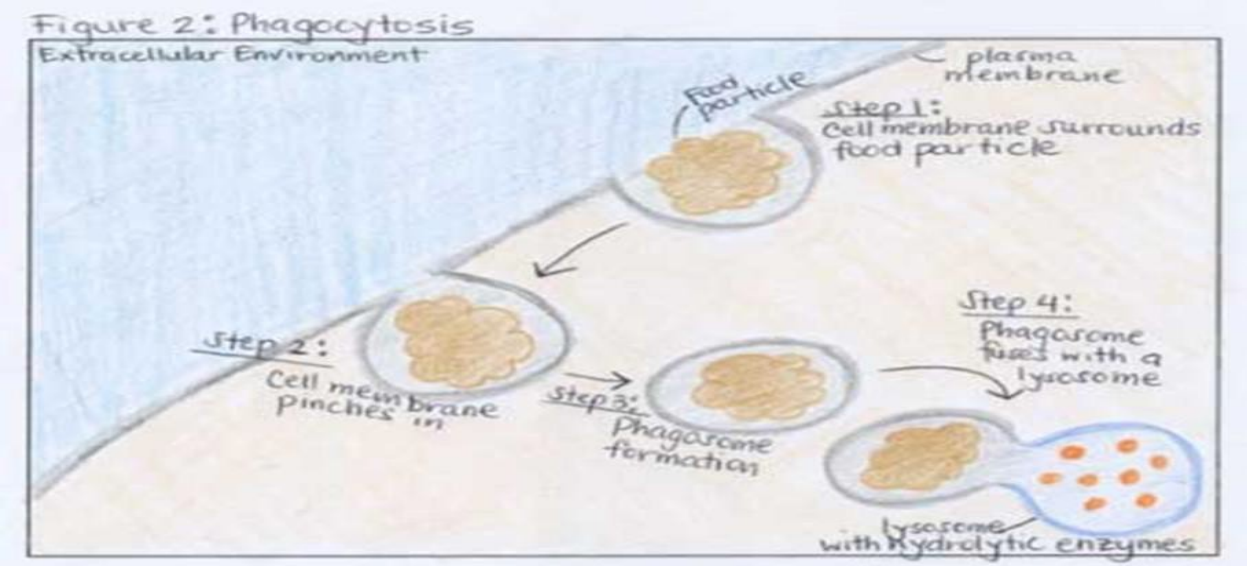
The movement of macromolecules such as proteins or polysaccharides into or out of the cell is called bulk transport. There are two types of bulk transport, exocytosis and endocytosis, and both require of energy (ATP).

2-Endocytosis

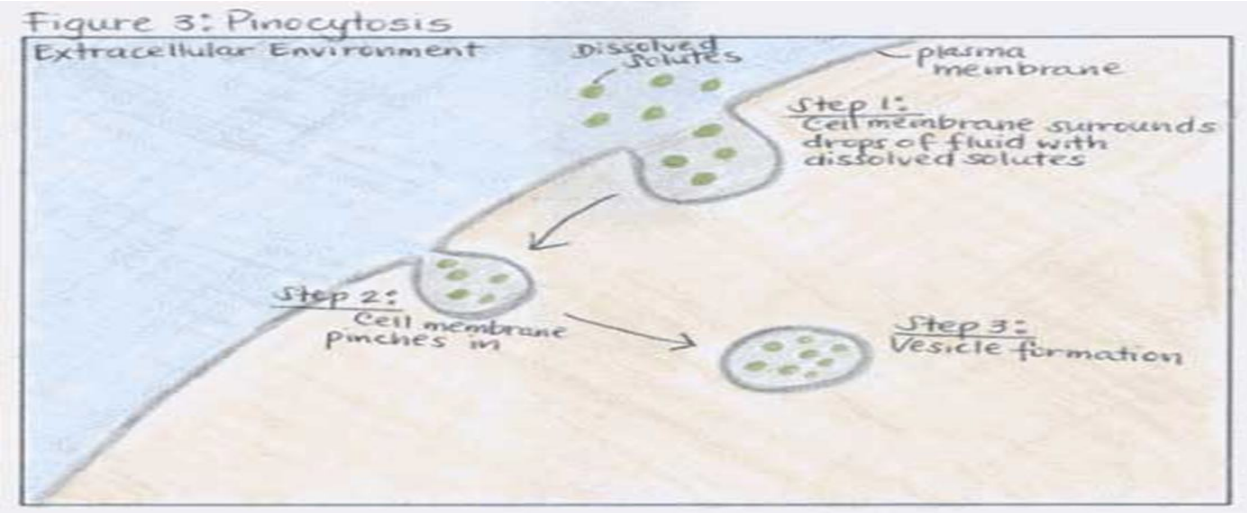
A process of cellular ingestion by which the plasma membrane folds inward to bring substances into the cell. There are three types of endocytosis: phagocytosis, pinocytosis, and receptor-mediated endocytosis.

Example: Secretion of neurotransmitters, hormones, mucus, etc.; ejection of cell wastes

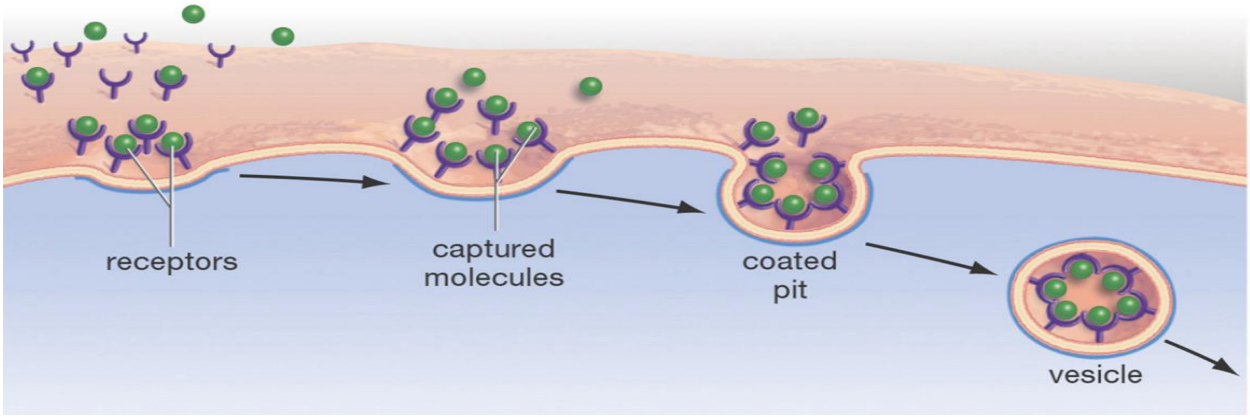
In ***phagocytosis*** or "cellular eating," the cell's plasma membrane surrounds a macromolecule or even an entire cell such as bacteria and buds off to form a food vacuole or phagosome. The newly-formed phagosome then fuses with a lysosome whose hydrolytic enzymes digest the "food" inside.



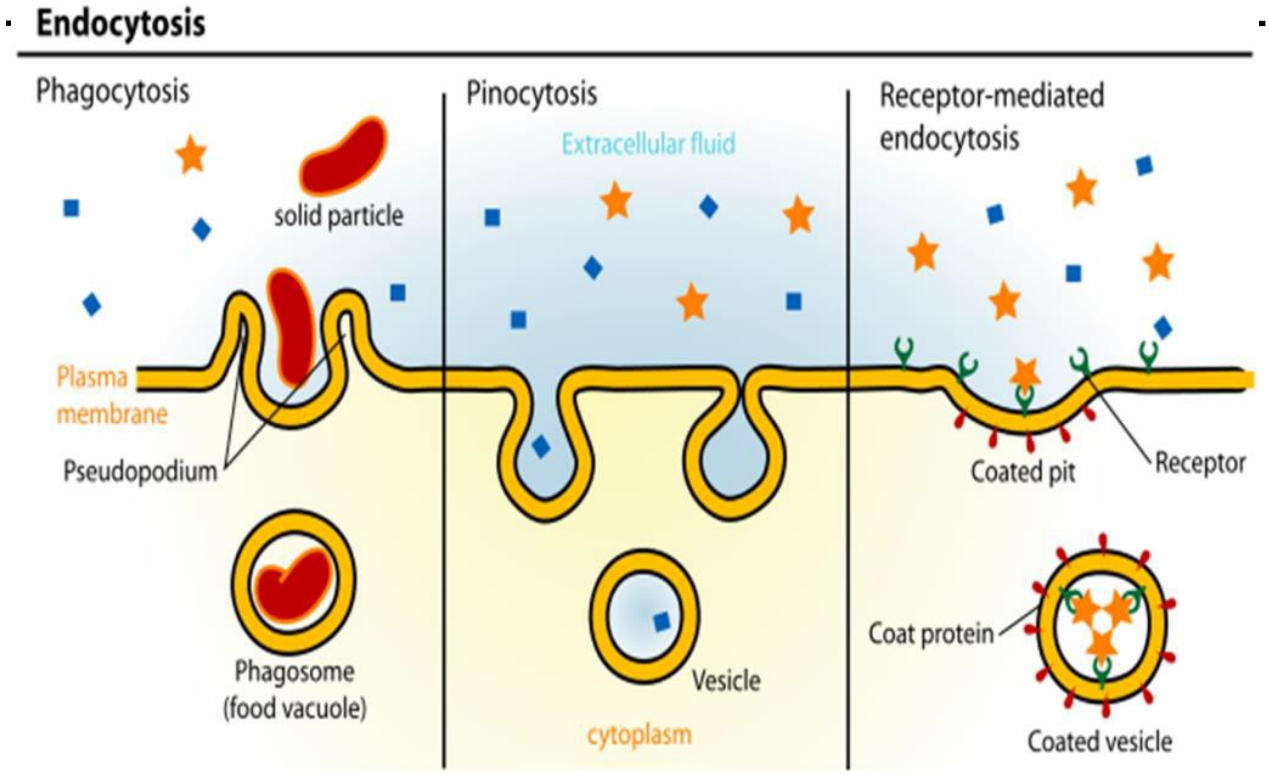
Pinocytosis or "cellular drinking," the cell engulfs drops of fluid by pinching in and forming vesicles.



Receptor-mediated endocytosis is a process by which cells absorb metabolites, hormones, proteins, viruses (endocytosis) by the inward budding of plasma membrane vesicles containing proteins with receptor sites specific to the molecules being absorbed.

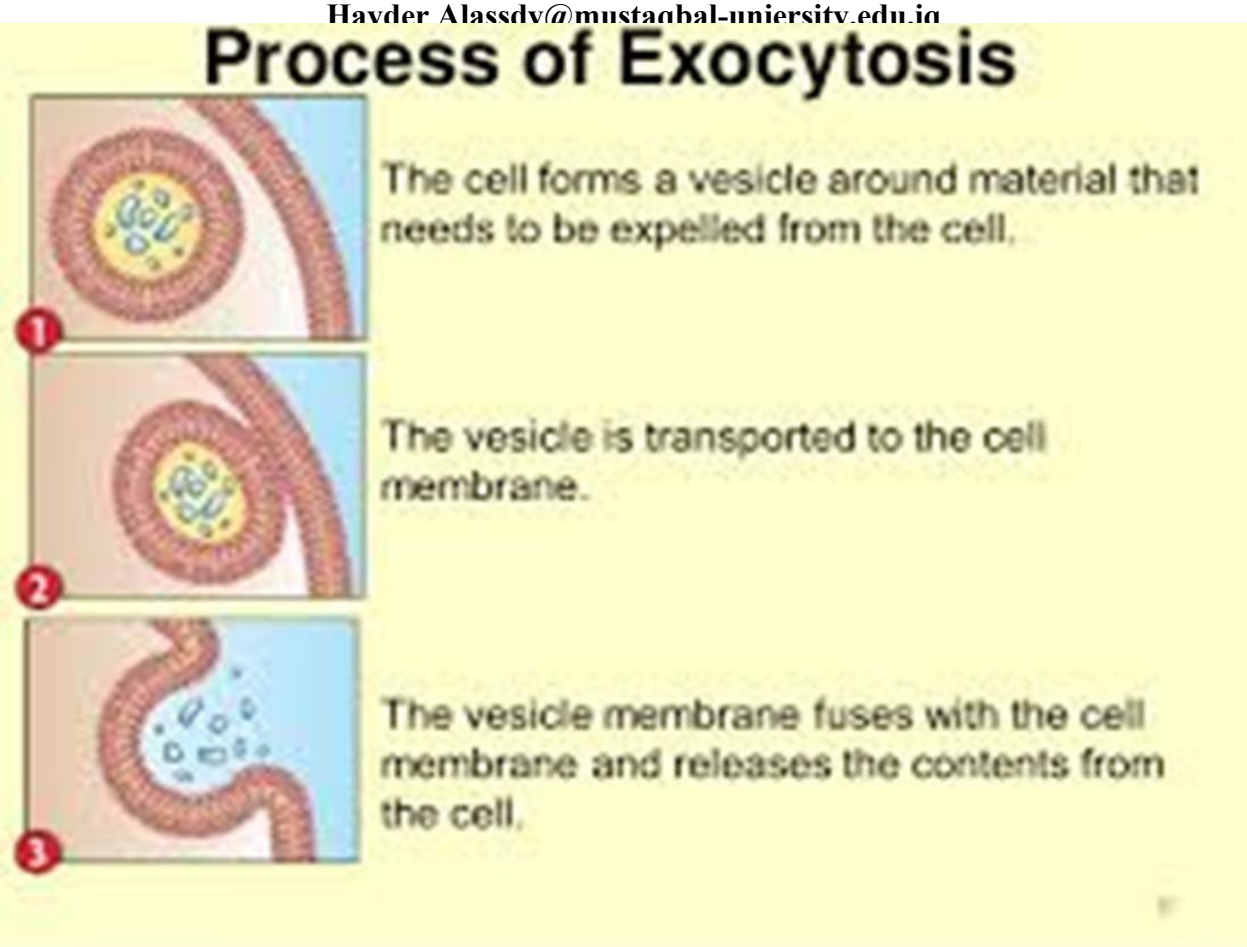


Receptor-mediated endocytosis



3-Exocytosis

In exocytosis, materials are exported out of the cell via secretory vesicles. In this process, the Golgi complex packages macromolecules into transport vesicles that travel to and fuse with the plasma membrane. This fusion causes the vesicle to spill its contents out of the cell. Exocytosis is important in expulsion of waste materials out of the cell and in the secretion of cellular products such as digestive enzymes or hormones.


Process of Exocytosis
The cell forms a vesicle around material that needs to be expelled from the cell.
1
The vesicle is transported to the cell membrane.
2
The vesicle membrane fuses with the cell membrane and releases the contents from the cell.
3

The End