PLASMA MEMBRAN

The ***plasma membrane*** **m**ay be defined as *the thin, elastic semipermeable living mem brane that serves as a boundary for the cytoplasm.* The term *"plasma membrane"* was coined by *Nageli* in 1855. Plasma membrane is otherwise called *cell me**mbrane or plasma lemma.***

Plasma membrane is the outer limiting membrane in all animal cells. But in plant cells and bacterial cells, it is present inner to the cell wall. It serves as a barrier for the flow of some components into and out of cells. Thus it determines the composition of cytoplasm in the cell.

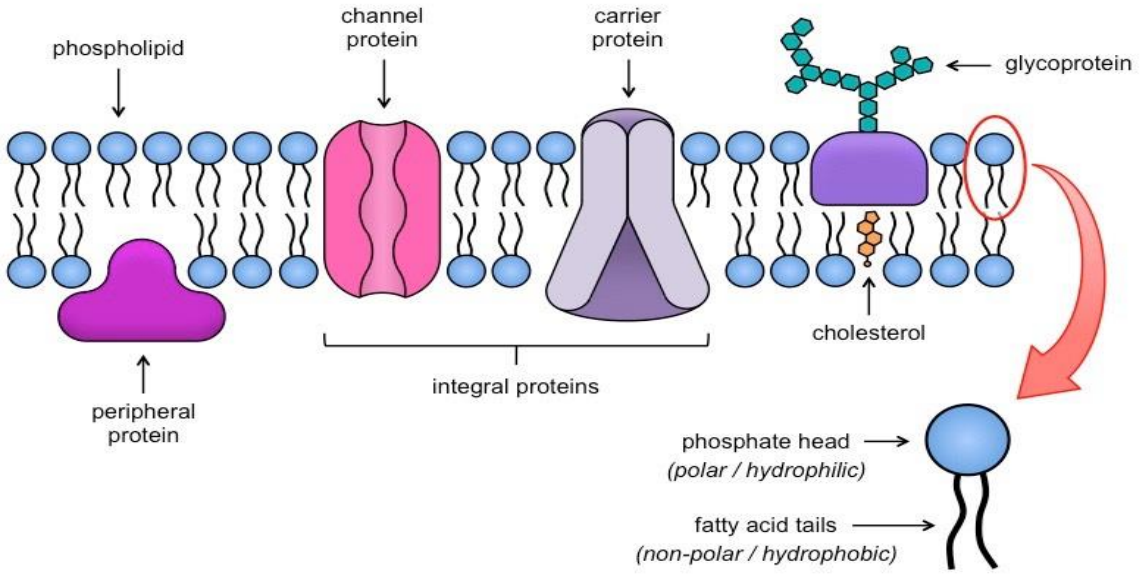
Plasma membrane is about 75A in thick. Its thickness is almost constant in all plant cells, animal cells and bacterial cells (Å ; One Angstrom unit = 108 cm (1/100000000cm). But the blood cells show variations. Even in the same cell its thickness varies at different points.

Plasma membrane is formed of glycoproteins and phospholipids. These molecules are arranged in a definite pattern.

Fluid Mosaic Model

- Fluid mosaic model explains the structure of plasma membrane. This model was proposed *Singer* and *Nicolson* in 1972. According to this model, the plasma membrane consists of *pids* and *proteins.* The lipid is in the form o*f fluid* and the proteins are embedded here and There in the lipid in a *mosaic* pattern. Hence the nam*e fluid mosaic model.*

- The lipids are arranged in the form of two layers, an *outer layer* and an *inner layer.* The proteins do not form a layer.
- Each lipid molecule has a *hydrophobic tail a*nd a *hydrophilic head.* The hydrophilic heads face outwards and the hydrophobic tails of the two



layers face each other.

- Lipid molecules are not rigidly positioned in their respective places. They are always in a constant motion and undergo lateral diffusions. While doing so, proteins bound with them also moves drastically.
- The protein molecules ar*e globular* and are of two types, namely *peripheral* or ex *trinsic protein*s an*d integral or intrinsic proteins.* The peripheral proteins are arranged on the surface and are loosely bound to the lipid. The integral proteins are deeply embedded and are tightly bound to the lipid molecules. The peripheral proteins as well as the outer part of integral proteins are studded with s*ugar*s. Such proteins with attached sugars are called *glycopr**oteins.***
- If the extrinsic proteins are removed from the membrane, there is no disruption in the mem brane structure, but if intrinsic proteins are removed, the membrane structure is disrupted.

- Similarly sugars are also attached to the outer surface of some lipids. These lipids with attached sugars are call*ed glycolipids.* The carbohydrates found in intrinsic proteins and glycolipids form a sugary covering called *glycocal*yx. It recognizes certain foreign proteins as in immune cells and protects the cell from the extracellular digestive fluids.
- The fluid mosaic model stresses that the plasma membrane is *semi fluid* in nature; the lipid as well as the intrinsic proteins *move* freely within the lipid bilayer. Fluid mosaic model is the *most accepted model* because it convincingly explains the trans port through the membrane.

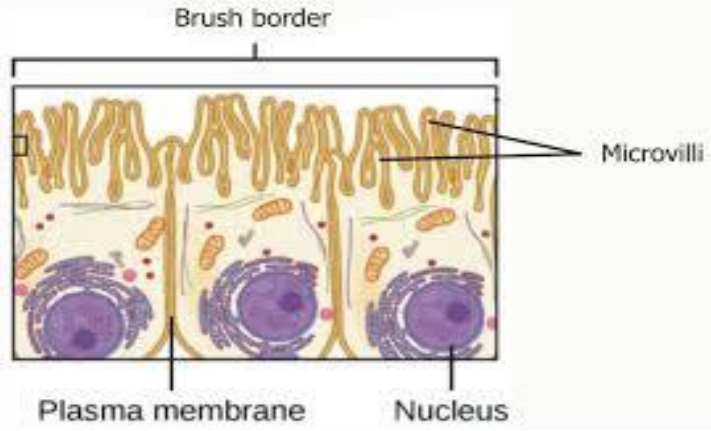
Specializations of Plasma Membrane

The plasma membrane shows here and there some specialized structures. These may be due to outgrowths or ingrowths or contact with adjacent membrane. Such structures include the following

- *Microvilli*
- *Desmosomes*
- *Gap junction (Nexus)*
- *Tight junction(Zona occludens)*
- *Interdigitations*
- *Basal infoldings*
- *Plasmodesmata*

Microvilli

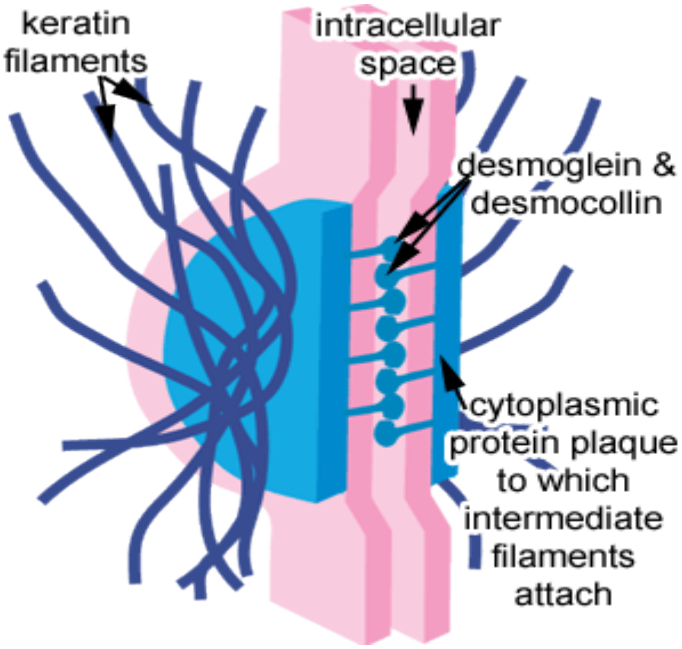
- ✓ *Microvilli are minute finger-like projections arising from the surface of certain cells.*
- ✓ They are found on the epithelial cells of intestine, kidney tubules, gall bladder, uterus, hepatic cels and yolk cells. A single cell contains about 3000 microvilli.
- ✓ Each microvillus is *cylindrical* in shape.



- ✓ The microvillus is 0.6 to 0.8 micrometer long and has a diameter of 0.1 micrometer.
- ✓ It has a core of *cytoplasm* enclosed by the *plasma membrane*.
- ✓ The cytoplasmic core is traversed by fine *micro filaments* made up of *actin.* The micro-filaments are attached to the tip of the microvillus by *a - actin.* The micro-filaments give rigidity to the microvilli.
- ✓ *The outer surface of the microvillus of cells is covered by a coat of fine filaments* called *fuzzy coat*. The fuzzy coat is composed of *glycoproteins.*
- ✓ ***Site***
- ✓ At the base of microvillus, the microfilaments are joined to a transverse network of actin myosin microtubules, that form th*e terminal web.*
- ✓ Functions:
- ✓ The microvilli increase the surface area of the cell and help in effective absorption.
- ✓ The narrow spaces lying between the microvilli form a kind of sieve through which substances pass during the process of absorption.

Desmosomes

- ✓ *Desmosome*s are *disc-shaped thick areas of plasma membranes of two adjacent cells, which glue the adjacent cell*s. They are *anchoring cell junction*s. They are also called *macula adherens*. They are found only in vertebrate cell.



- ✓ Desmosomes are abundant in *cardiac muscle* and *skin* that are subjected to severe me chanical stresses
- ✓ The desmosome consists of *a plaque, a network of keratin filaments,* transmembrane, linker proteins called *cadherins* and an *intercellular space.*
- ✓ The *plaque* is a button-like structure attached the cytoplasmic side of each cell membrane. It is made up of intracellular attachment proteins called *placoglobins.*
- ✓ The *cadherins* are transmembrane proteins present in the intercellular space. They are Ca dependent cell wall adhesion proteins. They link the plaques of adjacent cells.
- ✓ The *intercellular* space in the desmosome remains normal as in other places.

There are four types of desmosomes. They are the following:

- *Belt desmosomes*
- *Hemi-desmosomes*
- *Spot desmosomes*
- *Septate desmosomes*

Belt Desmosomes

- ✓ Belt desmosome is found just below the tight junction. It is in the form ofa band encircling the borders on the inner side of the cell membrane of epithelial cells. The intercellular space is filled with fine filaments. The belt desmosomes help to close gaps and also help in the movement and change in shape of embryonic epithelial cells.

Spot Desmosomes

- ✓ Spot desmosomes are like *rivets* or *spot welds* between the plasma membrane of adjacent cells. The spot desmosome consists of an *intercellular plaque* lying on the cytoplasmic surface of each cell membrane*, keratin filaments* and trans *membrane linkers.*
- ✓ The transmembrane linkers arise from the plaques and *traverse* the intercellular space joining the plasma membranes.
- ✓ The spot desmosome is meant for *mechanical attachment.*

Hemi Desmosomes

- ✓ Hemi desmosomes are *half desmosomes. They* have only one *plague.* They are present at th*e basal surface o*f certain *epithelial cells.* They resemble a typical desmosome, but their outer side remains coated with *collagen fibrils.* They help to join the cell membrane ofepithelial cells to the underlying basement membrane.

Septate Desmosomes

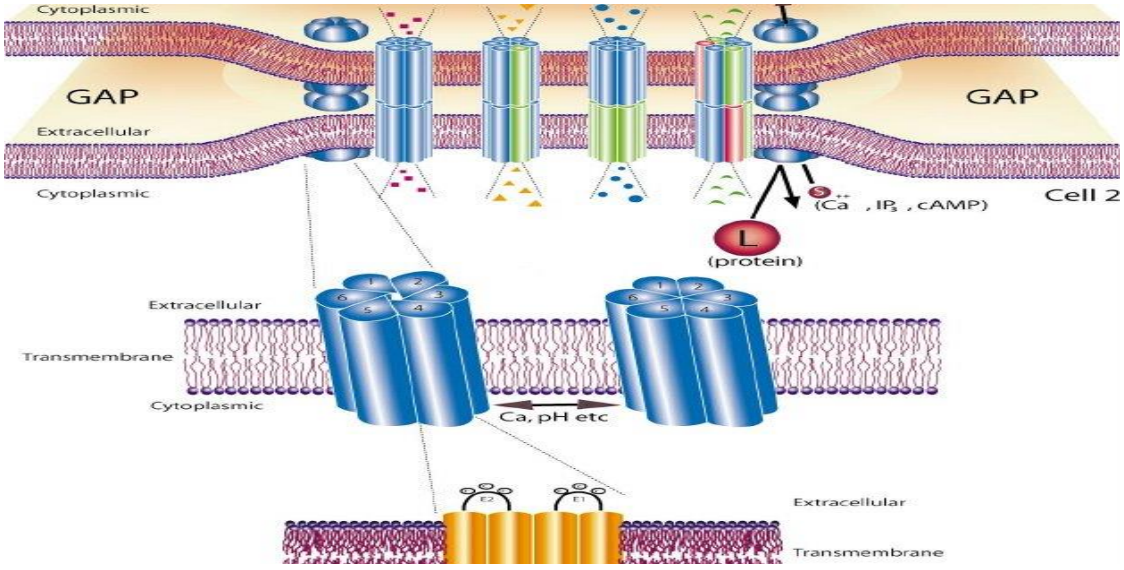
- ✓ Septate desmosome is a desmosome containing many transverse septa between the plasma membranes in the intercellular space. It is found in the epithelial cells of invertebrates. In these desmosomes, intercellular cementing substance and keratin filaments are absent. They help in the attachment of cells for intercellular communication.

Gap junction

- ✓ *Gap junction* is a *junctional complex between two cells at the point of contact. It is a channel or pore through two cell membranes across the intercellular space between* two *adjacent cells.*
- ✓ In the region of the gap junction, the intercellular space is narrow and has a width of only 20*8*.
- ✓ The gap junction consists of a hollow containing a pair of hexagonal cy*linde*rs called *connexon*s. Each plasma membrane contains one connexon. The two connexons are arranged end to end to form a channel or pipe between the two cells.
- ✓ Each connexon is made up of six *protein* sub-units called ***conne*xins**.
- ✓ Calcium ions help to regulate the opening and closure of the gap junctions. When the intracellular calcium ion concentration increases, the channels are closed.

Functions:

- ✓ In cardiac muscles and synapses, the gap junctions conduct *electrical signals* (ions).
- ✓ Gap junctions allow passage of ions, sugars, vitamins, nucleotides and metabolites between cells.



Tight Junction

- ***Tight junction*** is an occluding junctional complex where the plasma membranes of adja cent cells fuse together so intimately, that the intercellular space disappears.
- The tight junctions occur in the *epithelial cells o*f intestine, glands, gall bladder and brain. Tight junctions are found in *vertebrates.*
- Tight junctions serve to seal the space between the cells and act as barriers for the diffusion of substances through these regions.
- The tight junction consists of an interlocking network ofridges on the inner surface of plasma membrane. These ridges are called *sealing strand*s. Each sealing strand is formed of a double row of proteins called o*ccludins* and *claudins.*

  Function:
- Tight junctions prevent the passage of materials to and from the cells.
- They prevent the leakage of pancreatic secretory products into the blood.

Interdigitations

- *The plasma membranes of adjacent cells project into the cytoplasm as finger-like projections* called *interdigitations.*
- The interdigitations help to compartmentalise the cytoplasm.

Basal infoldings

- *Basal infoldings* are *finger-like invaginations of the plasma membrane into the cu toplasm from the base of the cell*. They arise from plasma membrane that faces the basement membrane.
- They are found in kidney cells. The basal infoldings function as septa and they split the cytoplasm into compartments.
- The basal infoldings enclose many mitochondria. They are concerned with the *acti*ve *transport* of materials.

Plasmodesmata

- ✓ *Plasmodesma* (singular) is a c*ytoplasmic bridge connecting adjacent cells*. Plasmodes mata are found only in *plant cells.* The plasmodesmata form fine channels of 20 to 40um diameter between adjacent cells.
- ✓ The centre of the plasmodesma has a narrow cylindrical structure called *desmotubille.* The desmotubule is continuous with the endoplasmic reticulum of the adjoining cells.
- ✓ The space between the wall of the plasmodesma and desmotubule is called *cytosolic annulus.* Molecules pass through the cytosolic annulus.
- ✓ The cell wall contains many small openings called *pits.* The adjacent cells are connected by cytoplasmic bridges through these pits.
- ✓ The cytoplasm and the endoplasmic reticulum of the adjacent cells make contact through the plasmodesmata.

Functions:

- ➢ Free movement o*f small metabolites a*nd *growth hormone*s between cells.
- ➢ Transport *viral genomes.*
- ➢ Intercellular transport of *RN*A and *proteins.*
- ➢ Transport of *actin filaments.*

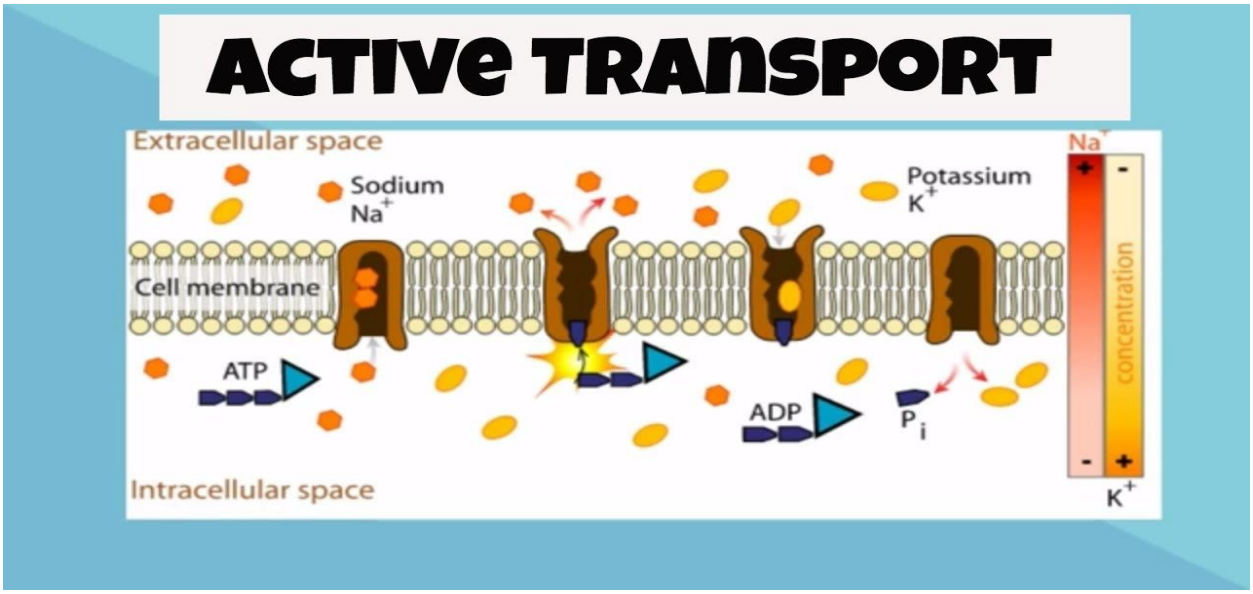
MEMBRANE TRANSPORT

- ➢ The plasma membrane allows the free movement of water. *The process of movement of* w*ater molecules from the region of higher water concentration to the region of lower* w*ater concentration* is known as *osmosis.*
- ➢ *The osmotic process in which the water molecules enter the cell* is known *as endosmosi*s and the reverse process is known as ex-*osmosi*s. Due to endosmosis, the pressure inside the cell increases. This pressure is termed as *hydrostatic pressure.* Since this pressure is caused by osmosis, it is also termed a*s osmotic pressure.* The

plasma membrane maintains a balance between the osmotic pressures of the inter and intracellular fluids.

Active Transport

- *The movement of molecules and ions from the region of lower concentration to the region of higher concentration, against the concentration gradient* is called *active trans port.* So it is compared to *uphill movement.* It needs energy: The energy is provided by the mitochondria. In this case, substances do not move by themselves, but they are carried by some carriers present in the membrane. These carriers are mainly membrane *proteins.*
- In kidney and nerve cells, Na ions are expelled outside and Kions are accumulated inside. This phenomenon is called *ionic pump.* These cells actively pump these ions against the concentration gradient.
- The blood contains 1 mg of glucose per 100 ml. In the formation of urine, the glomerular filtrate present inside the nephron also contains large amount of glucose. From this filtrate, the entire amount of glucose is actively reabsorbed into the blood, so that the urine is completely free from glucose.



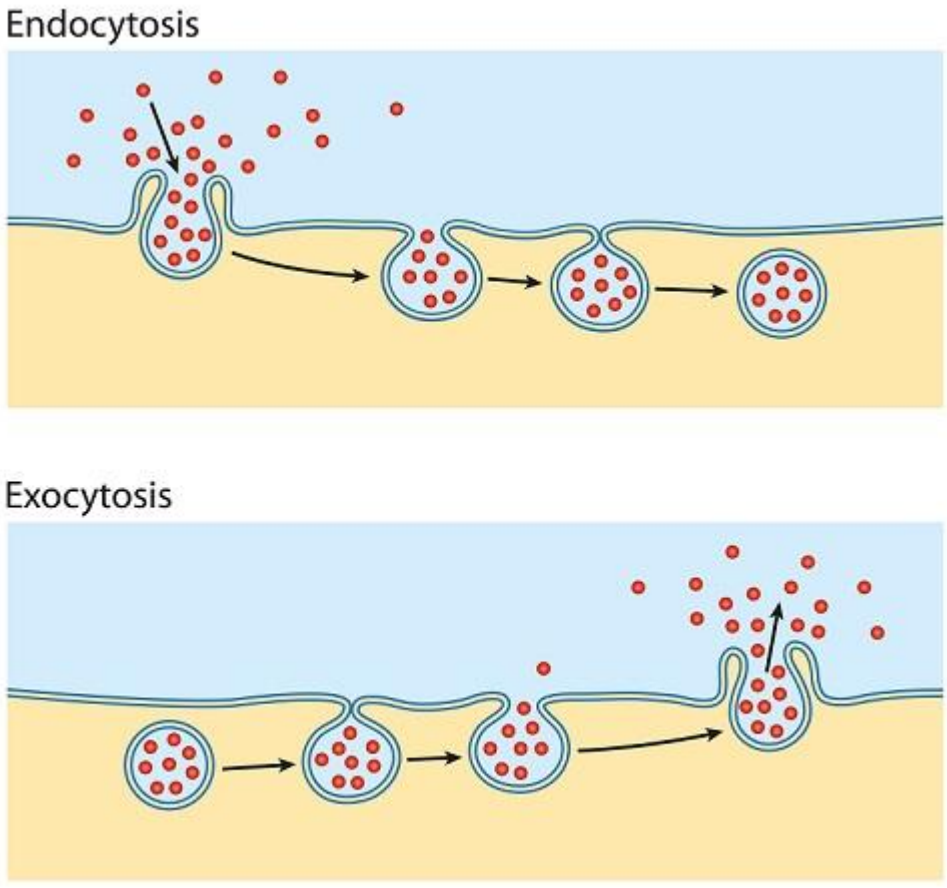
Passive Transport

- *The movement of molecules across the plasma membrane from the region of higher concentration to a region of lower concentration* is called *passive transport or diffusion.*
- Diffusion occurs through pores present in the cell membrane. This process does not utilize energy. Hence this process is also called *down hi**ll move**men**t*

Vesicular transport

Two types of vesicular transport

1.Endocytosis & 2. Exocytosis



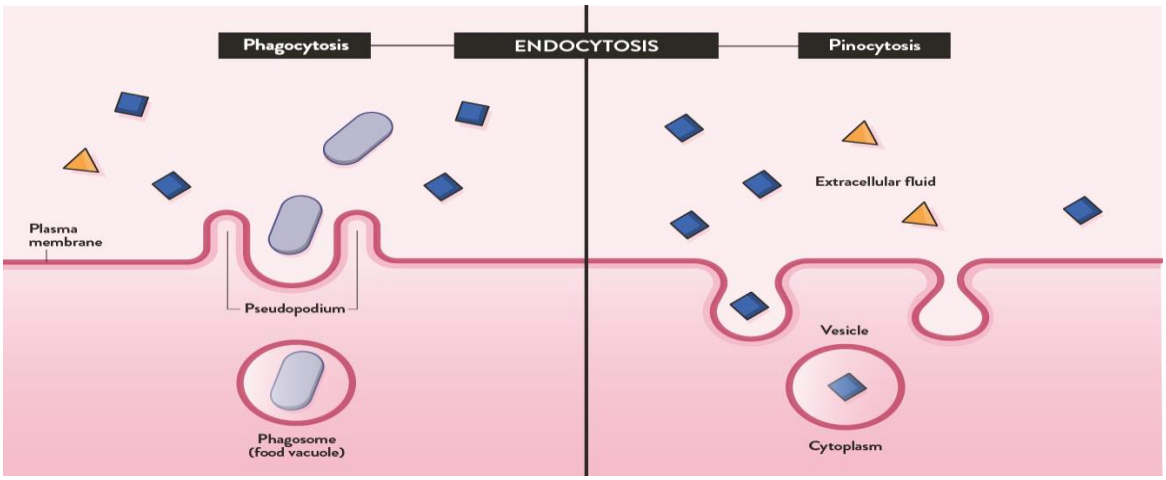
- ***Endocytosis*** is the *engulfing of food or foreign particles through the plasma mem brane.* The endocytosis can be differentiated into *phagocytosis* and *pinocytosis.*

Phagocytosis or Cell Eating:

- *Phagocytosis* is the *engulfing of solid particles through the plasma membran*e. It is also called *cell eating*. It is observed in a number of protozoans and leucocytes. The cells exhibiting phagocytosis are called *phagocyte*s. The tenin *'phagocytosis'* was coined by *Metchnikoff* in 1885.
- The food particles are adsorbed at the surface of the membrane. Later on, they are taken into the cytoplasm by the infolding of the plasma membrane. *The plasma membrane at the infoldings gets pinched off in the form of a small vesicle* called *phagosomes.* Then the phagosomes fuse with lysosomes to form the *digestive vacuoles.* The food is digested inside the vacuole and the digested food diffuses into the cytoplasın.
- *Capturing and ingestion of diatoms Devouring of disease callS ing germs hi WBC, macrophage*s, etc.

Pinocytosis or Cell Drinking:

- Pinocytosis is the *process of engulling of fluid parti cles through the plasma membrane.* It was first observed by *Lewis.*
- During pinocytosis, the plasma membrane is invaginated to form sac- like structures. The fluid food is drawn into the sac. Then the sac is pinched offliom the plasma membrane, forming a vesicle called *pinosome*. The pinosome later fuses with lysoson. The food is digested by the enzymes of the lysosome. The digested food dilluses into the cytoplasm. Eg. *Absorption of fat droplets hintestinal epitheliul cells.*



Exocytosis or CellVomiting

- *The process of exudating the secretory products from the secretory cells to the out side of the cell cytoplasm* is known as ex*ocytosis o*r *cell vomiting.* This process is also called *emeiocytosis* or rev*erse endocytosis.* E*g. In pancreatic cells, the enzymatic secretions are passed out through the plasma membrane b*y exoc*ytosis.*

Cytopemphis

- *Cytopemphis is the transport of materials through a cell.* The material passes into the cell by endocytosis and then it comes out of the cell by exocytosis without any change.
- Glucose molecules from the intestine move into the blood capillary through the epithelial cells by cytopemphis.