CELL BIOLOGY

CELL STRUTURE

Cell boundaries

- Cell wall
- Glycocalyx
- Cell membrane

Cytoplasm

- Hyaloplasm (Cytosol)
- Trophoplasm

Cell organelles

- Mitochondria
- Golgibody
- Lysosomes
- E. Reticulum
- Plastids
- Cilia, Flagella
- Centrosome
- Ribosome
- Microbodies

Nucleus

Non living cell inclusions (Vacuoles) **(Deutoplasm)**

- **Reserve products**
  - Carbohydrate
  - Nitrogenous products
  - Fats & oil
- **Excretory products**
  - Alkaloids
  - Essential oil
  - Gums
  - Glycoside
  - Latex
  - Organic acid
  - Resin
  - Tanin
  - Mineral crystal
- **Secretory Products**
  - Colouring matter
  - Nectar

- Nucleus control metabolic activity of cytoplasm by sending mRNA in cytoplasm.

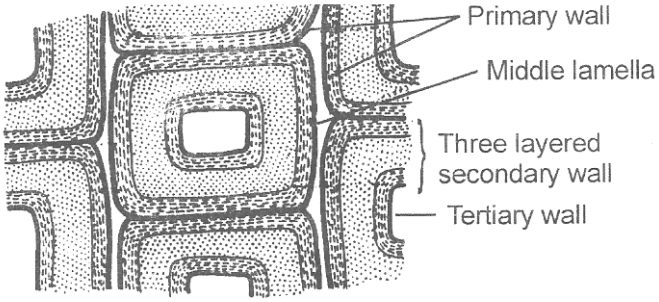
CELL WALL

- Cell wall was discovered by **Robert-Hooke.**
- Outer most but dead Boundary of plant cell is wall.
- Bacteria included in plants because they have cell wall.

Cell wall

- **Primary wall** : Outermost layer, thin elastic composed of cellulose, Hemicellulose & Pectin.
- **Secondary Wall (S_1, S_2, S_3)** : Rigid, thick & composed of cellulose, Hemi- cellulose, Pectin. (absent in Meristem cells)
- **Tertiaty wall** : Present only in tracheids of Gymnosperm. Composed of Hemi cellulose & xylan.
- **Middle lamella** : Common layer between two cells.

- Middle lamella is consist of Ca & Mg pectates (plant cement) . Amount of Ca is more.
- Fruits become soft and juicy due to dissolve of middle lamella.
- Cellulose is a main constituent of cell wall but addition to cellulose- Hemicellulose, cutin, Pectin , Lignin, Suberin are also presents in cell wall.
- Cellulose microfibrils and macrofibrils arranged in layers to form skeleton of cell wall. In between these layers other substances like pectin, hemicellulose may be present. These form **matrix of cell wall.**

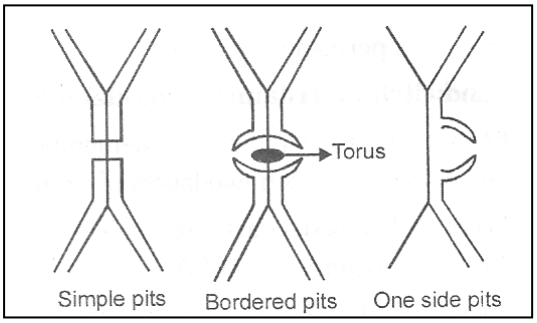


A few cells showing gross structure of cell wall

- Middle lamella is cement material between two adjacent cells in multi cellular plants or outermost layer of cell wall. (primary wall is consider as outermost layer in a cell)
- **Martinez and palamo** (1970) discovered cell-coat in animal cells, Which is Known as **Glycocalyx.** [Made by sialic acid, mucin and hyaluronic acid (animal cement)].
- Cell wall worked as frame or protective layer of cell.
- Network of cellulose fiber forms skeleton of cell wall.
  35-100 cellulose chain=1 micelle.
  20 micelle=1 Microfibril
  250 micro fibril= Macrofibril in cell wall.
- Cell wall materials (Cellulose, Hemicellulose, Pectin, and lignin) are synthesized in plant golgibobies or **dictyosomes**.
  Materials of lipid nature (cutin and suberin) are synthesized in **sphaerosome.**
- **Formation of cell wall I occur by two methods: -**
  (1) Intussusception: - This is a deposition of wall material in the form of fine grains.
  (2) Apposition : - Deposition of layers.
- Primary wall is formed mainly by intussusception, While secondary wall formed by both methods. Growth of all ready formed cell wall is occurs by only intussusception.
- A Special protein called **expansin** helps in growth of cell wall by loosing the cellules microfibril and addition of new cell wall material takes place in the space, Thus expansion is called ad" cell wall loosening factor"

Specialisation of cell wall:

(1) Lignification : Lignin (coniferyl alcohol) is a cellulose derivative carbohydrate which deposits on walls of Sclerenchyma, vessels and tracheids. Excess of lignin is decrease the economic importance of pulp.



PITS

Pits are formed in lignified cell wall. Deposition of lignin occurs throughout the cell wall leaving some small thin walled areas called **pits** are generally formed in pairs on the wall of adjacent cells. Two pits of a pair are separated by a thin membrane called **pit membeaneS** (completely permeable) (earlier composed of middle lamella and primary wall). But, after some time primary wall may be dissolve. There are two types of pit pairs-

(i) **Simple pits-** When diameter of a pit cavity is uniform throughout its length then such type of pits are called simple pits.

(ii) **Bordered pits-** When diameter of pit cavity increases from inside to outside then such pits are called **Bordered pits.** In such pits, pit membrane have a thickening, composed of suberin called Torus. Torus functions like a valve to regulate the flow of materials.

☞ Pits occur in **sclerenchyma**, **vessels** and **tracheids.** Tracheids in gymnosperms have maximum number of bordered pits.

(2) Suberisation: Subeisation occues on cork and casparion strips of ennndodermal cells. Suberin is highly impermeable material, It is water tight and air tight material. So suberisation also leads to death of cell. Maximum suberisation occurs in middle lamella. It reduces the transpiration rate in plants.

(3) Cutinisation: Cutin-is also hydrophobic, waxy substance Cutinisation is that deposition of cutin on cell walls of leaf epidermis. It reduces the transpirationrate in plants.

(4) Cuticularistion: Deposition of cutting on the surface of leaf. It leads to formation of cuticle.

(5) Mucilage deposition: Mucilage deposits on the surface of hydrophytes.

(6) Deposition of silica: Occurs on the Leaves of grasses, Equisetum, Atropa, Diatoms, rice.

Primary wall	Secondary wall
(1) Cellulose microfibrils are arranged in a dispersed manner. (2) Hemicellulose more (50%) (3) Permicellulose wall have lipds (5-10%) (4) Forms by Intussusception (5) Primary wall is universal layer	(1) Microfibrils are parallel to long axis of cell. (2) Hemicellulose less (25%) (3) Proteins and lipids either absent or in little amount. (4) By both methods. (5) Absent in meristem cells

BIOMEMBRANES OR CELL-MEMBRANES

☞ All the living cells are covered by a thin, delicate, elastic, selectively-permeable and living boundary, which is called cell membrane (by Nagli & Kramer) or plasma lemma (By J. Q. plower) or Bio membrane or plasma membrane,

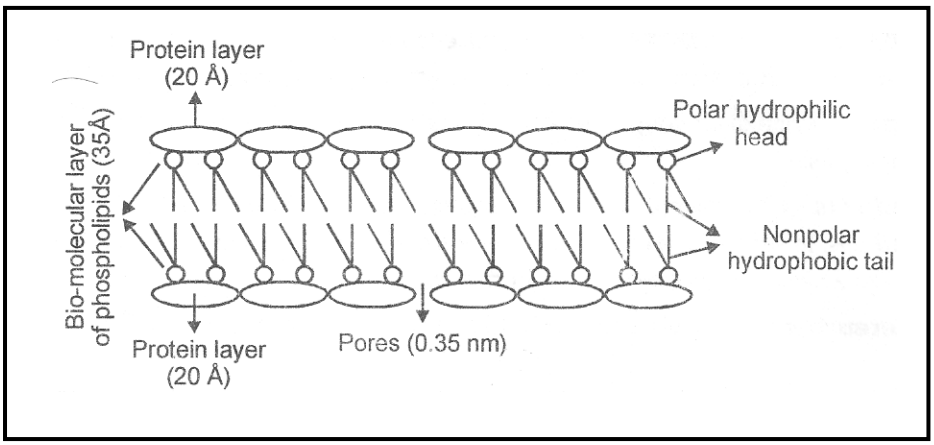
☞ Term-" Unit- membrane" was proposed by Robertson**.**

STRUCTURE OF BIOMEMBRANES:

(1) Lipoidal theory: -Overton (1902) suggested that plasma membrane is a continuous single layer of lipids only (Based on permeability)

(2) Sandwitch or Trilamellar model: - By **Davson & Danielli** (1935) .

- Acco. to this model, the plasma-membrane is made up of three layers in which a bimolecular layer of lipid is sandwitched between two layers of proteins.
- Acco, to this model each protein layer is 20A and bilayer of phospholipid is35A. Thus total thickness is 75A (PLLP-structure, 75-100Aaverage)
- Phospholipi molecule called as **amhipathic molecule** use of presence of two type of parts (hydrophilic head and hydrophobic tail) .
- Hydrophilic head of the phospholipid binds with protein layer by hydrogen and ionic bonds.
- Hydrophobic tail of phospholipid are attached to each other by Vander wall force.



(3) Unit membrane model: -By Robertson-1959.

Acco. to this model all the cellular and orgaeller membranes are structurally & functionally similar (difference in chemically & size) .

- All these models are rejected because they fails to explain the elasticity and selective permeability of plasmalemma.

(4) Fluid mosaic model: By singer & Nicolson (1973)

- This is **latest & most widely accepted** model for the structure of plamalemma.
- According to fluid mosaic model protein are arranged in phospholipid as mosaic pattern.
- Thus membrane is termed as " **protein icebergh in a sea of phospholipid**" or **" Gulab jamun** (**Protein**) in a concentrated solution (p**hospholipid**) of sugar"

(1) phospholipids:

- Phospholipid is the **main component of cell membrane** because it forms continuous structural frame of cell membrane. Main type of phospholipids are phosphatidyl serine, phosphatidyl choline (Lecithin) , P-ethanol amine (cephalin)
- Phospholipid layer provides fluidity to plasma membrane because phospholipids are rich in unsaturated fatty acid which are liquid in nature,
- Cholesterol is also present in plasma membrane. Cholesterol are more rigid than phospholipid . So it helps in stability of membrane structure.
- Cholesterol is absent in membrane of prokaryote. Thus **hopanoidea** (pentacyclic sterol) provides stability to prokaryotic cell membrane.

(2) Proteins:

Two types of protein are present in plasma membrane.

- **(a) Integral or intrinsic protein (70%)**
  - These proteins are tightly binds with phospholipid. Thus nt easily released from membrane.

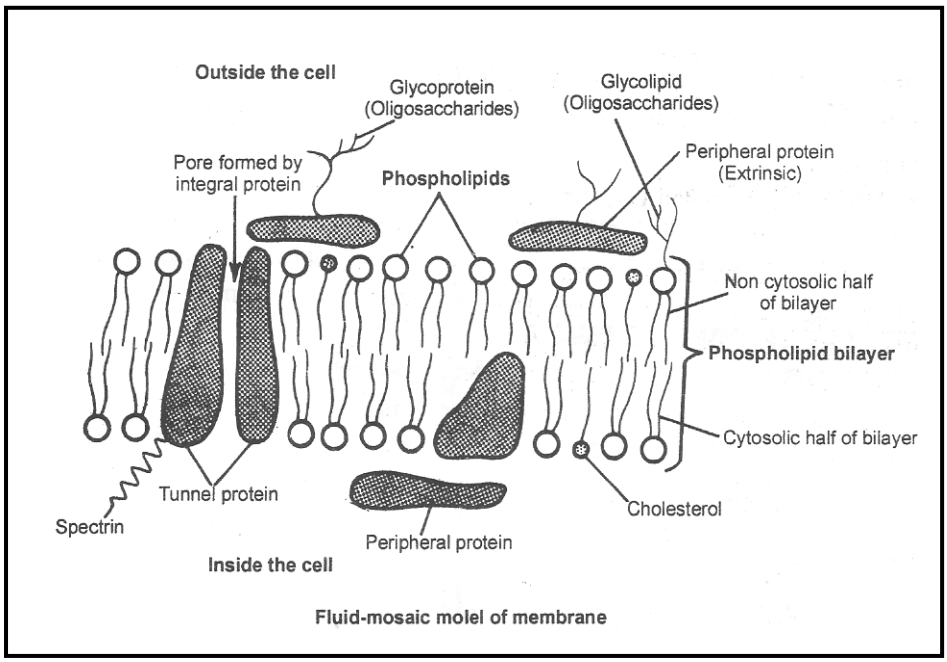
- Some intrinsic protein is confined in lipid bilayer (Stable protein) .
- Some integral proteins traverse the complete thickness of membrane. These type of protein are called as **tunnel protein** which passage water soluble material across the membrane.
- Some intrinsic protein extending from outside to inside are called as **trnsmembrane** protein eg. Glycophorin, porins founds in outer mitochondrial Membrane and Bacterial Membrane.

(b) peripheral or extrinsic protein (30%)

- These ate superficially arranged on outer side and can be separate easily. These protein have enzymatic activity. Extrinsic protein can move freely in membrane structure.
- Some protein like permeased and translocase function as **carriers** for the transport of materials. **Spectrin** are helical type of membrane and attached to intrinsic protein. Spectrums are part of cytoskeleton.

- However phospholipid bilayer has fluid property but no evidence of **flip flop mechanism** for protein molecule (**Flip Flop means** exchange of molecules from one monolayer with those in the monolayer on the other side) .
- Rotational diffusion and lateral diffusion of protein and lipids is possible in membrane.
- Absennnnce of flip flop movement detected by electro spin resonance (ESR) spectroscopy.

Lipids- 40% (phospholipids, cholesterol, glyeolipids)
Proteins- 58-59% (Arfinine, Lusine rich)
Carbohydrates- 1-2%



Fluid-mosaic molel of membrane

- Oligosacccharides of the glycolipids & glycoprotrins on the outer surface of plasma membranes are involved in cell to cell recognition mechanism. Best example of cell recognition **is fertillisation**, (where sperm & egg recognize to each other) and **blood-Antigens**.
- Plasma membrane have approximate 30 types of enzyme in which ATP ase (ATPhydrolysing) is more important.
  ATP ase enzyme helps in active transport of materials.
- Plasme membraneis an **asymmetrical structure** because carbohydrate is presents on outer surface and spectrin protein is present only in inner surface of plasme membrane.

Expertmental Demonstration-
Fluid nature of cell membrane has been demonstrated by a simple experiment by **Frye and Edidin in 1970**. Amouse cell was labeled with a green fluorescent antibody or a pigment **fluorescein**, and a human cell was labelled with **red fluorescent**. antibody or a rhodamine. These cells were then fused. The composit cell so formed, called cybrid, was immediately seen under a microscope. Its one half looked green and the other half red. It was kept at 370C an reexamined after some time it was found that the green and red colours had fully mixed up. This could happen only if the lipid bilayer was fluid, and the labelled proteins could move in it. If the fused cell kept immediately at00C, the colour did not mix because lipids solidify at low temperature. This further proved the ***fluid*** nature of the cell membrane When **temperature** was raised, the **lipid** bilayer regained **fluidity and the colours** mixed.

SPECIALISATION OF PLASMA MEMBRANE

(1) Microvilli: - These are Finger like evagination of P. M. . Microvilli increase surface area of absorption.
(2) Caveolae: - These are cave like invaginations on the cell surface. Increase surface area.
(3) Lomasomes : - Discovered by Moore and Mc Aear. These structure occurs in fungi. These are also called border bodies" Lomasomes are located between the cell wall and cell membrane and concern with cell wall synthesis.
(4) **Mesosome** present in Aerobic bacteria for respiratory ETS.

CELL SURFACE JUNCTONS

(1) **Desmosomes (Zona adhrence) : -** These are thickened button shape structure on P. M. of adjacent cells with radiating fibres in cytoplasm. These fibrils called**tonofibrils.** . Desmosmes generally occurs In rpithelial cells and provide cell adhesion.
(2) **Tight junction or Zona occludence: -** These are fused outer most layers of two P. M. at the site of attachment . Fused membrane has a 5-layered structure. Tight junction occur in nerve tissue at synapses.
(3) **Gap junction or Nexus**: These are fine protein channels (connexons) which joins two P. M of adjacent cells with protein connexine.
Desmosomes, Tight junction and Gap junction occurs in animal cell.
(4) **Plasmodesmata: -** Name proposed by strasburger (1901) . These are cytoplasmic connections between two adjacent plant cells. Plasmodesmata are characteristic of multi-cellular plants and they maintain continuity of cytoplasm between adjacent cells, E. S. tubles (Desmotubules) helps in formation of continuity.

TRANSPORT THROUGH PLASMA MEMBRANE

☞ Plasma membrane is semi-permeable but now consider as selectively or differentially permeable because it allows certain solues to pass through it and prevents others

