Cell membrane

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Cell Wall:

1.) Plant cell is surrounded by Cell wall.

2.) It is a non-living str., formed by the living protoplast (protoplasm)

3.) Plant cell wall is made up of cellulose, hemicellulose, pectin & protein.

In Fungi cell wall is ⟶ Chitin
In Bacteria " " has ⟶ protein – lipid – polysaccharide complexes.

4.) It is rigid, protective layer around plasma membrane. It provides mechanical support & also determines the shape of plant cells.

Str.

Cell wall is complex in nature & is differentiated into following layers :-

1.) Primary cell wall :-

→ It is the outermost layer of the cell.
→ In immature meristematic & parenchymatous cell it is the only cell wall.
→ It is thin & permeable.
→ Some epidermal cells having cutin & cutin waxes make the primary cell wall impermeable.

2.) Secondary Cell Wall :-

follows the primary cell wall.

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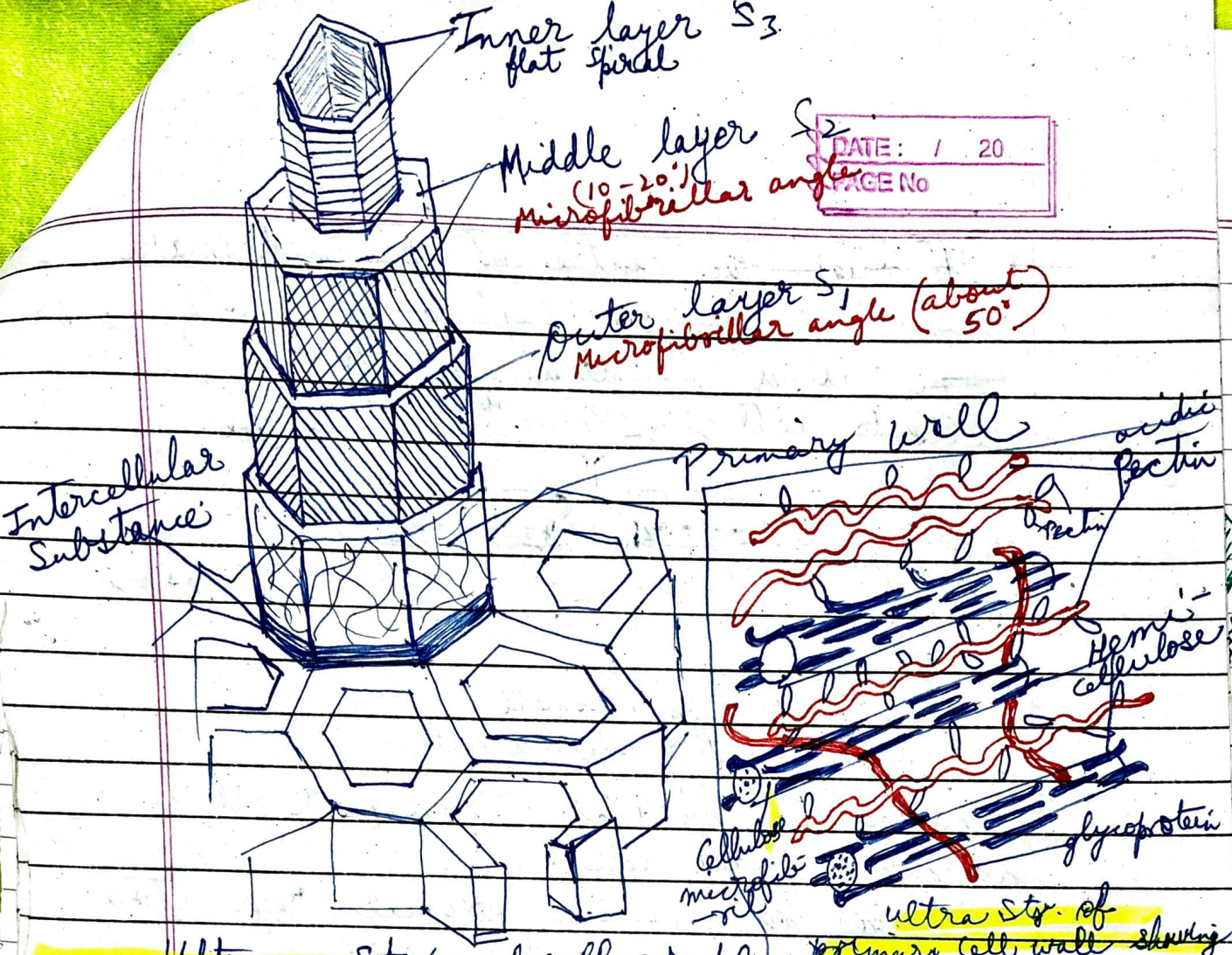
→ It is thick, permeable & lies near plasma membrane.
→ It is made up of 3 concentric layers S_1, S_2 & S_3 which occur one after the other.
→ Chemically Sec. cell wall is composed of compactly arranged macrofibrils of cellulose, in between which occurs lignin as interfibrillar material.
(most abundant natural polymer)

3.) Tertiary Cell Wall :-
→ In some plant cells, just beneath Sec. Cell wall occur tertiary Cell Wall.
→ They differ from Primary & Sec. cell wall in morphology, chemistry & staining properties.
→ They contain Cellulose & another chemical substance, called Xylan.

Middle Lamella :- (intercellular matrix)
→ Cells of plant tissue remain cemented together by intercellular matrix called Middle lamella.
→ Mainly composed of pectin, lignin & some proteins.

ULTRASTRUCTURE
Electron microscopy reveals In the primary cell wall, the fibres & matrix molecules are cross-linked by Covalent & non-covalent Bonds. This forms a highly complex str.



Ultra Str. of cell wall

Ultra Str. of primary cell wall showing interconnections between cellulose microfibrils & the matrix

→ Hemicellulose molecules (eg. Xyloglucans) are linked by hydrogen bonds to surface of cellulose microfibrils.

→ Some of these hemicellulose molecules are cross linked to acidic pectin molecules (rhamnogalacturonans) through short neutral pectin molecules (arabinogalactans)

→ Cell Wall Glycoproteins are tightly woven into the texture of cell wall.

Plasmodesmata :

Every living cell in higher plants is connected to the neighbouring cell by cytoplasmic channels called plasmodesmata

→ Roughly cylindrical, membrane lined channel. Diameter 20 to 40 nm

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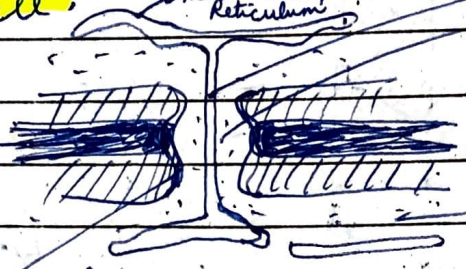
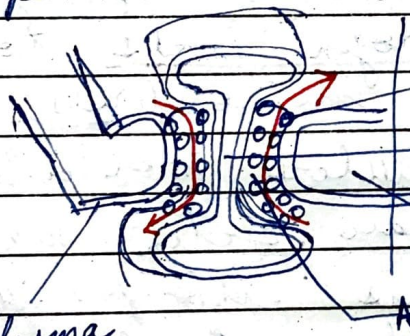
→ Through the centre of plasmodesmata runs a narrow cylindrical strand called desmotubules that runs from cell to cell.



Plasmodesmata mediate transport btw adjacent plant cells.

It does so is under normal regulatory mechanism of plasmodesmata.

But TMV protein P30 passes through plasmodesmata to spread into other cells.



Chemical Composition of Cell Wall (All polysaccharides)

1) Cellulose — Polysaccharide, Unbranched polymer, 1→4 β glycosidic bonds between glucose units forms straight glucan chains

These glucan chains with inter & intra molecular hydrogen bonding produce microfibrils.

• Many microfibrils produce macro-fibrils

having upto 0.5 μm diameter.

2.) Hemicellulose — short, branched heteropolymers made of diff. kinds monosaccharides like arabinose, Xylose, mannose, galactose, glucose & Uronic acid.

Names of hemicellulose :-
Xylans, Arabinoxylans, Glucomannans, Galactomannans & Xyloglucans

3.) Pectin — water Soluble, Branched polysaccharide, Negatively charged.
→ When Ca^{2+} is added to a sol^{n} of pectin molecules, it cross links them & produces semi rigid gel.

4.) Mannan —
is homopolysaccharide. Found in cell wall of sea weeds, yeast, fungi & bacteria

5.) Agar — polysaccharide, Found in cell wall of sea weeds. Contains D- & L- galactose residues

6.) Lignin — is a biological plastic.
Non fibrous material. Found in mature cell walls. Made up of insoluble hydrophobic aromatic polymer of phenolic alcohols.

7.) Chitin — polymer of glucosamine

Glycoproteins — is hydroxyproline-rich proteins (like the collagen).
They act as glue & increases strength of wall.

Cutin — made up of fatty acids (waxes)

Suberin — water resistant. Made up of fatty acids & found in cork & cell wall of many plants.

Sporopollenin — is lipoidal polymer forming tough wall of pollen grains.

Mineral deposits — occur in cuticle in form of Ca & Mg carbonates & silicates (in Gramineae family) (in cell wall of Cruciferous & Cucurbitaceous plants).

Functions of Cell Wall

Provides mechanical strength.
Acts like a skeletal framework of plants.
~~They are~~ It is fully premable to water & solutes because the matrix is riddled with minute water-filled channels through which free diffusion of water & water soluble substances take place.
Allows movement of globular macromolecules with a M.W much above 20,000 daltons but it is

extremely slow.

Most plant signalling molecules like growth regulating substances — auxins, cytokenins & gibberellins have M.W less than 500 daltons.

→ Once lignification is done the protoplasm cant no longer absorb materials from outside the cell therefore ~~it~~ dies.

∴ Lignified tissue is always dead.

It performs 2 functions

a.) Provide mechanical strength ✓

b.) Transports H_2O & salts because lignification results in loss of protoplasm thus forming hollow waterproof tube.

LYSOSOMES

→ Lysosomes are variously shaped bodies in the cytoplasmic matrix of the cells.

→ Lysosomes are bounded by a single limiting membrane of lipoprotein. Lysosome membrane contains trans-membrane proteins which help in transport of final products of digestion to the cytosol, where they are either excreted or reutilized by the cell.
Lysosomal membrane also has H^+ pumps which maintains its lumen at acidic pH of 5.

→ Chemically lysosome is a bag packed with a variety of hydrolysing enzyme.
There are 40 types of hydrolytic enzymes in Lysosomes eg.

1) Phosphatase — Acid phosphatase, Acid phosphodiesterase.

2) Glycosidases — β- galactosidase, β-glucuronidase
β-N-acetyl glucosinaminidase
α-glucosidase
α-manosidase.

3) Proteases — Cathepsin A, Cathepsin B, Collagenase
Peptidases

4) Lipases — Acid lipase, Phospholipase A,
Phosphotidic acid phosphatase

5) Nucleases — Acid ribonucleases
Acid deoxyribonuclease

Particular lysosome may contain only a few or even a single species of enzymes.

Enzymes of lysosomes become active only when the surface of membrane is ruptured.

Lysosomes were first reported by Christian de Duve & co-workers in Belgium in 1955.

Lysosome are absent in prokaryotes.

Particles containing hydrolases & with characters of lysosomes

have been observed in many plants cells like tobacco & Maize.

They are found in slime moulds, fungal hyphae. In 1964, P. Matile reported occurence of lysosomes in Neurospora.

Lysosomes appear as dense bodies in the cell & are surrounded by a membrane.

Their interior contain a granulated stroma & a vacoule.

Their shape & density vary greatly.

They are 0.23 — 0-50 μm in size.

Only criterion for their identification is the presence of lytic enzymes in them.

Polymorphism: Lysosome exhibit polymorphism i-e a variety of them are found in diff. cells & even within a single cell.

TYPES OF LYSOSOMES: depending on the function they perform.

1) **Primary Lysosomes** (Starch granules) are small bodies having enzymes synthesized by Ribosomes attached to E.R. (These enzymes first enter golgi complex where acid phosphatase reaction take place. Then they are transported to Primary Lysosome.

Autoradiography technique show tranfer of protein (enzymes) in the following sequence.

ER → Golgi Complex —(acid phosphatase reaction take place)→ Primary Lysosome.

2) **Secondary Lysosomes** (Heterophagosome or Digestive Vacuoles.) are formed from phagocytosis or pinocytosis of foreign material by the cell.

The engulfed material is digested by hydrolytic enzymes. The digested material pass through membrane of lysosome & are incorporated into the cell.

3.) Residual bodies — form if the digestion is incomplete
These may be removed by defacation as in Protozoas.
In some case they persist & play a role in aging.
Incomplete digestion is due to absence of some enzymes & lead to accumulation of phospholipids or Sphingolipids. This leads to pathologic disturbance.

4.) Autophagic Vacoules (Cyto lysomes or Autophagosomes) are lysosomes containing a part of the cell itself for digestion.
These intracellular parts involved in digestion may include mitochondria or ER & are formed during pathologic process.
Autophagic vacoules may cause digestion without irreparable damage.

5.) Plant & Fungal Vacoules
occupy 30% to 90% of cell's volume & are comparable to lysosomes of animal cells.

Functions:

Lysosomes are lytic in nature & are involved in digestion of intracellular or extracellular particles.

EXTRACELLULAR DIGESTION. diff. functions :-

1) Endocytosis & digestion of macromolecules :- Bulk intake of exogenous materials is Endocytosis.
These molecules are first delivered to early endosomes (vacoule) then to late endosomes & finally to lysosomes.
Hydrolysis starts in the endosomes (pH is 6) & is completed in lysosomes (pH is 5)
Intake of liquid material is pinocytosis
Intake of solid matter is phagocytosis
Endocytosis phenomenon occurs in all cells. but
Phagocytosis " " " Specialised cells.

2.) Digestion of external particles :-

The cell engulfs large particles including micro organisms by process of phagocytosis.

The cell engulfs then forms invagination which gets pinched off from cell membrane & then forms an internal sac. This sac is known as phagosome.

Phagosome moves towards a lysosome & fuses with it to form a str. Enzymes present in lysosome bring about digestion. Lysosome is now called digestive vacuole or Secondary lysosome.

Vacuole now moves towards cell membrane & a process reverse to phagocytosis occurs.

Intracellular Digestion.

a.) Autophagy (b.) Heterophagy.

Lysosome digest substance of the same cell to which they belong.

The substance to be digested penetrates cell's own lysosomes. This process is known as Autophagy.

~~eg.~~ degeneration of tadpole tail is brought about by the action of certain proteolytic enzymes called Catepsins found in lysosomes.

Autophagy brings about cellular digestion (autodigestion) after the death of a cell (lysosomal enzymes digest the dead cell). So, it brings about self-clearance of dead cells.

∴ lysosomes are known as Suicide Bags.

3.) Lysosomal activity in relation to Pathology.

Irregularities in lysosomal activity cause fever, congestive heart failure, hepatitis, hypertension etc.

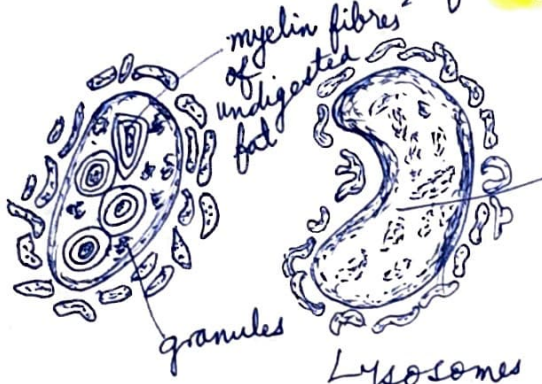
Release of Nucleases (RNAase & DNAase) (enzyme that attack RNA & DNA) cause chromosomal breakage which leads to harmful mutations. This leads to carcinogenesis (cancer formation)

4.) Protection Lysosomes of leucocytes help in defence

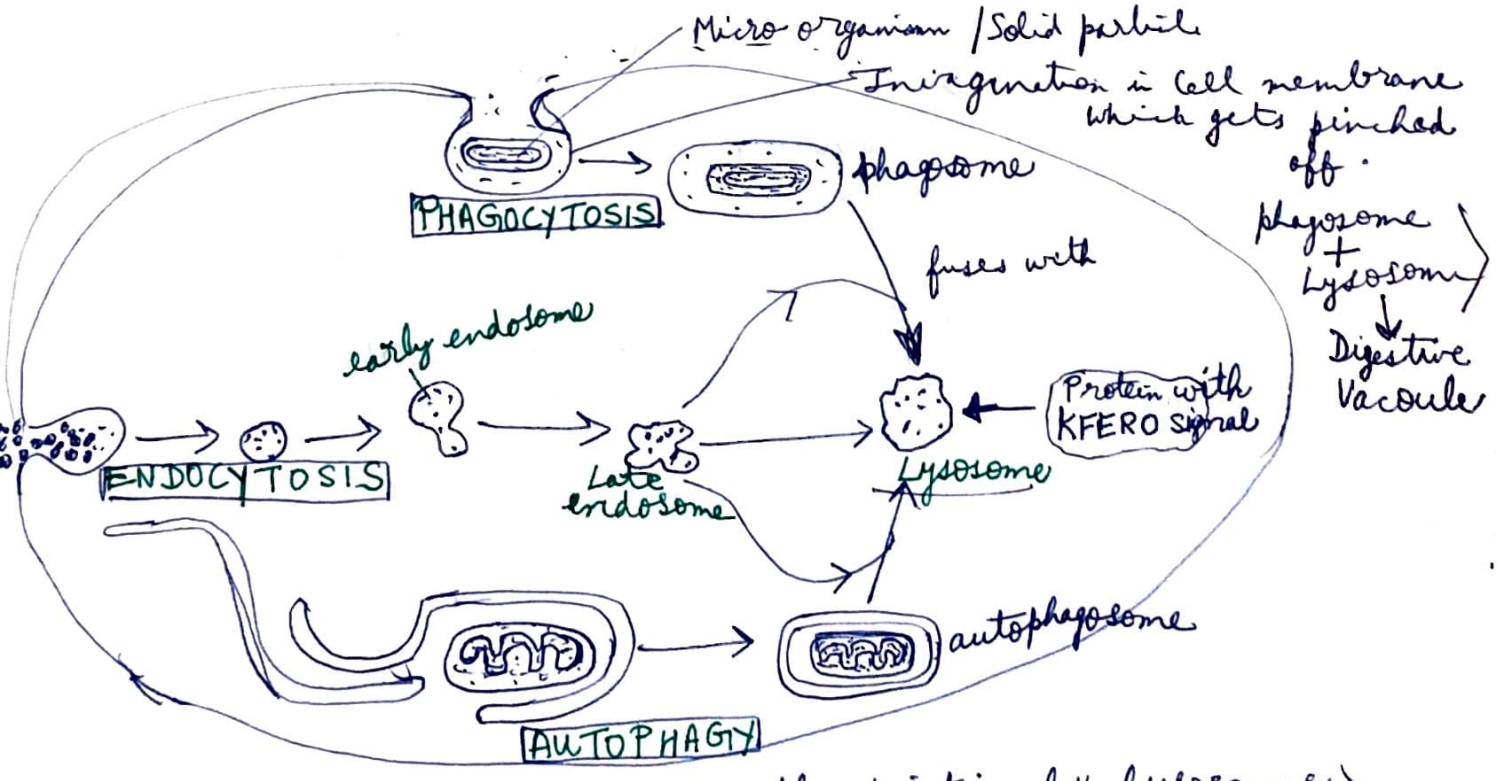
against infection by bacteria & microbes by digesting them & their toxic molecules.

ORIGIN :-

According to modified hypothesis, lysosomes are exclusively formed from Golgi vesicles & the hydrolases (enzyme/protein) synthesized on ribosomes are subsequently transported through involvement of ER.



Lysosomes in kidney cell of rat.



Diff. stages in the digestion by lysosomes.