

PLANT CELLS

Structure of the plant cells

1. **Cell Wall:** The plant cell wall is thick, rigid and boxlike. It consists of cellulose fibrils encased in a cement of polysaccharides and proteins.

It protects the cell membrane from mechanical or osmotic rupture, firmly fixes the position of the cell, and confirms physical shape and strength upon plant tissues.

2. **Cell Membrane:** made of a lipid bilayer and proteins. It is selective in permeability, containing active transport systems.

3. **Nucleus:** It is about 4-6 μm in diameter, is surrounded by a perinuclear envelope. The DNA is combined with histone and organized into chromosomes, the nucleolus is rich in RNA.

4. **Chloroplast:** It is a membrane surrounded organelle, that contains plastid, some of which possess a distinctive DNA. Those containing chlorophyll are called chloroplasts. There may be one, several or many per cell. Chloroplasts are relatively large compared to mitochondria.

They are the main source of energy of photosynthetic cells in the light with the production of oxygen.

5. **Mitochondria:** found in all plant cells, made of the membranes outer and inner membranes which differ in lipid composition and in enzymatic activity. The inner membrane surrounds the matrix which is rich in enzymes. Mitochondria also contain a specific type of DNA.

In non-photosynthetic plant cells the mitochondria are the main source energy via respiration. In photosynthetic cells mitochondrial respiration is the main sources of energy in the dark.

6. **Vacuole:** They are characteristic of plant cells, they are small in young cells and greatly in size with age, often causing the cytoplasm to become compressed against the cell wall. They contain dissolved sugars, salts of organic acids, proteins, mineral salts, pigments, oxygen and CO₂.

7. **Endoplasmic reticulum** RER / SER Ribosomes are the site of protein synthesis, RER serves to channel protein products through.

8. **Golgi complex:** flattened, single membrane vesicles, it functions in the secretion of cell products.

9. **Microbody (Peroxisome):** single membrane structure that contains oxidases (oxidative coenzymes).

10. **Lysomes:** single membrane vesicles that contains hydrolytic enzymes.

Plants cells are of different types, they are divided into two main categories:

1. The first is responsible for performing all the metabolic activities of plants.
2. Responsible for other functions either as mechanical support or conduction of fluids.

PLANT CELL WALL

The plant cell wall is a specialized form of extracellular matrix that is closely applied to the external surface of the plant cell plasma membrane.

The plant cell wall is generally much thicker, stronger, more organized and most important, more rigid, than the extracellular matrix of the animal cells.

Significance and Functions of the plant cell wall

- Provides a home for the plant cell proper.
- Each cell wall interacts with that of the neighbours, binding the cells together to form the intact plant.
- It forms channels of the circulation of fluids within the plant and for intercellular communication.
- They are responsible for functions that in animals are provided by the skeletal, the skin, and the circulatory system.

To perform all these functions cell walls with highly varied compositions and structures have evolved.

The chemical composition of the plant cell wall

They are made from long, tough fibers that are held together by a matrix of protein and polysaccharide. In higher plants the cell wall fibers are generally made from the polysaccharide cellulose. The matrix is composed predominantly of two other sorts of polysaccharide hemicellulose and pectin. The exact composition varies considerably both within and between spaces.

The fibers and matrix are loose-linked by covalent bonds and weak interchains into a very complex structure.

Cellulose

- Consists of a linear chain of several thousand glucose units, each covalently linked by a characteristic B1 – L glycosidic bond. The average of glu is 3000/module. The linkage gives each molecule a flat ribbon-like structure that is stabilized by internal hydrogen bond.

- Hydrogen bonds between adjacent cellulose molecules cause these ribbon-like molecules to adhere strongly to one another in parallel ways of 60-70 cellulose chains all having the same polarity, then by forming very long, highly ordered, crystalline aggregates called microfibrils.
- These microfibrils surrounded by a large number of less precisely packed chains of cellulose as well as by certain hemicellulose molecules.
- They bind tightly but noncovalently to the surface of the cellulose microfibrils and to each other.
- They coat the microfibrils and cross-link them via hydrogen bonds into complex network.
- There are many different classes of hemicellulose.
- They all have a long B-1-L linear bonds.
- The particular sugars vary with the type of hemicellulose.
- They are very thin but become thicker during cell growth.

Pectins

- Heterogeneous, branched, and highly hydrated polysaccharide (gallstone, Arabian galactoarabian).
- It contains many negatively charged galacturonic acid residues.
- Pectin is particularly abundant in the middle lamella, the region that serves to cement together the cell wall of adjacent cells.
- It has the ability to form gel.

Proteins

- In addition to the 3 classes of polysacchrides, the primary cell wall also contains a small amount of proteins.
- The major protein contains a large number of residues of unusual amino acids, hydroxyproline.
- The OH-PCO and serine residues are linked to start oligosaccharide chain. Thus following glycoproteins:
- Three layers can be distinguished in the cell wall. There are the middle lamella the primary cell wall, and the secondary cell wall. Occasionally a tertiary cell wall may be present.
- The middle lamella is formed cell wall between adjacent cell walls during cell division. It is viscous and jelly-like substance and acts as a cementing material between the primary cell wall of adjacent cells. The middle lamella is composed of protein, cellulose, calcium and polymers of various types. Pectin is a hydrophilic colloidal substance.
- The primary cell wall is formed during the early stage of growth and development. It is found in all plant cells and is 1-3 μm thick. It is composed chiefly of cellulose, hemicellulose and pectic compounds. The primary cell wall is elastic, and undergoes extension with the growth of the cell.
- The secondary cell wall is laid down on the primary cell wall when the latter has finished its growth. It is found only in certain mature and highly specialized cells. It is about 5-10 μm thick. It has 3 layers, the outer layer, one middle layer and the inner layer.

- In a typical plant tissue, the cell wall consist of 3 morphological layers:
 - a) The middle lamella (plasma lamella).
 - b) The primary cell wall
 - c) The 2° cell wall is usually deposited between the plasma membrane and the 1° cell wall.
- When the 1° cell wall become harder. It changes into secondary cell wall. Some times the cell deposit new wall material to form the 2° cell wall coat channels (pits) which play an important role in maintaining temp, osmotic pressure, transporting different ions and nutrients.
- Since the matrix of the wall is a highly hydrated polysaccharide gel (the 1° cell wall being 60%, water by weight), water, gases and small water-soluble molecules penetrate rapidly compared to the plasma membrane.
- In order for a plant cell to grow or change, its shape, the cell wall has to stretch a deform. Because cellulose microfibrils are highly in elastic. Such changes must involve the movement of microfibrils past one-another.

Lignin

The term lignin covers a group of high molecular weight polymeric compounds. It is derived from carbohydrates and give rigidity and strength to the cell wall. It is found in woody tissues. During the process of lignification lignin is added to the matrix of the cell wall. The process of lignification starts with the primary cell wall and then extends to the middle lamella and secondary cell wall.

Formation of the cell wall

- It happens immediately after nuclear division.
- Granules arising from the golgi complex arrange themselves on the equator of the cell. They fuse to form the cell plate.
- The cell plate grows in thickness by addition of new material from golgi complex.
- Narrow openings “the plasmodesmata” are left in the cell plate, and cytoplasmic connections between cells is retained through them.
- During the deveopment of all wall the middle lamella is formed first. The primary cell wall is secreted against the middle lamella. After the period of growth is over a secondary cell wall may be laid down between the primary cell wall and the cytoplasm of the cell.

Cell Wall

Most plant cells possess a cell wall, and this feature distinguishes them from animal cells. The cell wall is a nonliving structure which is formed by the living protoplast. It has a supportive and protective function. Three layers can be distinguished in the cell wall. These are the middle lamella, the primary cell wall, and the secondary cell wall (Fig. 15.1). Occasionally a tertiary cell wall may be present.

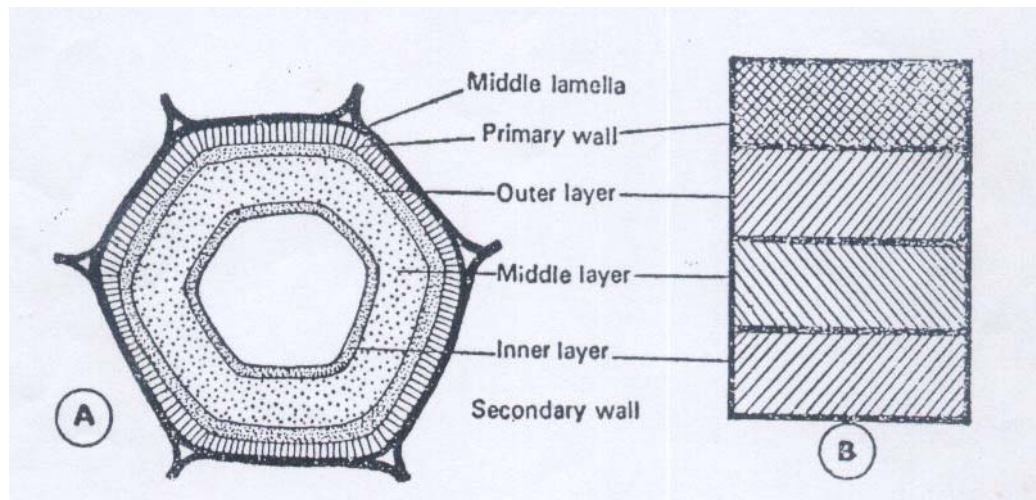
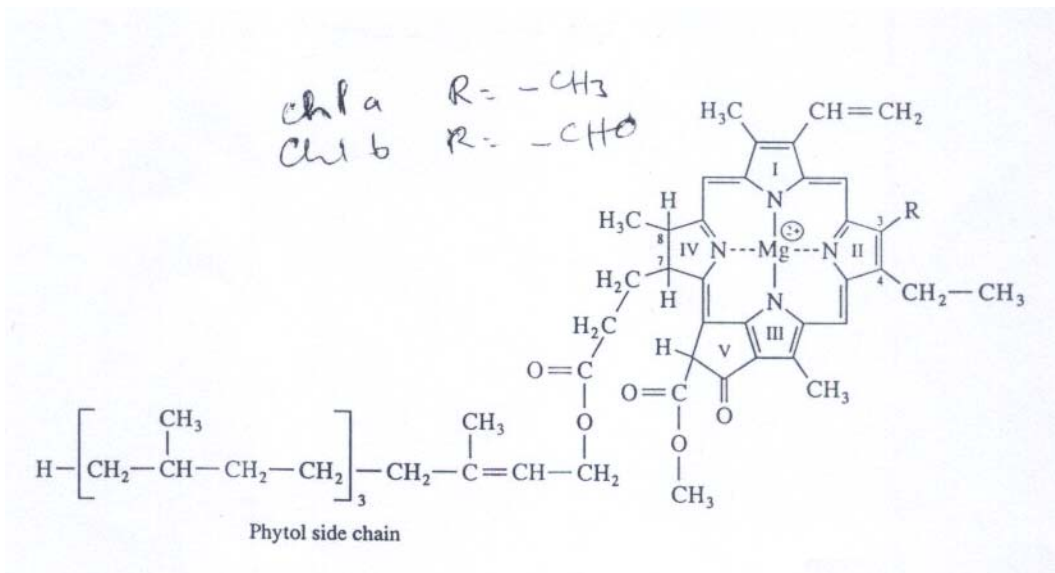
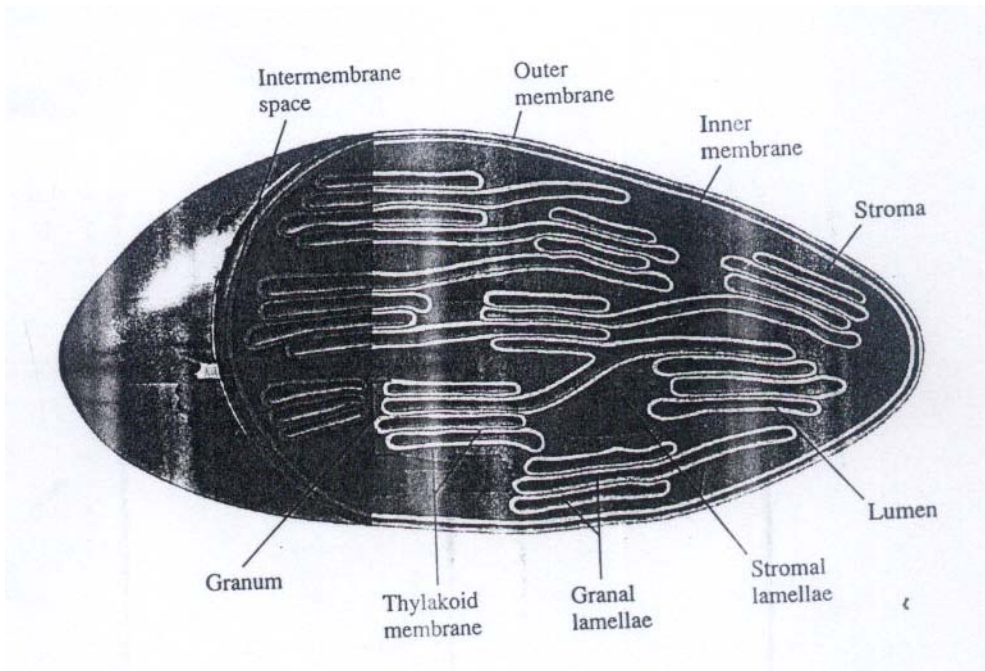


Fig 15.1 (A) Layers of the cell wall. (B) Arrangement of fibrils in the different layers.

The middle lamella is formed between adjacent cell walls during cell division. It consists of a comparatively thin layer of intercellular material. It is viscous and jelly-like substance and acts as a cementing material between the primary cell walls of adjacent cells. The middle lamella is composed of pectin, cellulose, calcium and polymers of various types. Pectin is hydrophilic colloidal substance.

The primary cell wall is formed during the early stages of growth and development. It is found in all plant cells and is 1 to 3 μm thick. It is composed chiefly of cellulose, hemicellulose and pectic compounds. The primary cell wall is elastic, and

undergoes extension with the growth of the cell. In many roots, fleshy stems, fruits and leaves the cell contain only the primary cell wall and the middle lamella. The cellulose



Chloroplasts

- 5 μm long.
- Made of outer membrane, inner membrane, with an intervening intermembrane space. The inner membrane surrounds a stroma containing soluble enzymes and membranous structure called thylakoids, which are flattened sacs. A pile of these sacs is called a granum.
- The Thylakoid membrane contain the energy – transducing machinery, the light – harvesting proteins, reaction centers, electron transport chains and ATP syntax.
- The stroma contains the soluble enzyme that utilizes the NADPH and ATP synthesized by the Thylakoid to convert CO_2 into sugar.
- The thylakoid membrane is impermeable to most molecules and ions.
- The outer membrane is highly permeable to small molecules and ions.
- Chloroplasts contain their own DNA and the machinery for replicating and expressing it.

