Various Plant Cell Constituents

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A. Cell Wall

Structure:

- Outer non-living layer found only in plant cells (absent in animal cells).
- Primarily made of cellulose, a complex carbohydrate (polysaccharide).
- May also contain hemicellulose, pectin, and in older cells, lignin (for rigidity).
- **Composed of three layers:**
  - **Middle lamella**: First formed during cell division; rich in pectin; acts as a cementing layer between adjacent cells.
  - **Primary cell wall**: Formed while the cell is still growing; flexible and thin; made mainly of cellulose.
  - **Secondary cell wall**: Formed inside the primary wall after the cell stops growing; thicker and more rigid; contains lignin.

Functions:

- Provides mechanical support and maintains the shape of the cell.
- Prevents over-expansion when water enters by osmosis.
- Provides protection against mechanical stress and pathogens.
- Allows the development of turgor pressure (important for plant rigidity).
- Has **plasmodesmata** – cytoplasmic channels through the cell wall allowing communication between adjacent cells.

B. Cell Membrane (Plasma Membrane)

Structure:

- Semi-permeable membrane just inside the cell wall.
- Made of a phospholipid bilayer with embedded proteins.
- Contains carbohydrates attached to proteins and lipids (glycoproteins and glycolipids) important for signaling.
- Fluid mosaic model describes its dynamic and semi-fluid nature.

Functions:

- Regulates transport of substances in and out of the cell (selective permeability).
- Involved in cell signaling and cell recognition.
- Maintains homeostasis of the internal environment.

- Acts as a barrier, protecting the internal contents.

C. Cytoplasm

Structure:

- A gel-like matrix (cytosol + organelles) enclosed by the plasma membrane.
- Composed of water (70–90%), dissolved ions, organic molecules, enzymes, and cytoskeletal filaments.
- Contains all organelles except the nucleus.

Functions:

- Site of metabolic reactions (glycolysis, synthesis of amino acids, etc.).
- Provides a medium for the movement of organelles.
- Helps maintain cell shape and consistency.
- Stores nutrients and waste products.

D. Nucleus

Structure:

- Large, central organelle, surrounded by a double membrane (nuclear envelope).
- Contains nuclear pores allowing material exchange.
- Inside: nucleoplasm, chromatin (DNA + proteins), and nucleolus.

Chromatin:

- Exists in two forms: euchromatin (light-staining, active genes) and heterochromatin (dark-staining, inactive).
- During cell division, chromatin condenses into chromosomes.

Nucleolus:

- Dense structure inside the nucleus.
- Not membrane-bound.
- Site of ribosomal RNA (rRNA) synthesis and assembly of ribosomal subunits.

Functions:

- Stores genetic material (DNA) and controls all cellular activities.
- Directs protein synthesis by sending mRNA to the cytoplasm.
- Nucleolus is essential for ribosome production.
- Controls cell division and growth.

E. Endoplasmic Reticulum (ER)

Structure:

- Extensive network of membranous tubules and sacs (cisternae) connected to the nuclear envelope.
- **Two types:**
  - **Rough ER (RER)**: Ribosome-studded; involved in protein synthesis.
  - **Smooth ER (SER)**: Lacks ribosomes; involved in lipid metabolism.

Functions:

- **RER**:
  - Synthesizes and modifies **proteins** (especially those for secretion or membrane insertion).
  - Transports proteins to the **Golgi apparatus** via vesicles.
- **SER**:
  - Synthesizes **lipids and steroids**.
  - Involved in **detoxification** of chemicals.
  - Stores **calcium ions**.

F. Ribosomes

Structure:

- Small, non-membranous organelles.
- Made of rRNA and proteins.
- Two subunits: large and small.
- Found either free in cytoplasm or attached to the RER.

Functions:

- Site of protein synthesis (translation of mRNA).
- Free ribosomes: make proteins for internal use.
- RER-bound ribosomes: synthesize proteins for export or for membranes.

G. Golgi Apparatus (Golgi Body/Complex)

Structure:

- Stack of flattened membrane-bound sacs (cisternae).
- **Has two faces:**
  - **Cis face** (receiving side, near ER).
  - **Trans face** (shipping side, near plasma membrane).

Functions:

- Modifies, sorts, and packages proteins and lipids received from the ER.
- Forms vesicles for transport.
- Produces lysosomes and cell plate material during cell division.
- Plays a role in polysaccharide synthesis for the plant cell wall.

H. Mitochondria

Structure:

- Double membrane-bound organelle.
- Outer membrane: smooth.
- Inner membrane: folded into cristae (increases surface area).
- Contains matrix (fluid inside), with enzymes, mitochondrial DNA, and ribosomes.

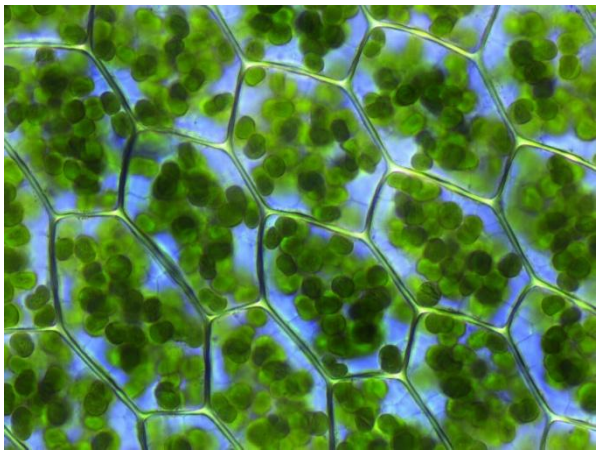
Functions:

- Powerhouse of the cell – site of cellular respiration.
- Converts glucose into ATP (adenosine triphosphate).
- Involved in metabolism, calcium storage, and apoptosis (programmed cell death).

I. Plastids

Structure:

- Double membrane-bound organelles unique to plant cells.
- Contain their own DNA and ribosomes.
- **Types:**
  - **Chloroplasts**: Green, contain chlorophyll.
  - **Chromoplasts**: Colored (red, yellow, orange), contain pigments like carotenoids.
  - **Leucoplasts**: Colorless, used for storage.



Chloroplasts:

- Have stroma (fluid), grana (stacks of thylakoids), and thylakoid membranes (contain chlorophyll).

Functions:

- Chloroplasts: Site of photosynthesis – converts sunlight into chemical energy (glucose).
- Chromoplasts: Give color to flowers/fruits to attract pollinators/seed dispersers.
- Leucoplasts:

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