Republic of Iraq
Ministry of Higher Education
&Scientific Research
University of Anbar
College of Science

Lecture 2

Plant Cell

6. Golgi Apparatus
7. Mitochondria
8. Plastids
9. Plasmodesmata
10. Microbodies
11. Cell Wall

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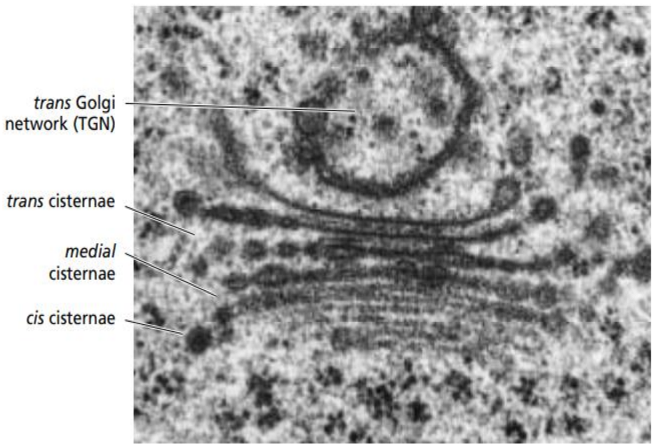
6. Golgi Apparatus

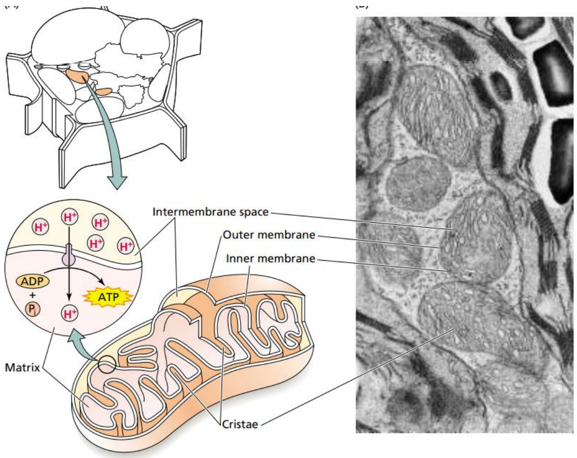
The Golgi apparatus (also called Golgi complex) of plant cells is a dynamic structure consisting of one or more stacks of three to ten flattened membrane sacs, or cisternae, and an irregular network of tubules and vesicles called the trans Golgi network (TGN). Each individual stack is called a Golgi body or dictyosome. The Golgi body has distinct functional regions: The cisternae closest to the plasma membrane are called the trans face, and the cisternae closest to the center of the cell are called the cis face. The medial cisternae are between the trans and cis cisternae. The trans Golgi network is located on the trans face. The entire structure is stabilized by the presence of inter cisternal elements, protein crosslinks that hold the cisternae together. The Golgi apparatus plays a key role in the synthesis and secretion of complex polysaccharides (polymers composed of different types of sugars) and in the assembly of the oligosaccharide side chains of glycoproteins . In plant cells, the Golgi body plays an important role in cell wall formation. Secretory vesicles derived from the Golgi carry the polysaccharides and glycoproteins to the plasma membrane, where the vesicles fuse with the plasma membrane and empty their contents into the region of the cell wall. Secretory vesicles may either be smooth or have a protein coat. Vesicles budding from the ER are generally smooth. Most vesicles budding from the Golgi have protein coats of some type. These proteins aid in the budding process during vesicle formation.



Golgi apparatus

7. Mitochondria

A typical plant cell has two types of energy-producing organelles: mitochondria and chloroplasts. Both types are separated from the cytosol by a double membrane (an outer and an inner membrane). Mitochondria (singular mitochondrion) are the cellular sites of respiration, a process in which the energy released from sugar metabolism is used for the synthesis of ATP (adenosine triphosphate) from ADP (adenosine diphosphate) and inorganic phosphate (Pi). Mitochondria can vary in shape from spherical to tubular, but they all have a smooth outer membrane and a highly convoluted inner membrane. The infoldings of the inner membrane are called cristae (singular crista). The compartment enclosed by the inner membrane, the mitochondrial matrix, contains the enzymes of the pathway of intermediary metabolism called the Krebs cycle. In contrast to the mitochondrial outer membrane and all other membranes in the cell, the inner membrane of a mitochondrion is almost 70% protein and contains some phospholipids that are unique to the organelle.



Mitochondria

8. Plastids

♦**proplastids:** which have few or no internal membranes, no chlorophyll, and an incomplete complement of the enzymes necessary to carry out photosynthesis. In angiosperms and some gymnosperms, chloroplast development from proplastids is triggered by light. Upon illumination, enzymes are formed inside the proplastid or imported from the cytosol, light-absorbing pigments are produced, and membranes proliferate rapidly, giving rise to stroma lamellae and grana stacks. Seeds usually germinate in the soil away from light, and chloroplasts develop only when the young shoot is exposed to light. If seeds are germinated in the dark, the proplastids differentiate into ♦**etioplasts:** which contain semicrystalline tubular arrays of membrane known as prolamellar bodies. Instead of chlorophyll, the etioplast contains a pale yellow green precursor pigment, protochlorophyllide. . Within minutes after exposure to light, the etioplast differentiates, converting the prolamellar body into thylakoids and stroma lamellae, and the protochlorophyll into chlorophyll. The maintenance of chloroplast structure depends on the presence of light, and mature chloroplasts can revert to etioplasts during extended periods of darkness. Chloroplasts can be converted to ♦**chromoplasts**: as in the case of autumn leaves and ripening fruit, and in some cases this process is reversible. And ♦**amyloplasts** can be converted to chloroplasts, which explains why exposure of roots to light often results in greening of the roots.

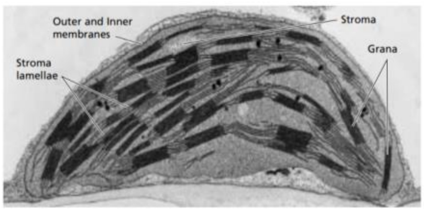
♦**Chloroplasts**: belong to another group of double membrane–enclosed organelles called plastids. Chloroplast membranes are rich in glycosylglycerides. Chloroplast membranes contain chlorophyll and its associated proteins and are the sites of photosynthesis. In addition to their inner and outer envelope membranes, chloroplasts possess a third system of membranes called thylakoids. A stack of thylakoids forms a granum (plural grana). Proteins and pigments (chlorophylls and carotenoids) that function in the photochemical events of photosynthesis are embedded in the thylakoid membrane. The fluid compartment surrounding the thylakoids, called the stroma, is analogous to the matrix of the mitochondrion. Adjacent grana are connected by unstacked membranes called stroma lamellae (singular lamella). The different components of the photosynthetic apparatus are localized in different areas of the grana and the stroma lamellae. The ATP synthases of the chloroplast are located on the thylakoid membranes. Plastids that contain high concentrations of carotenoid pigments rather than chlorophyll are called chromoplasts.

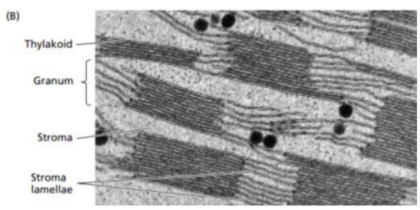
They are one of the causes of the yellow, orange, or red colors of many fruits and flowers, as well as of autumn leaves. Nonpigmented plastids are called ♦**Leucoplasts**. The most important type of leucoplast is the amyloplast, a starchstoring plastid. Amyloplasts are abundant in storage tissues of the shoot and root, and in seeds. Specialized amyloplasts in the root cap also serve as gravity sensors that direct root growth downward into the soil

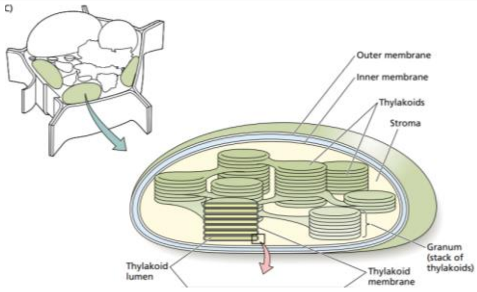
Note:

Both mitochondria and chloroplasts contain their own DNA and protein-synthesizing machinery (ribosomes, transfer RNAs, and other components) and are believed to have evolved from endosymbiotic bacteria. Both plastids and mitochondria divide by fission, and mitochondria can also undergo extensive fusion to form elongated structures or networks

The DNA of these organelles is in the form of circular chromosomes, similar to those of bacteria and very different from the linear chromosomes in the nucleus. These DNA circles are localized in specific regions of the mitochondrial matrix or plastid stroma called nucleoids. DNA replication in both mitochondria and chloroplasts is independent of DNA replication in the nucleus.







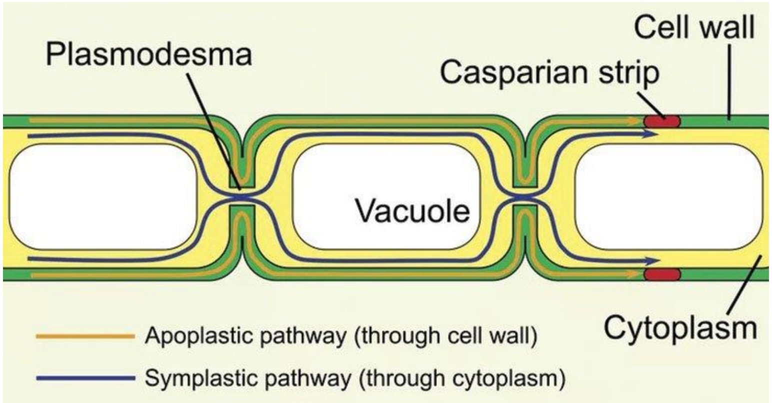
Chloroplastid

9. Plasmodesmata

Plasmodesmata (singular plasmodesma) are tubular extensions of the plasma membrane, 40 to 50 nm in diameter, that traverse the cell wall and connect the cytoplasms of adjacent cells. Because most plant cells are interconnected in this way, their cytoplasms form a continuum referred to as the symplast. Intercellular transport of solutes through plasmodesmata is thus called symplastic transport .There are two types of Plasmodesmata:

Primary plasmodesmata: form during cytokinesis when Golgi-derived vesicles containing cell wall precursors fuse to form the cell plate (the future middle lamella). Rather than forming a continuous uninterrupted sheet, the newly deposited cell plate is penetrated by numerous pores, where remnants of the spindle apparatus, consisting of ER and microtubules, disrupt vesicle fusion. Further deposition of wall polymers increases the thickness of the two primary cell walls on either side of the middle lamella, generating linear membrane-lined channels. Development of primary plasmodesmata thus provides direct continuity and communication between cells that are clonally related (i.e., derived from the same mother cell).

Secondary plasmodesmata: form between cells after their cell walls have been deposited. They arise either by invagination of the plasma membrane at the cell surface, or by branching from a primary plasmodesma. In addition to increasing the communication between cells.



10.Microbodies

Microbodies Play Specialized Metabolic Roles in Leaves and Seeds Plant cells also contain microbodies, a class of spherical organelles surrounded by a single membrane and specialized for one of several metabolic functions. The two main types of microbodies are peroxisomes and glyoxysomes.

Peroxisomes are found in all eukaryotic organisms, and in plants they are present in photosynthetic cells adjacent to mitochondria and plastids. Peroxisomes function both in the removal of hydrogens from organic substrates, consuming O_2 in the process, according to the following reaction:

$$RH_2 + O_2 \rightarrow R + H_2O_2$$

where R is the organic substrate. The potentially harmful peroxide produced in these reactions is broken down in peroxisomes by the enzyme catalase, according to the following reaction:

$$H_2O_2 \rightarrow H_2O + 1/2O_2$$

Glyoxysome, is present in oil-storing seeds. Glyoxysomes contain the glyoxylate cycle enzymes, which help convert stored fatty acids into sugars that can be translocated throughout the young plant to provide energy for growth.

11. Cell Wall

A **cell wall** is a rigid, semi-permeable protective layer in some cell types. This outer covering is positioned next to the cell membrane (plasma membrane). Animal cells however, do not have a cell wall. The cell wall has many important functions in a cell including protection, structure, and support.

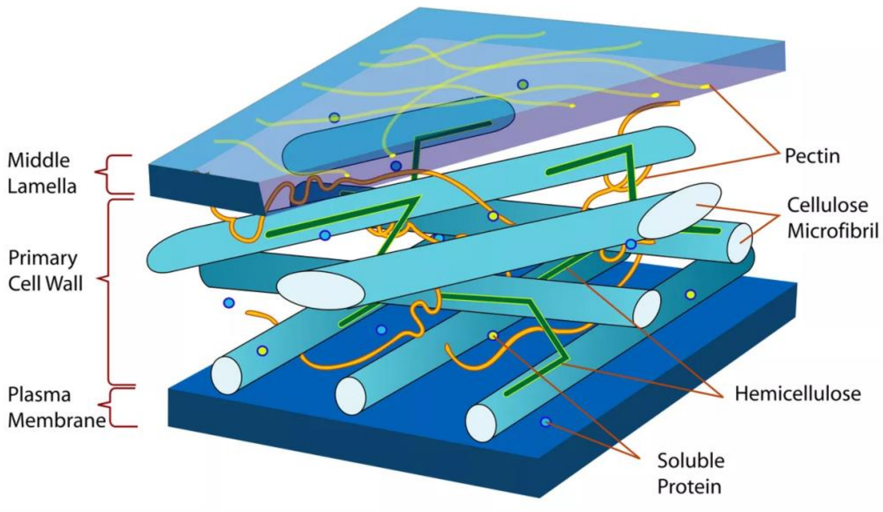
Cell wall composition varies depending on the organism. In plants, the cell wall is composed mainly of strong fibers of the carbohydrate polymer **cellulose**. Cellulose is the major component of cotton fiber and wood, and it is used in paper production. Bacterial cell walls are composed of a sugar and amino acid polymer called **peptidoglycan**. The main components of fungal cell walls are **chitin**, glucans, and proteins.

The plant cell wall is multi-layered and consists of up to three sections. From the outermost layer of the cell wall, these layers are identified as the middle lamella, primary cell wall, and secondary cell wall. While all plant cells have a middle lamella and primary cell wall, not all have a secondary cell wall.

- **Middle lamella:** This outer cell wall layer contains polysaccharides called pectins. Pectin said in cell adhesion by helping the cell walls of adjacent cells to bind to one another.
- **Primary cell wall:** This layer is formed between the middle lamella and plasma membrane in growing plant cells. It is primarily composed of cellulose microfibrils contained within a gel-like matrix of hemicellulose fibers and pectin polysaccharides. The primary cell wall provides the strength and flexibility needed to allow for cell growth.
- **Secondary cell wall:** This layer is formed between the primary cell wall and plasma membrane in some plant cells. Once the primary cell wall has stopped dividing and growing, it may thicken to form a secondary cell wall. This rigid layer strengthens and supports the cell. In addition to cellulose and hemicellulose, some secondary cell walls contain lignin. Lignin strengthens the cell wall and aids in water conductivity in plant vascular tissue cells.

A major role of the cell wall is to form a framework for the cell to prevent over expansion. Cellulose fibers, structural proteins, and other polysaccharides help to maintain the shape and form of the cell. Additional **functions of the cell wall** include:

- **Support:** The cell wall provides mechanical strength and support. It also controls the direction of cell growth.
- **Withstand turgor pressure:** Turgor pressure is the force exerted against the cell wall as the contents of the cell push the plasma membrane against the cell wall. This pressure helps a plant to remain rigid and erect, but can also cause a cell to rupture.
- **Regulate growth:** The cell wall sends signals for the cell to enter the cell cycle in order to divide and grow.
- **Regulate diffusion:** The cell wall is porous allowing some substances, including proteins, to pass into the cell while keeping other substances out.
- **Communication:** Cells communicate with one another via plasmodesmata (pores or channels between plant cell walls that allow molecules and communication signals to pass between individual plant cells).
- **Protection:** The cell wall provides a barrier to protect against plant viruses and other pathogens. It also helps to prevent water loss.
- **Storage:** The cell wall stores carbohydrates for use in plant growth, especially in seeds.



Cell wall structure

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