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

Lecture 1

Plant Cell

1. **Biological Membranes (cytoplasmic membrane):**
2. **.Cytoplasm**
3. **Vacuoles**
4. **The Nucleus**
5. **The Endoplasmic Reticulum**

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Plant physiology

Is the study of plant function and behavior, encompassing all the dynamic processes of growth, metabolism, reproduction, defense, and communication that account for plants being alive. Considering that most of these processes take place at the level of cells, tissues, and organs, there is, because of the close association between structure and function in plants, also a close association between plant physiology and plant anatomy. Moreover, within the living cell, much of the metabolic activity is at the molecular level; therefore, a full understanding of a plant's physiology requires an essential background in chemistry and physics.

Plant cell

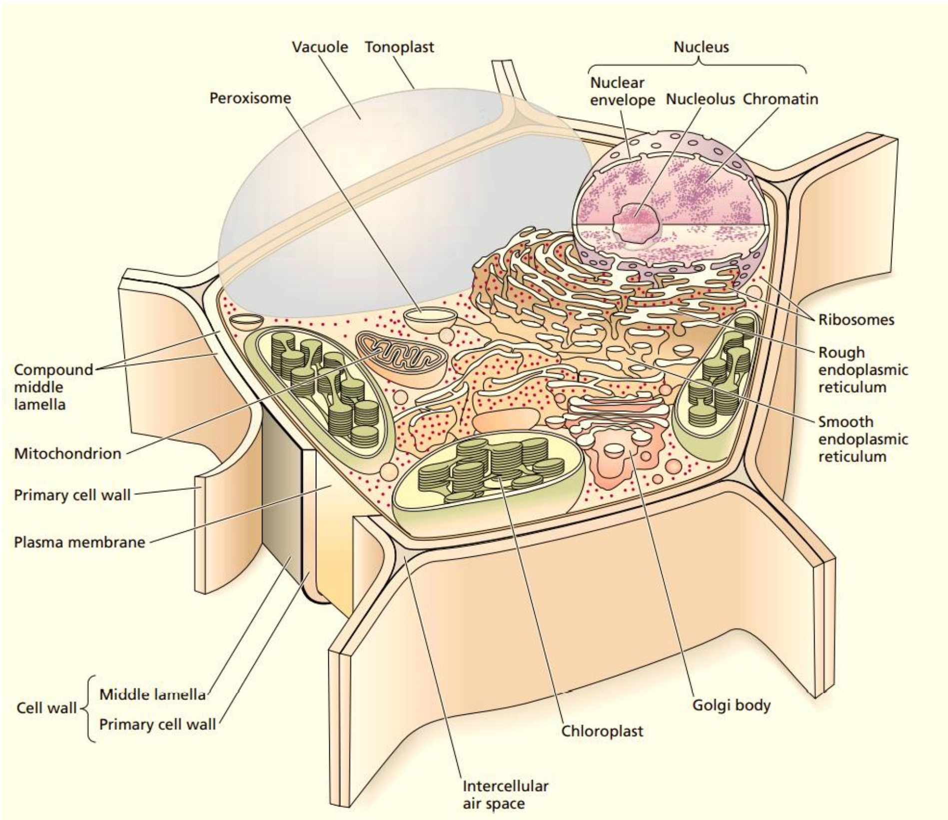
The term cell is derived from the Latin cella, meaning storeroom or chamber. It was first used in biology in 1665 by the English botanist Robert Hooke to describe the individual units of the honeycomb-like structure he observed in cork under a compound microscope.

The "cells" Hooke observed were actually the empty lumens of dead cells surrounded by cell walls, but the term is an apt one because cells are the basic building blocks that define plant structure.

Despite their apparent diversity, all seed plants have the same basic body plan. The vegetative body is composed of three organs: leaf, stem, and root. The primary function of a leaf is photosynthesis, that of the stem is support, and that of the root is anchorage and absorption of water and minerals. Leaves are attached to the stem at nodes, and the region of the stem between two nodes is termed the internode. The stem together with its leaves is commonly referred to as the shoot.

There are two categories of seed plants: gymnosperms (from the Greek for "naked seed") and angiosperms (based on the Greek for "vessel seed," or seeds contained in a vessel). Gymnosperms are the less advanced type; about 700 species are known. The largest group of gymnosperms is the conifers ("cone-bearers"), which include such commercially important forest trees as pine, fir, spruce, and redwood. Angiosperms, the more advanced type of seed plant, first became abundant during the Cretaceous period, about 100 million years ago. Today, they dominate the landscape, easily outcompeting the gymnosperms.

Plants are multicellular organisms composed of millions of cells with specialized functions. At maturity, such specialized cells may differ greatly from one another in their structures. However, all plant cells have the same basic eukaryotic organization: They contain a nucleus, a cytoplasm, and subcellular organelles, and they are enclosed in a membrane that defines their boundaries. Certain structures, including the nucleus, can be lost during cell maturation, but all plant cells begin with a similar complement of organelles.



Typical Plant Cell

1. Biological Membranes (cytoplasmic membrane):

All cells are enclosed in a membrane that serves as their outer boundary, separating the cytoplasm from the external environment. This plasma membrane (also called plasma lemma) allows the cell to take up and retain certain substances while excluding others. Various transport proteins embedded in the plasma membrane are responsible for this selective traffic of solutes across the membrane. The accumulation of ions or molecules in the cytosol through the action of transport proteins consumes metabolic energy. Membranes also delimit the boundaries of the specialized internal organelles of the cell and regulate the fluxes of ions and metabolites into and out of these compartments.

According to the fluid-mosaic model, all biological membranes have the same basic molecular organization. They consist of a double layer (bilayer) of either phospholipids or, in the case of chloroplasts, glycosyl glycerides, in which proteins are embedded. In most membranes, proteins make up about half of the membrane's mass. However, the composition of the lipid components and the properties of the proteins vary from membrane to membrane, conferring on each membrane its unique functional characteristics.

Phospholipids: Phospholipids are a class of lipids in which two fatty acids are covalently linked to glycerol, which is covalently linked to a phosphate group. Also attached to this phosphate group is a variable component, called the head group, phospholipid molecules display both hydrophilic and hydrophobic properties. The nonpolar hydrocarbon chains of the fatty acids form a region that is exclusively hydrophobic-that is, that excludes water.

Plastid membranes are unique in that their lipid component consists almost entirely of glycosylglycerides rather than phospholipids.

The fluidity of the membrane, in turn, plays a critical role in many membrane functions. Membrane fluidity is also strongly influenced by temperature. Because plants generally cannot regulate their body temperatures, they are often faced with the problem of maintaining membrane fluidity under conditions of low temperature, which tends to decrease membrane fluidity.

Proteins: The proteins associated with the lipid bilayer are of three types: integral, peripheral, and anchored. Integral proteins are embedded in the lipid bilayer. Most integral proteins span the entire width of the phospholipid bilayer, so one part of the protein interacts with the outside of the cell, another part interacts with the hydrophobic core of the membrane, and a third part interacts with the interior of the cell, the cytosol. Proteins that serve as ion channels are always integral membrane proteins, as are certain receptors that participate in signal transduction pathways. Some receptor-like proteins on the outer surface of the plasma membrane. Peripheral proteins serve a variety of functions in the cell. For example, some are involved in interactions between the plasma membrane and components of the cytoskeleton, such as microtubules and actin microfilaments. Anchored proteins are bound to the membrane surface via lipid molecules, to which they are covalently attached. These lipids include fatty acids .

Functions

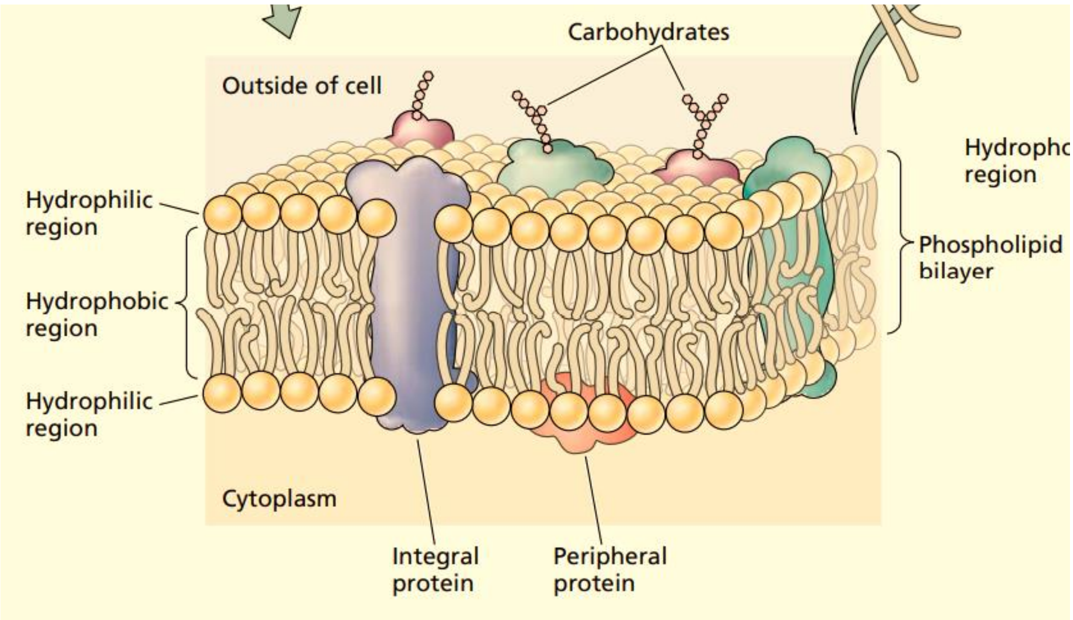
A. controlling the passage of substances from and to the cell, as the membrane is described as selectively permeabl The passage of materials is through the lipid layer or through protein channels or through carrier proteins or through new protein channel called aquaporines.

B. Exocytosis and Endocytosis

C. Receive various signals and stimuli, where special proteins do this work. These compounds are called receptor proteins

D. Diagnosing and identifying substances outside the cell, where glycoprotein compounds play this role

E. It has a role in the biological pathways due to the presence of enzymes



Plasma membrane

2.Cytoplasm

It is the basic material for protoplasm, and inside it there are all components and cellular organelles The cytoplasm is a complex colloidal system, fluid in texture and more viscous than water, and contains 80-90% water, but this amount of water may decrease in seeds. It refers to the contents of the cell located between the nucleus and the plasma membrane, but by discovering the cell organelles that are usually separated from the cytoplasm by a plasma membrane, the rest of the cytoplasm, which is described as the fluid part and not included in any of the organelles, is called the cytosol. The cytosol contains large amounts of protein and other solutes. In the cytosol of eukaryotic cells, there is an organized network of protein filaments known as the cytoplasmic structure. The cytosol is organized into a three-dimensional network of filamentous proteins called the cytoskeleton.

This network provides the spatial organization for the organelles and serves as a scaffolding for the movements of organelles and other cytoskeletal components. It also plays fundamental roles in mitosis, meiosis, cytokinesis, wall deposition, the maintenance of cell shape, and cell differentiation. Plant Cells Contain Microtubules, Microfilaments, and Intermediate Filaments Three types of cytoskeletal elements have been demonstrated in plant cells: microtubules, microfilaments, and intermediate filament–like structures. Each type is filamentous, having a fixed diameter and a variable length, up to many micrometers. Microtubules and microfilaments are macromolecular assemblies of globular proteins. Microtubules are hollow

The cytoplasmic structure plays the role of maintaining the shape and movement of the cell and changing its shape As for the vital actions that take place in the cytoplasm in general, the most prominent of them are the following

1. Glycolysis
2. Formation of important carbohydrate such as sucrose
3. Protein synthesis
4. Fatty acid synthesis
5. Pentose phosphate pathway

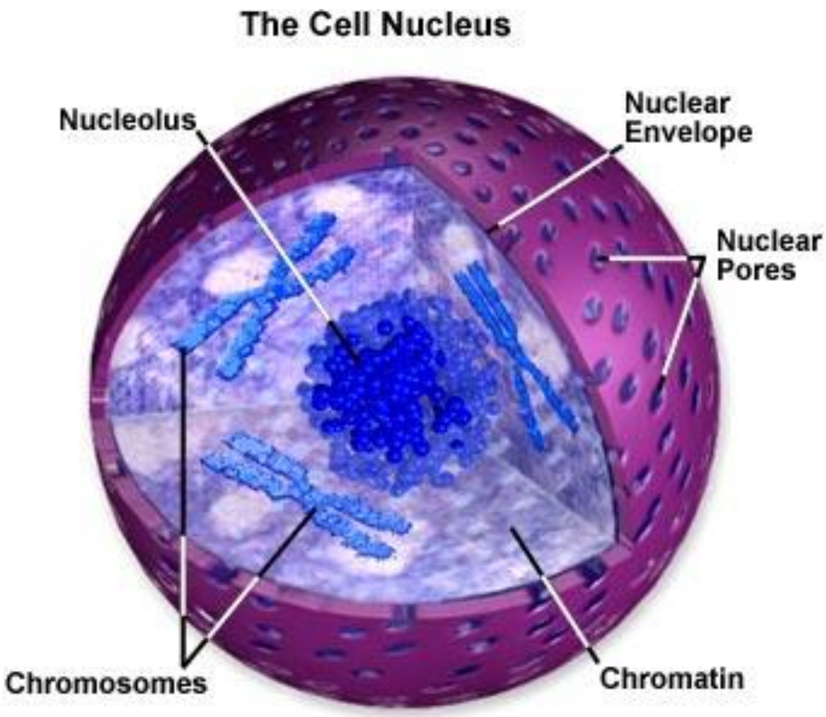
3.Vacuoles

One of the prominent features of a fully-grown plant cell is the presence of a large central vacuole, which can occupy about 80-09-80 of the cell volume. Vacuole is surrounded by tonoplast The vacuole contains various substances of inorganic ions, organic acids, sugars, enzymes and secondary metabolites. The presence of these solutes in the vacuoles suggests that they are a storehouse for the products of metabolism that the cell gets rid of by removing them in non-vital areas, or that they are important in maintaining the water balance of the cell, which plays an important role in the process of cellular filling (turgidity). The active, young cells contain a large number of small vacuoles, which quickly unite, coalesce and expand to form one large vacuole when the cell reaches the stage of full growth. Active solute accumulation provides the osmotic driving force for water uptake by the vacuole, which is required for plant cell enlargement. The turgor pressure generated by this water uptake provides the structural rigidity needed to keep herbaceous plants upright, since they lack the lignified support tissues of woody plants. Like animal lysosomes, plant vacuoles contain hydrolytic enzymes, including proteases, ribonucleases, and glycosidases. Unlike animal lysosomes, however, plant vacuoles do not participate in the turnover of macromolecules throughout the life of the cell. Instead, their degradative enzymes leak out into the cytosol as the cell undergoes senescence, thereby helping to recycle valuable nutrients to the living portion of the plant. Specialized protein-storing vacuoles, called protein bodies, are abundant in seeds. During germination the storage proteins in the protein bodies are hydrolyzed to amino acids and exported to the cytosol for use in protein synthesis. The hydrolytic enzymes are stored in specialized lytic vacuoles, which fuse with the protein bodies to initiate the breakdown process

4. The Nucleus

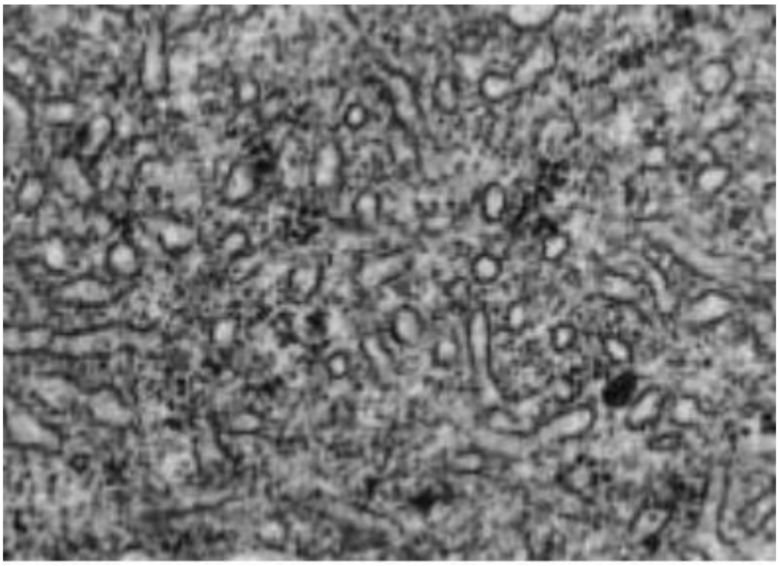
The nucleus (plural nuclei) is the organelle that contains the genetic information primarily responsible for regulating the metabolism, growth, and differentiation of the cell. Collectively, these genes and their intervening sequences are referred to as the nuclear genome. The size of the nuclear genome in plants is highly variable. The nucleus is surrounded by a double membrane called the nuclear envelope. The space between the two membranes of the nuclear envelope is called the perinuclear space, and the two membranes of the nuclear envelope join at sites called nuclear pores. The nuclear "pore" is actually an elaborate structure composed of more than a hundred different proteins arranged octagonally to form a nuclear pore complex. The nucleus is the site of storage and replication of the chromosomes, composed of DNA and its associated proteins. Collectively, this DNA–protein complex is known as chromatin. The linear length of all the DNA within any plant genome is usually millions of times greater than the diameter of the nucleus in which it is found. To solve the problem of packaging this chromosomal DNA within the nucleus, segments of the linear double helix of DNA are coiled twice around a solid cylinder of eight histone protein molecules, forming a nucleosome.

At interphase, two types of chromatin are visible: heterochromatin and euchromatin. About 10% of the DNA consists of heterochromatin, a highly compact and transcriptionally inactive form of chromatin. The rest of the DNA consists of euchromatin, the dispersed, transcriptionally active form. Nuclei contain a densely granular region, called the nucleolus (plural nucleoli), that is the site of ribosome synthesis. The nucleolus includes portions of one or more chromosomes where ribosomal RNA (rRNA). Typical cells have one or more nucleoli per nucleus.

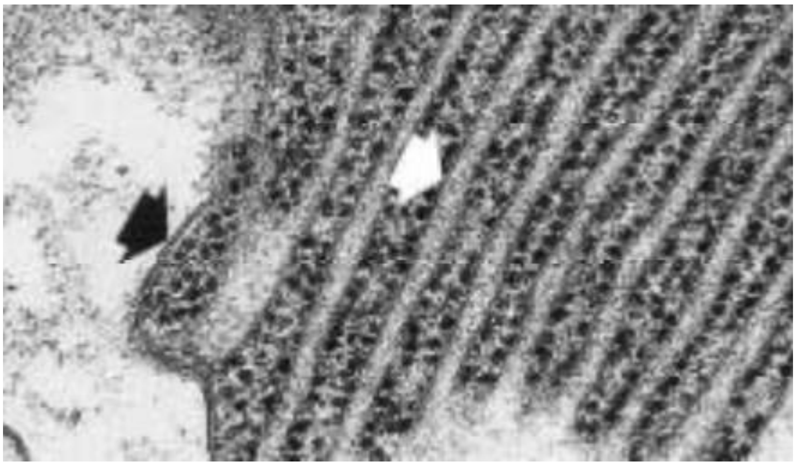


5.The Endoplasmic Reticulum

Cells have an elaborate network of internal membranes called the endoplasmic reticulum (ER). The membranes of the ER are typical lipid bilayers with interspersed integral and peripheral proteins. These membranes form flattened or tubular sacs known as cisternae (singular cisterna). These membranes increase the surface of the cell from the inside to facilitate various biological reactions. Ultra structural studies have shown that the ER is continuous with the outer membrane of the nuclear envelope on the hand and with the neighboring living cell on the other hand through the plasmodesmata. There are two types of ER smooth and rough and the two types are interconnected. Rough ER (RER) differs from smooth ER in that it is covered with ribosomes that are actively engaged in protein synthesis; in addition, rough ER tends to be lamellar (a flat sheet composed of two unit membranes), while smooth ER tends to be tubular, although a gradation for each type can be observed in almost any cell. The structural differences between the two forms of ER are accompanied by functional differences. Smooth ER functions as a major site of lipid synthesis and carbohydrate metabolism and membrane assembly. Rough ER is the site of synthesis of membrane proteins and proteins to be secreted outside the cell or into the vacuoles. Secretion of Proteins from Cells Begins with the Rough ER Proteins destined for secretion cross the RER membrane and enter the lumen of the ER.



Smooth ER



Rough ER

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