BOTANİKA

LECTURE 2

THEME: **The basics of cytology.**
The particularis of the plant cell. The structure components of the cell and their functions.

Plant cell

Cytology is the science about the cell.

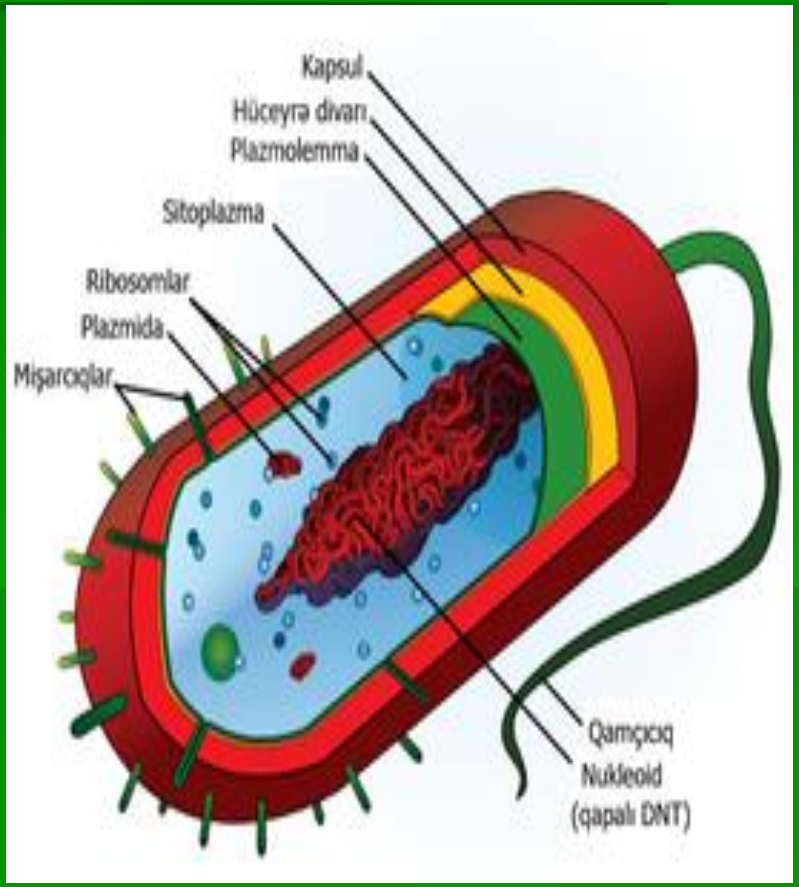
- The cell is the basic structural and functional unit of living organisms. Very small organisms are composed of one cell, and large organisms are composed of billions of cells, each of which performs a specific function and is relatively independent.
- In a multicellular plant organism, each cell is autonomous and functions independently.
- The cell was first discovered by R. Hook in 1665. He, examining the thin section of the oak phellem under a microscope, discovered the cellular structure and published this information in his work "Micrography."

- Robert Hook (1635-1703)

PROCARIOTHIC AND EUCARIOTHIC CELLS

- According the presence of the nucleus, all living organisms are divided into two groups: prokaryotes and eukaryotes (from the Greek word karyon-nucleus of the nut). Prokaryotes are non-nuclear organisms, and eukaryotes are organisms that have a formed nucleus. In other words, prokaryotes are called bacteria. Blue-green algae belong to prokaryotes.

- Prokaryotic cells are mostly smaller than eukaryotic cells. Their sizes are usually 2-3 μm. The size of eukaryotic cells varies from 10 to 100 μm.



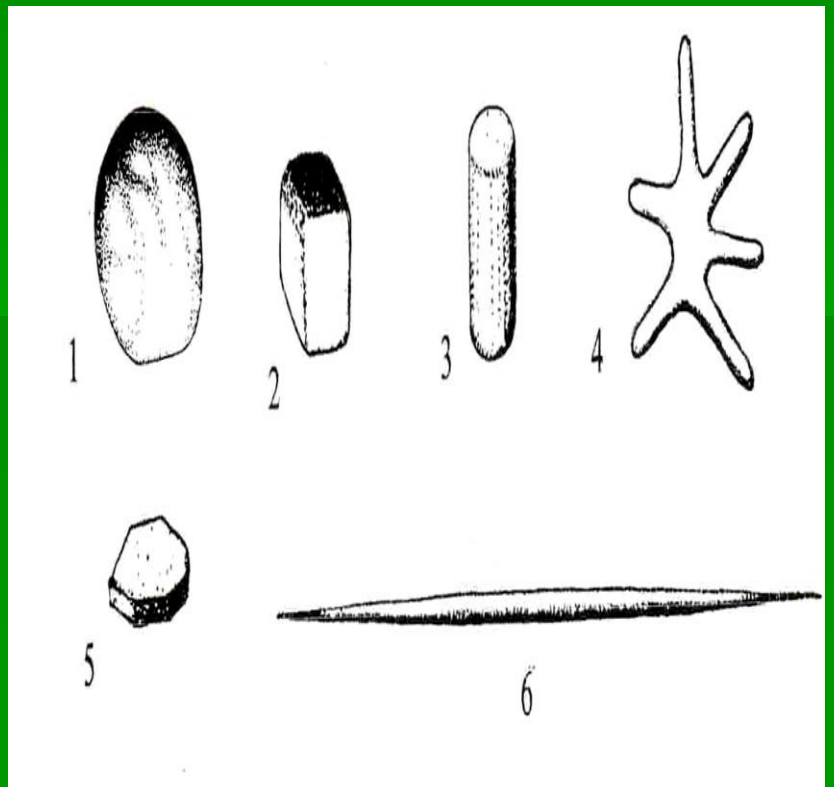
The main difference between prokaryotic cells and eukaryotic cells is that their DNA is not organized into chromosomes and is not surrounded by a nuclear envelope. In the eukaryotic cell, the carriers of the genes-the chromosomes-are in the morphologically formed nucleus. Chromosomes consist of DNA, which is in a complex with proteins-histones. Histones are rich in amino acids arginine and lysine. In addition, the eukaryotic cell has a variety of organelles that are absent in the prokaryotic cell.

- Prokaryotic cells can be divided into equal parts by a constriction or form a daughter cell of a smaller size than the maternal cell, but they never divide by mitosis. Cells of eukaryotic organisms are divided by mitosis. A number of processes peculiar to eukaryotic cells, for example, Phagocytosis, pinocytosis and cyclosis (ie, rotational motion of the cytoplasm) in prokaryotes was not detected.
- A prokaryotic cell does not need ascorbic acid in the metabolism process, but eukaryotic cells can not live without it.

FORMS AND SIZES OF THE CELL

- According to the shape and size, there are two main types of cells:
- 1) parenchymatous cells 2) prosenchymatous cells. In parenchymatous cells, the size is approximately the same in all three dimensions (length, width and thickness). Prosenchymatous cells are elongated in length, which exceeds the width and thickness several times.

- ***Parenchymatous(1-5) and prosenchymatous cells(6)***



The plant cell consists of a cell wall and a protoplast. Earlier protoplast was called protoplasm. Protoplast is the protoplasm of an individual cell; In a plant cell, protoplasm surrounded by a shell is called protoplast.

Protoplast consists of the nucleus, cytoplasm and organoids located in it. Organoids include mitochondria, lysosomes, ribosomes, endoplasmic reticulum, Golgi apparatus, plastids.

Plants and animal cells share many structures, however plants contain a number of structures not found in animals, such as:

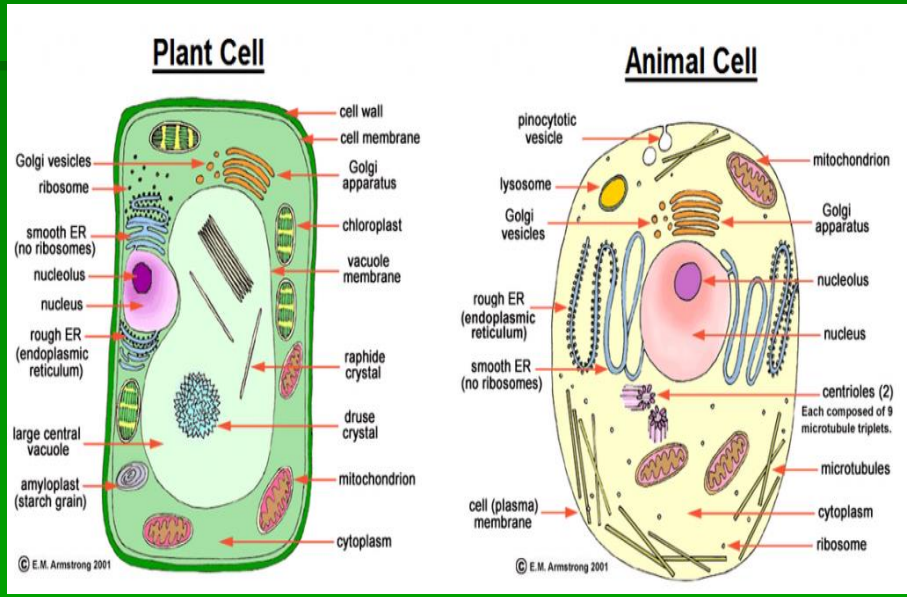
a cell wall (from cellulose)

plastids

vacuoles

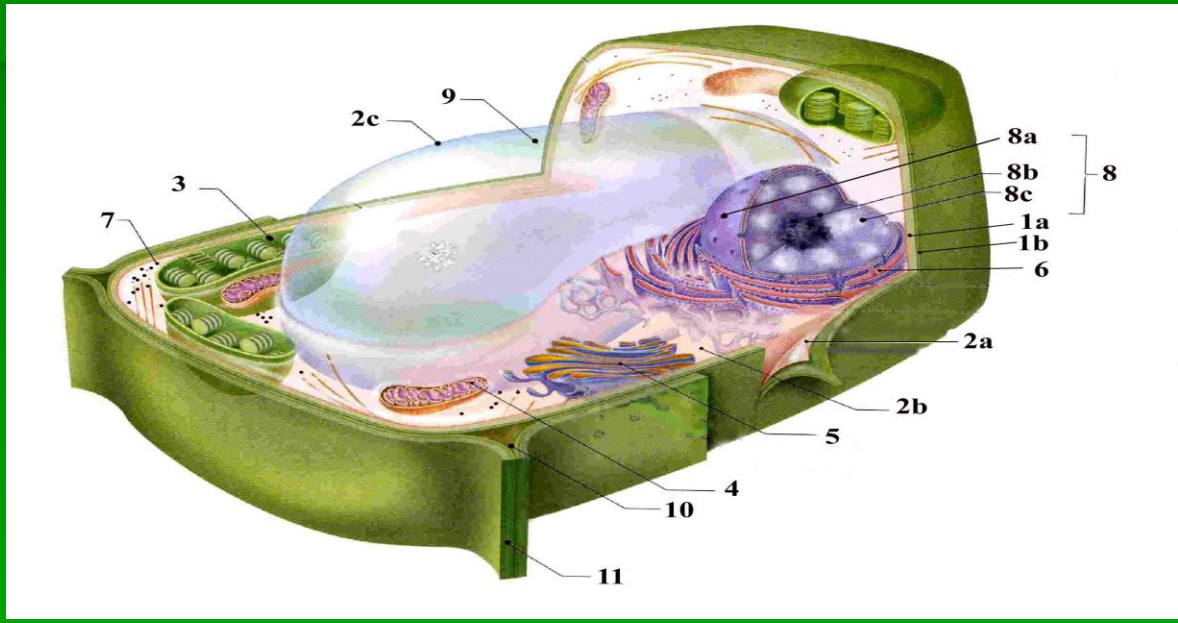
There are three parts of plant cells:

- **cell wall**
- **protoplasm**
- **vacuole**



General scheme of a young leaf cell's structure. Generalized drawing.

1- cell wall:
a - primary;
b - secondary
2 - cytoplasmic fluid:
a – plasmolemma;
b – hyaloplasm;
c - vacuolar membrane (tonoplasts)
3 - green plastid
4 - mitochondrion
5 - Golgi complex
6 - endoplasmic reticulum
7 - ribosome
8 - nucleus:
a - nuclear envelope with pores; b - nucleolus; c - nuclear sap
9 - vacuole with cell sap
10 - intracellular space
11 - cell wall of adjacent cell

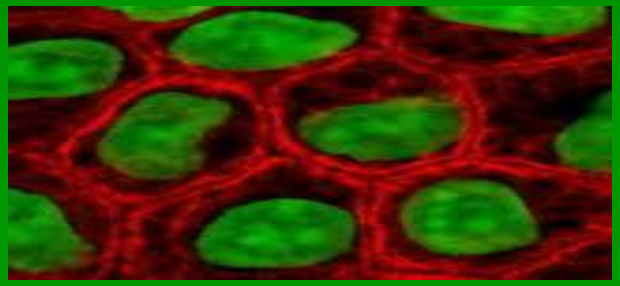


Organoids

CYTOPLASM

- Most of the protoplast is occupied by the cytoplasm, on the outside, it is limited by a semipermeable membrane-plasmalemma, and on the inside by a biological membrane - by a tonoplast. Plasmalemma is located between the cytoplasm and the wall and separates the cytoplasm from the cell wall. Plasmalemma (or plasma membrane) consists of 3 layers performs the following functions: 1) the metabolism between the cell and the environment; 2) coordinates the synthesis and assembly of cellulose microfibrils of the cell wall; 3) transmits hormonal and external signals controlling the growth and differentiation of cells.
- The basis of the cytoplasm is the matrix or hyaloplasm. Hyaloplasm is a complex, colorless, transparent colloidal system capable of reversible transitions from the hydrosol to the gel. The most important role of hyaloplasm is to unite all cellular structures in a single system and to ensure interaction between them in the processes of cellular metabolism. In the cytoplasm, all processes of cellular metabolism are carried out, in addition to the synthesis of nucleic acids (occurring in the nucleus). In a living cell, the matrix or hyaloplasm is in constant motion and the organoids are involved in this movement. The movement of the hyaloplasm is called cyclosis. Cyclos stops in dead cells. Cyclos facilitates the movement of substances in the cell and their exchange between the cell and the environment. The motion of the cytoplasm can be circular, streamlike, etc. Circular motion occurs on or counter-clockwise (in cells of Elodea). At the streaming motion, the strands of the cytoplasm diverge from the center along the edges (nettle, pumpkin, Tradescantia, in the hairs of saxifrage). The movement of the cytoplasm was observed in 1772 by Corti, and in 1811 by Traviranus.

- **Plasmatic filaments-plasmodesmata-bind cytoplasm of neighboring cells among themselves. The cytoplasm performs the following functions: movement, growth, transmission of stimulation, transmission of hereditary information (cytoplasmic), reduction of the fission spindle in the dividing cell,**
- **The cytoplasm consists of organic and inorganic substances. The organic substances of the cytoplasm include proteins, carbohydrates, ribonucleic acids and lipids. The cytoplasm consists of simple proteins (proteins) - histones, albumins, globulins, and complex proteins (proteins) - nucleoproteins, lipoproteins, glucoproteins. In the cytoplasm, enzymes regulate respiration and metabolism of sugars, amino acids, lipids and other compounds (peroxidase, invertase, lipase, protease, etc.). About 10,000 different types of enzymes were found in the plant cell. Of inorganic compounds in the cytoplasm, up to 90% of water is present, as well as up to 2-6% of mineral substances, i.e. Magnesium, calcium, sodium, potassium salts of hydrochloric, phosphoric, nitric and sulfuric acid, trace elements (Fe, Mn, Co, Cu, Zn, I, etc.).**



Nucleus

- The nucleus was first discovered by the English botanico Kernel - an obligatory part of eukaryotic cells. The nucleus regulates the vital activity of the cell, stores hereditary information and passes it to the daughter cells in the process of division. Cells with a deleted or destroyed nucleus die. Of the organelles, only mitochondria and plastids are autonomous to some extent and independent of the nucleus.
- The nucleus is spherical, ellipsoidal, star-shaped, arrow-shaped, etc. In young cells, the nucleus occupies a central position. In adult cells, it moves to the shell. Most often in cells there is one nucleus, rarely 2 or more (eg in mushrooms). The dimensions of the nucleus are different, from 2-3 μm to 500 μm.
- The core consists of a nuclear envelope, nucleoplasm (karyoplasm), nucleolus and chromatin. The nuclear envelope consists of two membranes pierced with pores. These pores are complicated holes, have a very complex structure, the nuclear membrane through the pores is communicated with the endoplasmic reticulum. When dividing the cells, the chromatin strands are converted into chromosomes. DNA is located in chromosomes and provides storage of hereditary information. The number of chromosomes is constant for each plant species. For example, cabbage has -20 chromosomes, wheat-42, sunflower-34, man-46 (in cells).

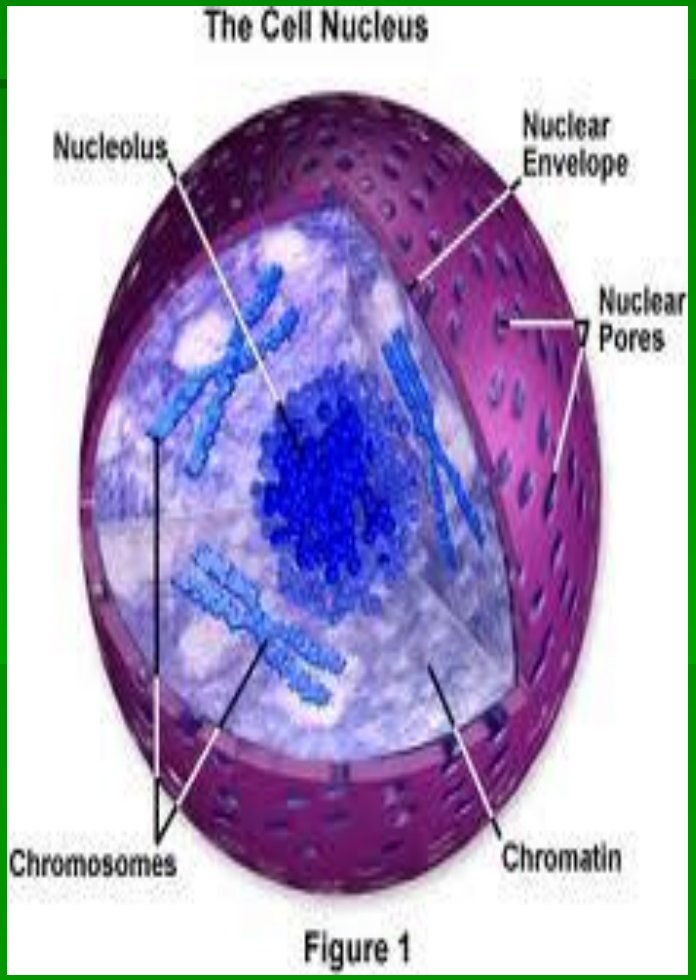
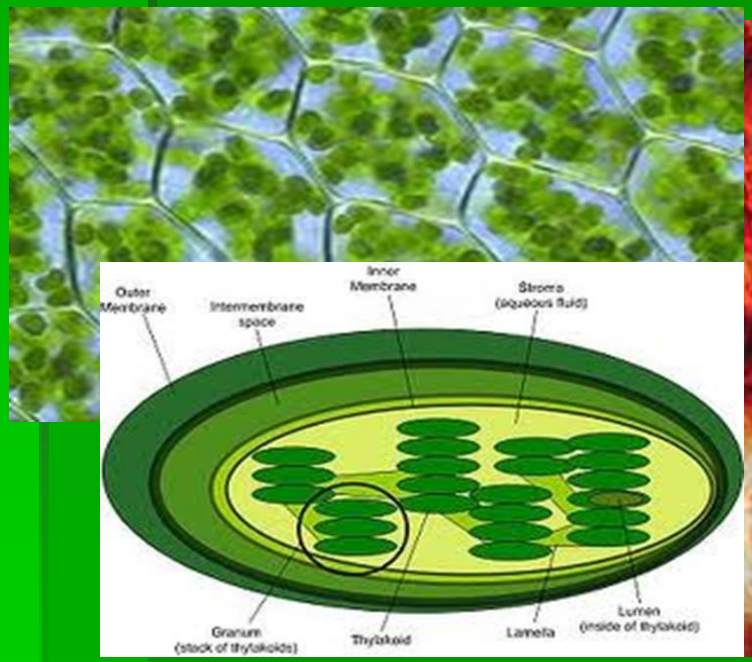
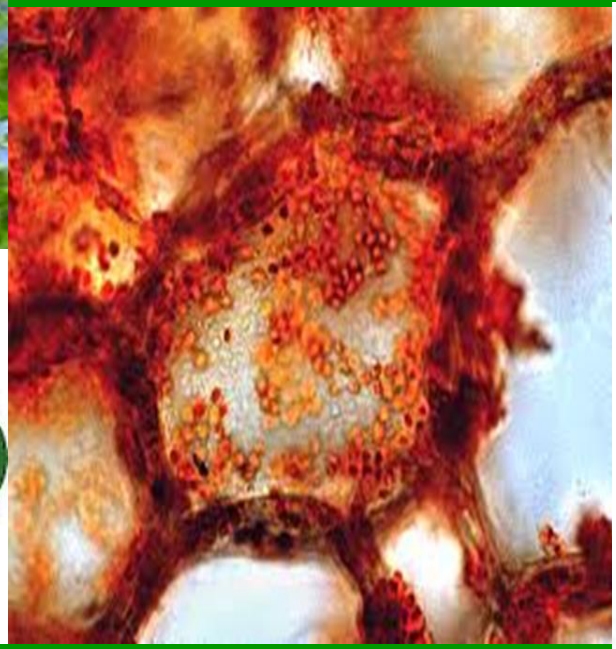


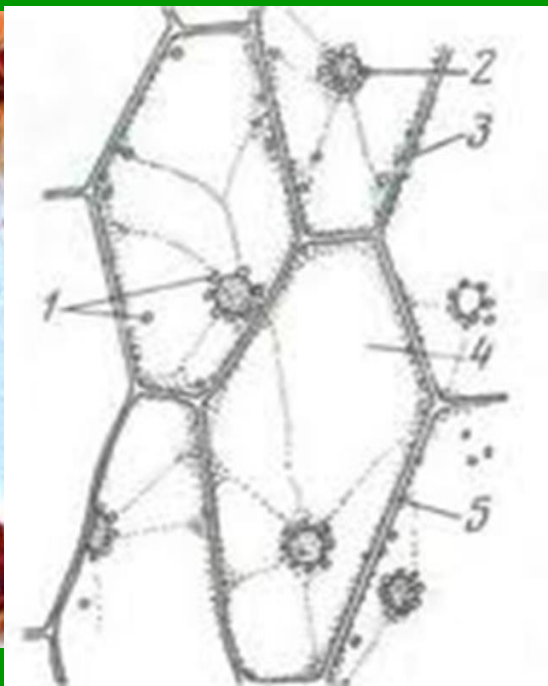
Figure 1

PLASTIDS

- Plastids are found in photosynthetic eukaryotic organisms, algae and some unicellular organisms. Mushrooms, bacteria, slime, and blue-green algae do not have plastids. Plastids as independent organoids are located only inside the cytoplasm. There are protein-lipid nature.
- There are three types of plastids: chloroplasts, chromoplasts and leucoplasts.







- MITOCHONDRIA
- (GRINDER mitos - THREAD, xondrom - GRAIN). Surrounded by a double membrane, and the internal space is filled with an unstructured matrix. They are the energy and respiratory center of the cell. In the mitochondria, a large number of enzymes are found, due to which oxidation of organic compounds occurs, a large amount of energy is released and ATP synthesis occurs.
- Lysosomes
- (Greek lizis-dissolve, soma-body). Small corpuscles of different shapes and sizes contain hydrolytic enzymes that break down proteins, nucleic acids, lipids.

- RIBOSOMS
- Small corpuscles in the form of granules with a diameter of 15-45 microns. The ribosomes contain 65% of the entire RNA of the cell. They are located freely in the hyaloplasm, they are also present in nuclei, chloroplasts and mitochondria. Ribosomes are the centers of protein synthesis.
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- GOLDZHI APPARATUS
- This organoid was first described by the Italian scientist Golgi and named after him. The Golgi apparatus is a component of all eukaryotic cells. The Golgi apparatus consists of individual dictyosomes. Diktiosomes are formed from cisterns (not in contact with each other). The number of dictyosomes varies from one to several tens. It is believed that polysaccharides are synthesized in dictyosomes, the resulting polysaccharides are transported by Golgi vials, and participate in the formation of the cell wall.

ENDOPLASMIC RETICULUM

- The endoplasmic reticulum was discovered by Porter in 1945 using electron microscopy. The endoplasmic reticulum is a reticulum of membranes of protein-lipid nature 30-40 A thick, which forms tubules, cisterns, bags and connects different parts of the cytoplasm with each other and the nucleus. A system of double membranes, between which there is a narrow, transparent space. In some cells, the surface of the endoplasmic reticulum is roughened, containing many ribosomes on its surface. The grouping of 5-70 ribosomes is called polyribosomes. In some cells, the endoplasmic reticulum is smooth and there are not ribosomes on the surface. In the same cell, the endoplasmic reticulum can be presented in a smooth and rough form. On the membranes there are many folds that repeatedly increase the surface of the membrane. The endoplasmic reticulum performs many diverse functions. Various biochemical processes occur on the membrane surface. The synthesis of proteins, polymerization of amino acids and specific polypeptides occurs on the ribosomes, and lipids and carbohydrates are synthesized on the surface of the tubular membrane. The endoplasmic reticulum carries the transport of matter within the cell and the transport of substances from the environment into the cytoplasm, also forms membranes of vacuoles, microcells, dictyosomes and cells.

SPHEROSOMES

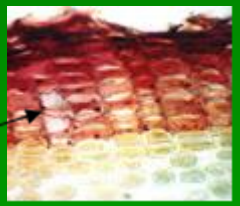
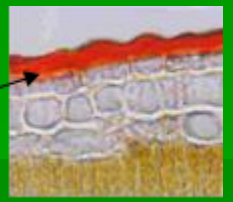
- Spherical, strongly refracting light and enzyme-rich corpuscles. Spherosomes are formed in the endoplasmic reticulum. Their main function is the synthesis and accumulation of fats.
- Small spherical or ellipsoidal organelles of 0.2 to 1.5 μm in size, surrounded by a single membrane, are called microbody. These include glyoxisomes and peroxisomes. Glyoxysomes contain enzymes necessary for the conversion of fats to carbohydrates, which occurs during the germination of seeds. They carry out a cycle of glyoxylic acid. Peroxisomes - like plastids and mitochondria, are autonomous microbodies and participate in photorespiration and metabolism of glycolic acid.
- **Paramular bodies** - the special bodies that originally arise as invaginations into the vacuole of the plasmalemma, such invaginations are later separated from the plasmalemma and are introduced into the cytoplasm or remain in the vacuole in the suspended state. Probably, their function is to take an action between the cell wall and the cytoplasm and the formation of the cell wall.
- Plasmids are circular double-stranded DNA molecules, in an autonomous, non-chromosome-bound state. They are extrachromosomal factors of heredity. They are used in genetic engineering as carriers of foreign DNA.

PRODUCTS OF THE PROTOPLAST METABOLISM

CELL WALL

- The cell wall supports the shape of the cell and gives it strength, protects the protoplast from excessive loss of water and mechanical damage. Also, the cell wall resists the high osmotic pressure of the vacuole and prevents the cell rupture. The cell wall is transparent and well transmits sunlight. Through it water and low-molecular substances easily penetrate, but for high-molecular substances it is impenetrable.

The cellulose wall is permeated with ultramicroscopic pores, which during the cell ages, fill the various substances formed by the protoplast. As a result, there is lignification, suberinization, cUtinization, sliming, mineralization of the cell wall. Until recently, it was believed that the cell wall is an inactive protoplast product. It has now been established that it has specific functions. It plays an important role in the absorption, transport and release of substances. It has digestive activity.

Name of secondary changes	Substances, which produce of secondary changes	Reagent	Result of reaction
lignification	lignin	aniline sulfate	yellow 
suberization	suberin	Sudan III	pink 
cutinization	cutin	Sudan III	pink 
sliming	mucus	methylene blue	blue 
mineralization	calcium carbonate and calcium oxalate	hydrochloric acid	combustion and formation of mineral skeleton

Vacuoles (cell sap)

Figure 1

The name comes from the Latin word "vacuum" - empty. Cavities in the protoplast of eukaryotic cells. Vacuoles are formed from the endoplasmic reticulum and are filled with cell sap. In young dividing cells, vacuoles represent a system of tubules and vesicles. As the cells grow, they merge into several or one large vacuole, which occupies 70 to 90% of the cell volume. The content of vacuole-cell juice consists of an aqueous solution of organic and inorganic substances. Cellular sap contains various nature substances that have pharmacological properties (alkaloids, flavonoids, glycosides, etc.). The functions of the vacuoles are numerous. They form the internal aqueousrelationship of the cell, and with their help the regulation of water-salt metabolism is carried out. Another important role of vacuoles is to maintain the turgor hydrostatic pressure of the intracellular fluid in the cell. Another function is the accumulation of reserve substances and final products of cell metabolism. Very often in the vacuoles anthocyanin pigments accumulate. They stain the cell sap in red, purple, blue and other colors. Most often, the cellular juice has a slightly acidic reaction, less often neutral and alkaline. The chemical composition of the cell sap is varied in different plants. Cellular sap contains a variety of organic acids, carbohydrates, glycosides, tannides, pigments, alkaloids, vitamins, as well as inorganic substances: calcium, magnesium, sodium, potassium salts of nitric, phosphoric, hydrochloric and other acids. All these substances are expended on the nutrition of the cell, the synthesis of complex organic compounds, or converted into final products of metabolism or waste. Vacuoles are spherical, filiform, rod-shaped and other forms.

ERGASTIC SUBSTANCES OF CELL

Ergastic substances are products of the metabolism of substances. Ergastic substances include storage and excretory substances, which are of diagnostic importance in pharmacy. Ergastic substances accumulate in vacuoles and cytoplasm.

OSMOTIC FEATURES OF CELL

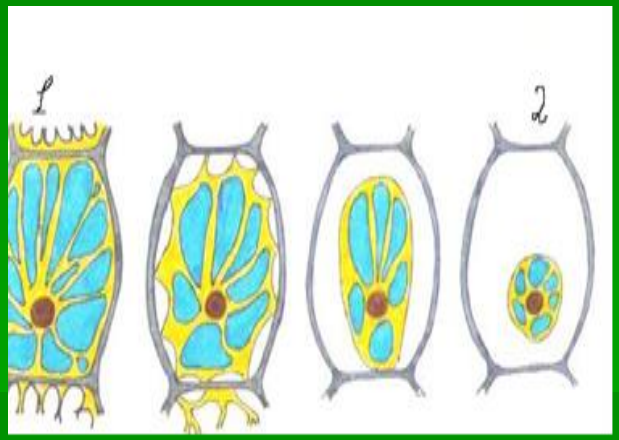
The substances enterers into cells and leaving it is according to the processes of osmosis.

Osmosis is passing of water into cell throw semipermeable membrane. When water with mineral substances enter a cell, cell sap pressing the cytoplasm and the cytoplasm in it's turn presses the wall. The walls of the cell are enlarge and are in abnormal condition. Such pressing is called turgor pressing. And the condition is called turgor.(1) Due to turgor the plant organs don't withered and the plant is in normal condition.

When the cell loses water (for example in the dry weather) the cell reduces (becomes less) because of this the turgor pressing becomes lower and the cell removes into plazmoliz condition (2).

In plazmoliz cell becomes less in size, becomes eugthosted, its walls lose the intensity and the plant is bad looking (eugthosted)

It the plant will be watered the cells will transfer from plazma into turqor again.



DIVISION AND GROWTH OF CELLS

- Reproduction - one of the main features of a living cell. Reproduction of cells occurs by division of them. When cells are dividing , the plant grows and its total mass increases. Sometimes, some cells can divide by other ways (for example- budding). There are three ways of division cells:
- 1) mitosis or complex division
- 2) meiosis or reduction division
- 3) amitosis or simple division