National University of Life and Environmental Sciences of Ukraine
Faculty of Plant protection, Biotechnology and Ecology

Department of physiology, biochemistry plants and bioenergetic

"APPROVED"
Dean of Faculty of Plant protection,
Biotechnology and Ecology

_____ Kolomiets Y.V.
"_____" _____2021

Approved at the meeting of the department
physiology, biochemistry plants and bioenergetic
Protocol from "03" 06 2021 № 10

Head of department
_____ (Prylutska S.V.)
(signature)
"_____"_____ 2021

WORK PROGRAM OF THE DISCIPLINE
CELL BIOLOGY

(code and the name of discipline)

the direction of training _____162 «Biotechnology and bioengineering»

specialty 162 «Biotechnology and bioengineering»
specialization _____

Faculty Plant protection, Biotechnology and Ecology_____

Developer: docent, Ph.D. Boyko O.A.

Kyiv – 2021

1. Description of discipline
«CELL BIOLOGY»

Field of knowledge, direction of training, specialty, education and qualification level	
Field of knowledge	162 «Biotechnology and bioengineering» (шифр і назва)
Direction of training	162 «Biotechnology and bioengineering»
Speciality	
Education and qualification level	«Bachelor»
Characteristics of discipline	
Kind	Normative
Total number of hours	129
Number of of credits ECTS	3
Number of content modules	3
Form of control	Exam

Indicators discipline for full-time students

	full-time education	correspondence form of training
Year of preparation	2	1
Semester	4	2
Lectures	129 hours	93 hours
Practical, seminars	_____ hours	_____ hours
Laboratory sessions	45 hours	_____ hours
Independent work	39 hours	93 hours
Individual work	_____ hours	_____ hours
Number of weekly hours for full-time: auditory independent work of student	6 hours	

1. Purpose, tasks and competencies of the discipline

The aim is to provide the future specialist with deep and comprehensive knowledge of cell evolution, cell structure and physiology of various organisms, cell regulation processes, exchange of genetic information, methods of studying cells, basics of molecular biology.

Objectives: To increase the quantity and quality of biotechnological products and their environmental safety, it is necessary to significantly increase the scientific level of specialists in this field, able to implement the latest scientific achievements, to master the latest advances in molecular biology and cell biology. In this case, a significant role is given to disciplines that provide fundamental knowledge of plant cell biology. Tasks set before the discipline:

1. Study of plant cell physiology - chemical and molecular composition of the cell, its structural components.

2. Study of cell life processes - photosynthesis, respiration, synthesis processes and the influence of biotic and abiotic factors on them.

3. Elucidation of features of intracellular regulation.

4. Study of the processes of genetic information exchange.

As a result of studying the discipline the student must:

know: the structure of different cells and their differences, have a modern understanding of bioenergetic and metabolic processes in the cell. Know the concepts of cell cycles and their regulation.

be able to: apply the acquired knowledge of plant cell biology in solving practical problems, develop and conduct research in biotechnology, plant physiology, understand the physiological processes of the organism at the cell level and have a scientific, professional approach to biotechnological methods.

Acquisition of competencies:

general competencies (GQ):

Ability to conduct research at the appropriate level.

Ability to search, process and analyze information from various sources.

Ability to show initiative and entrepreneurship.

professional (special) competencies (FC):

Ability to develop new approaches to the study of the structure and physiology of cells of different organisms, its chemical and molecular composition and its structural components.

Ability to apply modern methods of systems analysis to study cells.

2. Program and structure of the discipline

Content module 1. Evolutionary development of cells and modern research methods.

Topic of the lecture 1. Model objects. Modern research methods.

Unicellular microorganisms *Escherichiacoli*, *Saccharomycescerevisiae* their structure. Fundamental processes in the cell, which are studied by these objects. Intermediate organism between unicellular and multicellular organisms *Dictyosteliumdiscoideum*. The structure of mucous fungi and their use in genetic and cytological studies. Nematode *Caenorhabditiselegans*. The structure of her body and its advantages as a model object in cytological studies. *Drosophila melanogaster* - fruit fly. Conditions of cultivation and use in genetic research programs. Vertebrates *Xenopuslaevis* and *Brachydaniorerio.* Structure and use in biological research. *Arabidopsis thaliana* - the most common plant object in biotechnology and genetics of flowering plants. Microscopy. Methods of fixing and staining drugs. Production of paraffin sections. Fluorescence microscopy. Detection of specific molecules in cells. Phase-contrast and interference microscopes, principles of their operation. Electron microscope. Processing of research material. Scanning and transmission electron microscopes and their applications. Shading methods. Methods of electron microscopy: freezing-freezing and freezing. Methods of

negative contrast and cryoelectron microscopy. Nuclear magnetic resonance (NMR). Cell proliferation and cultivation. Growing cells in culture medium. Study of cellular macromolecules using antibodies and radioactive isotopes. Hybridization.

Topic of the lecture 2. General characteristics of cells of different forms of living organisms. Evolutionary cell development.

Features of the structure of prokaryotes. Morphological types of bacterial cells. Gram-positive and gram-negative bacteria. The structure of the bacterial cell. Features of the organization of the nuclear apparatus of bacteria. Organs of movement.

Features of the structure of eukaryotes. Differences between prokaryotes and eukaryotes. Differences in the structure of animal and plant cells. Haploid and diploid cells.

Features of the structure of viruses. Origin, structure, chemical composition, reproduction. Phages.

Stages of development of organisms from individual molecules to the first cell. Polynucleotides are able to direct their own synthesis. The first cell surrounds itself with a membrane. Development of metabolic reactions. Cyanobacteria are able to fix CO2 and N2. Bacteria can cause aerobic oxidation of molecules. Endosymbiotic theory of the origin of chloroplasts and mitochondria. Formation of multicellular organisms. Formation of colonies. Specialization of cells of higher organisms. Development of metabolic reactions.

Content module 2. Cell structure and functioning. Cellular regulation.

Topic of the lecture 1. Cell structure and functioning.

Modern ideas about the structure of the plasma membrane and their formation. Chemical composition of membranes. Membrane lipids. Lipid bilayer. Fluidity of lipid bilayer. Asymmetry of lipid bilayer. Glycolipids, their function. Protein composition of membranes and their functions. Transport of substances across membranes. Ion channels. Transfer of small molecules across the membrane. Active transport, (Na + - K +) - plasma membrane pump, (Na + - K +) ATPase. Some Ca2 + pumps. Membrane potential.

Cytosol. Chemical composition and functioning processes. Cytoskeleton and its structure. Functions and chemical composition of microtubules and microfilaments.

The composition of the vacuolar system. Synthesis, restructuring and export of biopolymers, membrane synthesis. Scheme of operation. Endoplasmic reticulum. Types, structure and functions. Cotranslational transport of soluble proteins. Lipid metabolism in the smooth endoplasmic reticulum.

Golgi apparatus. Structure and functions. Secretarial activity. Exocytosis. Modification of proteins in the Golgi apparatus. Types of endocytosis: pinocytosis and phagocytosis. Transcytosis.

Topic of the lecture 2. Cellular regulation.

Components of the nucleus structure. The nucleolus and its functions. Nuclear organizers. Chromosomes and chromatin. Number and shape of chromosomes. Heterochromatin. The structure of DNA and genes.

Cell cycle. Mitotic index. The duration of the cell cycle. Regulation of the cell cycle. The concept of mitosis and characteristics of its stages. Meiosis. The value of crossover.

Content module 3. Metabolism in the cell.

Topic of the lecture 1. The concept of metabolism and its meaning.

Energy metabolism. Stages of energy metabolism and its significance. Plastic exchange. Stages and biological significance of plastic metabolism in cell life.

Topic of the lecture 2. Biosynthesis of proteins.

Stages and significance of protein biosynthesis. Photosynthesis. Biological significance of photosynthesis.

The structure of the discipline

Names of content modules and topics	Number of hours											
	full-time						correspondence form					
	total	included					усьог о	included				
		lec	prac	lab.	ind.	in.w.		lec	prac	lab.	ind.	in.w.
1	2	3	4	5	6	7	8	9	10	11	12	13
Content module 1. Evolutionary development of cells and modern research methods.												
1. Model objects. Modern research methods.	20	7		7		5	10	2				5
2. General characteristics of cells of different forms of living organisms. Evolutionary cell development.	27	10		8		10	10					10
Total hours:	47	17		15		15	20					15
Content module 2. Cell structure and functioning. Cellular regulation.												
1. Cell structure and functioning.	23	6		8		8	17					8
2. Cellular regulation.	20	9		7		5	17					5
Total hours:	43	15		15		13	34					13
Content module 3. Metabolism in the cell.												
1.The concept of metabolism and its meaning.	19	6		9		5	19			9		5
2. Biosynthesis of proteins.	20	7		6		6	20			6		6
Total hours:	39	13		15		11	39			15		39
The total number of hours:	129	45		45		39	93			33		93

4. Topics of seminars

№	Topic title	Number of hours
1	Not provided in working curriculum	

5. Topics of practical training

№	Topic title	Number of hours
1	Not provided in working curriculum	

6. Topics of laboratory work

№	Topic title	Number of hours
1	Structure of prokaryotic and eukaryotic cells	2
2	Microchemical reactions to cutin, lignin, tannins and pectin	4
3	Microchemical reactions to proteins, fats and carbohydrates	4
4	Features of the structure of hydrophyte cells - with floating leaves (free-stitching and attached plants)	2
5	Features of the structure of hydrophyte cells - plants completely immersed in water	2
6	Determination of mitotic activity of plant tissues and relative duration of each of the phases of the mitotic cycle	4
7	Changes in the qualitative composition of plastid pigments during leaf aging	2
8	Photosensitizing effect of chlorophyll	2
9	Study of the phenomenon of plasmolysis and deplasmolysis in plant cells	1
10	Determination of the absorption spectrum of the pigments of the leaf	4
11	Study of membrane permeability	4
12	Spare nutrients of a plant cell	2
13	The structure of cell plastids.	4
14	Quantitative determination of chlorophyll	4
15	The movement of the cytoplasm in the cells of Elodea and Valisneria	3
Total hours:		45

7. Control questions, sets of tests to determine the level of knowledge acquisition by students

Form № H-5.05

National University of Life and environmental Sciences of Ukraine

Department — Plant protection, Biotechnology and Ecology
Educational qualification — Bachelor
Direction of training (specialty) — Biotechnology
Form of education
Semester, course — 4 semester, course 2
Academic discipline — Cell biology

Approved at the meeting of the Department of Physiology, Biochemistry of Plants and Bioenergetic
(name of department)

Protocol № 10 of "3" June 2021
Head of Department _____S.V. Prylutska
(signature) (name)
Examiner _____ O.A. Boyko
(signature) (name)

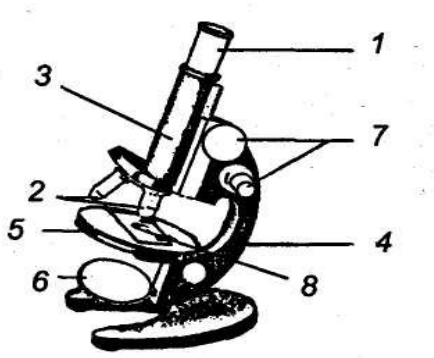
EXAMINATION TEST #1

1. 1. The structure of unicellular microorganisms (*Escherichia coli*, *Saccharomyces cerevisiae*).
2. The value of mitosis.

TESTS

1. Match the components of the structure of the microscope shown in the figure

A. eyepiece;
B. lens;
C. tube,
D. tripod;
E. subject table;
G.mirror;
J. screws;
I. slide



2. Viruses contain:

1 RNA only;
2 Proteins only;
3 DNA only;
4 DNA or RNA;

3. Name the bimembrane organelles of the cell

1 Golgi apparatus;
2 Chloroplasts;
3 Lysosomes;
4 Core;

4. The smear before fixing is dried:

1 in the air;
2 over the flame of alcohol;
3 using filter paper;
4 all answers are correct.

5. The main component of the cell membrane

1 Starch;
2 Cellulose;
3 Pectin;
4 Other

6. The President of the Ukrainian Academy of Sciences was an outstanding scientist microbiologist and epidemiologist:

1 N. F. Gamaleya
2 LS Tsenkovsky
3 DK Zabolotny
4 II Mechnikov

7. Rotational microtomes are

8. The lighting system of the microscope includes:

1 Tube and diaphragm
2 Glasses and lenses
3 Abbe condenser
4 Subject table

9 Material for microscopic examination in unstained form was taken from the patient. Microscope, which used a complete paraboloid condenser. What type of microscopy will be used?

1 Luminescent
2 Phase-contrast
3 Immersion
4 Dark Field

10. To detect Mycobacterium tuberculosis, the drug is stained by:

1 Burry — Ginsom;
2 grams;
3 Tsel — Nielsen;
4 Ozheshko.

_____ (Boyko O.A.)

8. Teaching methods

The success of learning in general depends on the internal activity of students, on the nature of their activities, it is the nature of activities, the degree of independence and creativity should be important criteria in choosing a method.

Explanatory-illustrative method. Students gain knowledge by listening to a story, lecture, educational or methodological literature, through an on-screen textbook in "ready" form. Perceiving and comprehending facts, assessments, conclusions, they remain within the limits of reproductive (reproductive) thinking. This method is most widely used to transmit a large array of information. It can be used to present and assimilate facts, approaches, assessments, conclusions.

Reproductive method. It is a question of application of the studied on the basis of a sample or rule. The activity of those who are taught is algorithmic, ie it corresponds to instructions, orders, rules - in situations similar to the presented sample.

Method of problem statement. Using any sources and tools, the teacher, before teaching the material, poses a problem, formulates a cognitive task, and then, revealing a system of evidence, comparing views, different approaches, shows how to solve the problem. Students become like witnesses and accomplices of scientific research.

Partial search, or heuristic method. Its essence is in the organization of active search for the solution of the cognitive tasks put forward by the teacher (or independently formulated) or under the guidance of the teacher, or on the basis of heuristic programs and instructions. The process of thinking becomes productive, but it is gradually directed and controlled by the teacher or the students themselves on the basis of work on programs (including computer) and with textbooks. This method, one of the varieties of which is a heuristic conversation, is a proven way to activate thinking, to encourage cognition.

Research method. After analyzing the material, posing problems and tasks, and briefing orally or in writing, those who are taught study the literature, sources, conduct observations and measurements, and perform other search activities on their own. Initiative, independence, creative search are most fully manifested in research activities. The methods of educational work directly turn into methods that mimic and sometimes implement scientific research.

9. Forms of control

Control of knowledge and skills of students (current and final) in the discipline is carried out in accordance with the credit-modular system of organization of the educational process. The student's rating for mastering the discipline is determined by a 100-point scale. It consists of a rating of academic work, for the assessment of which is assigned 70 points, and a rating of certification (exam) - 30 points.

Criteria for assessing the level of knowledge in laboratory, seminar and practical classes. In laboratory classes, each student on each topic performs individual tasks. The level of knowledge is assessed: "excellent" - the student gives comprehensive, reasonable, theoretically and practically correct answers to at least 90% of questions, problem solving and laboratory exercises are correct, demonstrates knowledge of textbooks, manuals, instructions, instructions, conducts , was present at lectures, has a synopsis of lectures or abstracts on the main topics of the course; "Good" - when the student has knowledge of the material, but makes minor mistakes in the formation of terms, categories and calculations, but with the help of the teacher quickly navigates and finds the right answers, was present at lectures, has a summary of lectures or abstracts; "Satisfactory" - when the student gives the correct answer to at least 60% of the questions, or gives insufficiently substantiated, inexhaustible answers to all questions, makes gross mistakes, which he corrects with the help of the teacher. This takes into account the presence of a synopsis on the topic of tasks and independence; "Unsatisfactory with the possibility of re-composing" - when the student gives the correct answer to at least 35% of questions, or gives unsubstantiated, inexhaustible answers to all questions, makes gross mistakes. Has an incomplete syllabus of lectures.

Final (general assessment) of the course of the discipline. Is the sum of rating assessments (points) received for separate assessed forms of educational activity: current and final testing of the level of assimilation of theoretical material during classroom classes and independent work (modular control); evaluation (points) for laboratory tests. The final grade is set after a complete study of the discipline, which is displayed as the sum of intermediate grades for content modules. The final assessment of the level of knowledge consists of a rating of academic work, for the assessment of which is assigned 70 points, and a rating of certification (exam) - 30 points.

10. Distribution of points received by students

Assessment of student knowledge is on a 100-point scale and is translated into national assessments according to table. 1 "Regulations on examinations and tests in NULES of Ukraine" (order of entry into force of 27.12.2019 № 1371).

Student rating, points	National grade for the results of exams, credit tests	
	exams	tests
90-100	Excellent	Credited
74-89	Well Score	Credited
60-73	Satisfactory	Credited
0-59	Unsatisfactory	Not credited

To determine the rating of the student (listener) for mastering the discipline RDIS (up to 100 points) the obtained rating for certification (up to 30 points) is added to the rating of the student (listener) for academic work R_{NR} (up to 70 points): $R_{DIS} = R_{HP} + R_{AT}$.

11. Methodical support

Scientific and methodological support of the educational process includes: state standards of education, curricula, curricula in all normative and elective disciplines; programs of educational, industrial and other types of practices; textbooks and manuals; instructional and methodical materials for seminars, practical and laboratory classes; individual educational and research tasks; control works; text and electronic versions of tests for current and final control, methodical materials for the organization of independent work of students.

12. Recommended Books

Basic

1. A.I. Atabekova Plant cytology / Atabekova A.I. —M.: Agropromizdat, 1987 - 206 p.
2. Gelston A. Life of a green plant / Gelston A., Davis P., Sztter R. -M .: Mir, 1983.-552 p.
3. Gerald M. Fuller Molecular biology of the cell / Gerald M. Fuller, Dennis Shields; lane from English. I.B. Zbarsky. - M .: Binom-Press, 2006.-256 p.

Additional

1. Zengbush P. Molecular and cellular biology / Zengbush P. - M .: Mir, 1982.-239 p.
2. Marchenko O.A. Biology of clergy (methodical recommendations) / Marchenko O.A., Tsarenko P.M., Petlyovaniy O.A. - K .: Vidavnichy Center NAU, 2007. - 18 p.
3. Molecular biology of the cell / [Alberta B., Bray D., Lewis J. and others]. - M: Mir, 1994. - 386 p. (in 3 volumes).
4. Chentsov Yu.S. Introduction to cell biology / Chentsov Yu.S. - M .: IKTS Akademkniga, 2004 .-- 495s.
5. Cytilogy of Roslin. Understanding and terms: Ukrainian-English glossy vocabulary of scientific terms for students of agrobiological profile / Verkhoglyad I.M., Aleynikov I.M. - K .: Vidavnichy Center NAU, 2003 .-63 p.

13.Information resources

1. www.molbiol.ru - Textbooks, scientific monographs, reviews, laboratory workshops freely available on the site of practical molecular biology.
2. www.ncbi.nlm.nih.gov/PubMed - Free access to the largest scientific database in the field of biomedical sciences MedLine, including biochemistry.
3. www.nobel.se - Nobel Prize Winners in Chemistry, Physiology or Medicine.

Abstracts of lectures "Cell Biology"

Section 1. General concepts of the cell. Research methods

The cell is an elementary structural, functional and genetic unit in the composition of all living organisms. The body of an adult consists of approximately 1013 cells, which are divided into more than 200 types, which differ significantly in their structural and functional features, and the morphological characteristics of the cell vary depending on its function. However, cells of all types are characterized by similarity of the general organization and structure of the most important components. The process by which cells acquire their structural and functional properties and features is known as cell differentiation.

The main components of the cell. Each cell consists of two main components - the nucleus and cytoplasm.

The cytoplasm is separated from the environment by a plasma membrane (plasmolemma) and contains organelles and inclusions immersed in the cell matrix (cytosol, hyaloplasm).

Organelles are permanent components of the cytoplasm that have a characteristic structure and specialize in performing certain functions in the cell.

Inclusions - non-permanent components of the cytoplasm, formed as a result of accumulation of products of cell metabolism.

The nucleus contains the following components: nuclear envelope, chromatin, nucleolus and nuclear matrix (nucleoplasm).

Development from individual molecules to the first cell. Simple biological molecules can be transformed under prebiotic conditions. Polynucleotides are able to direct their own synthesis. Self-replicating molecules are subject to natural selection. Specialized RNA molecules are able to catalyze biochemical reactions. Information is transmitted from polynucleotides to polypeptides. The first cell surrounds itself with a membrane. All modern cells use DNA as hereditary material. Development of metabolic reactions. Cyanobacteria are able to fix CO2 and N2. Bacteria can carry out aerobic oxidation of molecules. Eukaryotic cells depend on mitochondria, which reproduce oxidative metabolism. Chloroplasts are the offspring of "captured" prokaryotic cells.

From cells to multicellular organisms. Single cells are able to combine and form colonies. The cells of higher organisms become specialized and interdependent. Development of metabolic reactions. Bacteria are able to perform aerobic oxidation of molecules.

Eukaryotic cells contain several characteristic organelles. Eukaryotic cells depend on mitochondria that perform oxidative metabolism. Chloroplasts are the offspring of "captured" prokaryotic cells. Eukaryotic cells contain many different inner membranes. Eukaryotic cells have a skeleton. Eukaryotic cells contain significantly more DNA than is needed to encode proteins. Vertebrate cells have more than 200 different types of specialization. Immune system cells specialize in chemical recognition. Nerve cells allow the body to adapt quickly to changing conditions.

Cells use four main types of molecules. Sugars as food for cells. Fatty acids are components of cell membranes. Amino acids are subunits of proteins. Nucleotides are subunits of DNA and RNA.

Photosynthetic organisms use sunlight to synthesize organic compounds. Chemical energy passes from plants to animals. Cells receive energy as a result of oxidation of organic molecules. The decay of organic molecules occurs as a result of successive enzymatic reactions. Part of the energy released in the oxidation reactions is spent on the formation of ATP. Hydrolysis of ATP provides order in the cell.

Nutrient molecules, broken down in three stages, form ATP.

ATP in the process of glycolysis can be formed even in the absence of oxygen. Oxidative catabolism supplies much more biologically useful energy. The central process of metabolism is the citric acid cycle.

In oxidative phosphorylation, the transfer of electrons to oxygen leads to the formation of ATP. Amino acids and nucleotides are involved in nitrogen conversion. Genes are made up of DNA. DNA molecules consist of two long complementary strands held together by base pairing.

The structure of DNA provides the key to understanding the mechanisms of heredity. DNA replication errors lead to mutations. The nucleotide sequence in a gene determines the amino acid sequence in a protein. RNA copies for protein synthesis are taken from DNA sequences. Eukaryotic cell RNA molecules are spliced to remove intron sequences. The mRNA sequence is "read" in groups of three nucleotides and translated into an amino acid sequence. The correspondence between amino acids and nucleotide triplets is established by tRNA molecules. Readings of mRNA from one end to the other are performed by ribosomes.

Molecular recognition processes. Relatively few potentially possible polypeptide chains may be useful. New proteins often result from minor changes to old ones. New proteins often arise as a result of combining different polypeptide domains. Structural homologies can help determine the functions of newly discovered proteins. Protein subunits are capable of self-assembly into large cellular structures. Identical protein subunits can interact with the formation of geometrically regular structures.

Microscopy. Using a light microscope, you can distinguish objects at a distance of 0.2 μm. For microscopic examination, the tissue is fixed and cut. Different components of the cell can be painted in different ways. Specific molecules can be detected in cells by fluorescence microscopy. Phase-contrast and interference microscopes allow the study of living cells. Images can be amplified or analyzed using electronic methods. An electron microscope allows you to analyze the fine structure of the cell. To observe under an electron microscope, biological samples must be subjected to special treatment. A scanning electron microscope is used to obtain a three-dimensional image of the surface. Shades are used to study the details of the surface in a transmission electron microscope. Freeze-scaling and freeze-digestion electron microscopy methods make it possible to observe the internal structure of a cell. Methods of negative contrast and cryoelectron microscopy provide a high distribution in the analysis of macromolecules. Nuclear magnetic resonance (NMR) can be used to determine chemical conditions in a population of living cells. The concentration of ions can be measured by intracellular electrodes. Rapid changes in the concentration of intracellular ions can be measured using light-emitting indicators. Cell division and cultivation. Cells can be isolated from tissues and divided into different types. Cells can be grown in culture medium. With the help of media of a certain chemical composition, it is possible

to identify specific growth factors. To obtain homogeneous cells usually use eukaryotic cell lines. Chromatography can be used for protein fractionation. Using polyacrylamide gel electrophoresis in the presence of sodium dodecyl sulfate (LTO), it is possible to determine the size and subunit composition of proteins. Fractionation of cell contents. Organelles and macromolecules can be separated by ultracentrifugation. More than 1000 proteins can be separated in one gel by gel electrophoresis. With the help of automatic instruments it is possible to analyze short amino acid sequences. Study of cellular macromolecules using antibodies and radioactive isotopes. Hybridization allows the detection of remotely related genes. Insitu hybridization is used to localize specific nucleic acids in chromosomes and cells. Recombinant DNA methods make it possible to study even the minor proteins of cells. Methods for detecting radioactive atoms are highly sensitive. Radioactive isotopes are used to study the movement of molecules in cells and in the body as a whole. Antibodies can be used to detect and isolate specific molecules. Hybridoma cell lines serve as a source of monoclonal antibodies. Recombinant DNA technology. Restriction nucleases cleave DNA in specific regions of nucleotide sequences.

Section 2. Exchange of genetic information.

RNA and protein synthesis. RNA polymerase "rewrites" the information contained in DNA in the form of RNA: the process of transcription. Protein synthesis reactions take place on ribosomes. The ribosome moves step by step along the mRNA chain. The protein chain separates from the ribosome as soon as it reaches one of the three termination codons. The reading frame of the matrix is set at the time of initiation of the synthesis of the polypeptide chain. In eukaryotes, only one type of polypeptide chain is synthesized on each mRNA molecule. Many ribosomes that join one mRNA molecule form a polysome. The overall rate of protein synthesis is regulated in eukaryotic initiation factors. The promoter sequence determines which DNA strand will be transcribed. Transport RNA molecules serve as adapters that translate nucleotide sequences into amino acids. Each amino acid is attached to the corresponding tRNA molecule by a specific enzyme. Amino acids join the carboxyl end of the growing polypeptide chain. The genetic code is degenerate. The accuracy of protein synthesis is ensured by two initiation factors. Mechanisms of DNA repair. High reliability of preservation of DNA sequences. Most mutation-altering proteins are harmful and eliminated by natural selection. Low frequencies of mutations are necessary to preserve the species as a whole and each individual. Low mutation rates mean that related organisms are made up of virtually the same proteins. Without correction, spontaneous damage to DNA would quickly alter its nucleotide sequences. Gene stability is ensured by DNA repair. Different types of DNA damage are recognized by different enzymes. Cells synthesize repair enzymes in response to DNA damage.

DNA replication, like its repair, is based on complementary base pairing. The replication plug is asymmetric. High accuracy of DNA replication implies the presence of a mechanism that performs correction. DNA replication in the 5 '3' direction provides effective correction. Special proteins help to unravel the double helix of DNA in front of the replication fork. Proteins in the replication fork act cooperatively, forming a "replication machine". Errors in DNA replication in bacterial cells are corrected by a special corrective system that recognizes incorrect base pairing. Replication plugs occur

at the points of origin of replication. DNA topoisomerases prevent DNA entanglement during replication. DNA replication in eukaryotes and prokaryotes is basically similar. Total recombination is initiated at the point of rupture of one of the two strands of the DNA double helix. DNA hybridization can serve as a model for the overall recombination step associated with complementary mating. The hexa protein in E. coli allows single strands of DNA to mate with the homologous region of the DNA double helix. Common genetic recombination involves cross-chain exchange. Total genetic recombination in combination with limited DNA synthesis leads to gene conversion. Site-specific recombination enzymes introduce special nucleotide DNA sequences into the genome and remove them from the genomes.

Section 3. Cell structure and function.

Membrane lipids are amphipathic molecules that independently form bilayers. Lipid bilayer is a two-dimensional fluid. The fluidity of lipid bilayer depends on its composition. Lipid bilayer serves as a solvent for membrane proteins. Lipid bilayer is asymmetric. Glycolipids are found on the surface of all

plasma membranes, but their function is unknown. The polypeptide chain of many membrane proteins permeates the lipid bilayer Transfer of small molecules across the membrane. Lipid bilayer, does not contain proteins that are impermeable to ions, but freely permeable to water. Membrane transport proteins can act as carriers or channels. Active transport is carried out by carrier proteins associated with the energy source. Carrier proteins act as membrane-bound enzymes. (Na + + K *) - the plasma membrane pump is Rhinestone. (Na + + K) ATPase is required to maintain osmotic balance and stabilize cell volume. Some Ca + pumps are also membrane-bound ATRAses. Membrane-bound enzymes that synthesize ATP are transport ATPases that act in the opposite direction. Active transport can occur using ionic gradients. Antiports in the plasma membrane regulate the intracellular pH value. The basis of intercellular transport of solutes is the asymmetric distribution of carrier proteins in epithelial cells. Protein channels form pores in the plasma membrane. The membrane potential depends on the K + -flow channels and the K + gradient through the membrane. Potential-dependent gate ion channels are responsible for the electrical excitability of nerve and muscle cells. The registration of currents passing through an isolated section of the membrane shows that the individual Na + channels are opened on an "all or nothing" basis. There are two types of endocytosis: pinocytosis and phagocytosis. Schnocytic vesicles form surrounded pits in the plasma membrane. Receptor-mediated endocytosis serves as a concentrating device for the uptake of specific extracellular macromolecules. The contents of the endosomes enter the lysosomes, if not returned in a specific way. Ligand-receptor complexes are sorted into endosomes. Macromolecules can be transported through the folds of epithelial cells during transcytosis. Surrounded pits and vesicles provide the main route of liquid-phase endocytosis in many cells. Specialized cells - phagocytes - absorb particles that bind to specific receptors on their surface. Phagocytosis is a local response that occurs by "closing" the membrane on the principle of a zipper. Membrane fusion in exocytosis and endocytosis, catalyzed by special fusion proteins.

A plant cell consists of a membrane, a protoplast (cell contents) and a vacuole (a cavity filled with cell sap).

The protoplast consists of the cytoplasm and the large organelles included in it: the nucleus, plastids and mitochondria.

The cytoplasm is a complex system that includes numerous submicroscopic structures (Golgi apparatus, endoplasmic reticulum, ribosomes, microtubules and microfilaments), the structural components are in the matrix of the cytoplasm - hyaloplasm. Cytoplasm -semi-liquid, transparent and viscous homogeneous mass, located under the cell membrane (a set of boundary membranes - plasmalemma, tonoplast and mesoplasm). Chemical composition of the cytoplasm: water - 80-90-%, proteins - 10-12%, lipids - 2-3%, sugars - 1-2%, minerals - 1-1.5%.

Plasmalema is a cytoplasmic membrane that separates the cytoplasm from the environment, and the tonoplast surrounds the vacuole. Plasmalema is thicker (7.5 nm) than tonoplast (bnm) because it has a more complex structure and performs barrier, enzymatic, acceptor and regulatory functions. Tonoshiast contains specific transport proteins and is less permeable than plasmalemma.

The cytoplasmic matrix has the properties of a colloidal system and under the influence of external and internal factors easily changes its physical and chemical state: from liquid (sol state) to almost solid, jelly-like (gel state). It is believed that the mixotropic properties of the cytoplasmic matrix are due to the presence of filamentous formations of microfilaments. Each microfilament consists of two spirally twisted threads of globular protein - actin. Microfilaments can form a complex molecular network, thus giving the matrix the properties of a solid or disintegrate, determining the properties of the liquid. This occurs when proteins are in a highly dispersed state, that is, when they are charged with charges of the same name and surrounded by water shells - hydrate and diffuse, which prevent them from sticking together. Microtubules together with microfilaments form the structure of the cytoskeleton.

The value and sign of the charge depends on the pH of the cell contents. The inverse transitions from sol to gel are determined by the pH value. It is known that for each protein there is one pH value (isoelectric point) at which its particle becomes neutral. The isoelectric point of most plant tissue proteins is in the range of slightly acidic pH values, and the pH inside the cell is close to neutral (6.3 - 7.0). Therefore, proteins of the cytoplasmic matrix, as a rule, are negatively charged. When the pH of the cell juice deviates in one direction or another from the pH of the corresponding isoelectric point, the protein molecules are collectively charged positively or negatively, repel each other and thus contribute to maintaining a highly dispersed state of cytoplasmic colloids.

The degree of dispersion of colloids of the cytoplasmic matrix changes under the influence of factors that destroy the aqueous membranes of protein molecules (acids, alkalis, high temperature). Due to dehydration, protein molecules lose their natural spatial structure and coagulate. In this case, the cytoplasm loses its vital properties.

Cytoplasmic viscosity is the ability of the cytoplasm to resist the movement of some parts (ions, molecules, organelles) relative to others. The viscosity of the cytoplasm is determined by its physico - chemical state (sol and gel), which is based on the interaction between microfilaments. Therefore, the cytoplasm has a so-called structural viscosity, the degree of which is determined by its hydration and the specific structure of microfilaments.

At different stages of plant development, the degree of viscosity of the cytoplasm of their cells changes. In the cell division phase, the viscosity is high, in the stretching phase it decreases as a result of strong hydration of the cytoplasmic matrix, and during cell differentiation it increases again due to the removal of water from the cytoplasm colloids into the vacuole. The degree of viscosity of the cytoplasm of cells of different organs depends on their age. The change in the degree of viscosity of the cytoplasm in the ontogenesis of the organ reflects its changes in the ontogenesis of the cell. In the ontogenesis of the plant, the viscosity of the cytoplasm increases until the budding phase, then in the flowering phase decreases, and after flowering increases again. High viscosity of the cytoplasm is characteristic of cells of organs that are at rest (seeds, tubers, bulbs). The decrease in the viscosity of the cytoplasm corresponds to a more intensive metabolism, while the increased viscosity, but not very high, correlates with greater resistance of the organism against adverse environmental conditions.

The degree of viscosity of the cytoplasm depends on the genotype of the plant, which determines the specific structure of microfilament proteins. The viscosity of the cytoplasm is also determined by the nature of the plant ecotype. In species of steppes and deserts - it is high, in mesophytes - slightly lower, and in aquatic plants - only slightly exceeds the viscosity of water.

The viscosity of the cytoplasm is influenced not only by internal but also external factors. At low temperatures, the thermal motion of microfilaments is inhibited. This helps to stabilize their molecular network and increases viscosity. As the temperature rises, the microfilament network collapses and the cytoplasm becomes liquid. The viscosity of the cytoplasm also depends on the presence of certain cations in the medium: monovalent cations (K +, Na +, Li +) lower it, and divalent and trivalent (Ca21, Mg2 and, A131) increase it.

Cytoplasmic elasticity is the ability of the cytoplasm to regain its shape after deforming action. It is caused by the elasticity of microfilaments, as well as the ability of the cell membrane to change the size of its surface due to the rapid destruction (during plasmolysis) and the subsequent formation (during deplasmolysis) of individual areas. Elasticity has an adaptive value. Plants with higher cytoplasmic elasticity better withstand conditions of insufficient moisture. In xerophytes it is about 3 times higher than in mesophytes, which allows the first to tolerate prolonged dehydration without significant damage to the cytoplasm.

The elasticity of the cytoplasm changes during plant ontogeny. In particular, during flowering, in most plants, it decreases slightly. The higher the elasticity of the cytoplasm, the more difficult it is to plasmolize.

The movement of the cytoplasm is inherent in almost all living actively functioning cells. In some plants the cytoplasm moves with great speed (cells of aquatic plant leaves, epidermal hairs of pumpkin and glyoxin, hairs of stamen filaments of tradescantia), in others the movement is barely noticeable. accompanied by energy consumption of ATP. Therefore, it occurs at a certain temperature optimum corresponding to the pH value of the medium (4.5-5.0). The speed of movement of the cytoplasm increases under the influence of factors that contribute to the formation of ATP in the process of photosynthesis or respiration, namely - light and oxygen.

Selective permeability is the ability of the cytoplasm to pass different substances at different rates. Selective permeability is due to the presence of boundary membrane layers and is inherent only in the living cytoplasm. The permeability of the cytoplasm increases with increasing temperature and light, with water deficiency, as well as with cell aging - as a result of violation of the natural structure of the membranes.

Irritability is the ability of a cell to adequately respond to external and internal environmental factors. In the absence of a stimulus, the cytoplasmic membrane has a so-called resting potential. It occurs as a result of asymmetric distribution on both sides of the membrane of certain ions due to its unequal permeability. Ca +, Na + ions are concentrated on the outer side, and K +, C1- ions are concentrated on the inner side, as a result of which the latter is negatively charged in relation to the outer one and even becomes positive for a while. The potential of the opposite sign, which occurs in the membrane as a result of irritation, is called the action potential (PD). The duration of PD existence is a few seconds. After a short-term increase in the permeability of membranes for Ca2 + and SI ions, its permeability for K + ions increases. They move along the concentration gradient from the cell to the environment and accumulate on the outer side of the membrane, so that its positive charge relative to the inner side gradually increases. Restore the resting potential begins.

Irritability is of great adaptive importance. It is associated with the energy consumption of LTF. Therefore, factors that inhibit the synthesis of LTF (lowering the temperature, lack of acid) reduce the ability of the cytoplasm to perceive irritation.

Membrane elements are among the elements of the protoplast. They divide the cell into compartments. Membranes have a symmetrical, linear, three-layer structure. The basis of this structure is a bimolecular layer of lipids, located between two monolayers of proteins. The total thickness of the membranes is 6-10 nm. According to the data, there are pores (tubules) in the membranes. Only protein substances take part in the formation of tubular walls.

In 1972 S. Singer and G. Nicholson proposed a liquid-mosaic model of the membrane. Nowadays, the liquid-mosaic model of biological membranes enjoys the greatest recognition.

Membranes are lipoprotein complexes that consist of approximately 60% proteins and 40% lipids, among which phospholipids predominate (galactolipids, sterols, and fatty acids are also found). Lipids are turned to each other by their hydrophobic ends. In phospholipids, two hydroxyl groups in the glycerol molecule are replaced by fatty acids, and the third by phosphoric acid. Various compounds can be attached to phosphoric acid, most often amino alcohols - ethanolamine or choline. The molecule of phospholipids is polar, it contains a hydrophilic head (phosphoric acid, amino alcohol) and two hydrophobic carbohydrate tails. Unsaturated fatty acids of polar lipids provide a somewhat loose (liquid) state of the biolayer at physiological temperatures. Sterols also contribute to this. Lipids are not fixed firmly, but continuously change places. There are two types of lipid movement: within its monolayer and by moving two lipid molecules in two monolayers ("flip-flop"). During material diffusion, lipid molecules change places a second a million times. The movement of lipid molecules from one monolayer to another is much less frequent. The lipid layer is stabilized by hydrophobic interactions (Vanderwals forces, adhesion of molecules), while between lipids and

proteins interactions of hydrophilic nature develop. In the liquid layers of lipid membranes are specialized protein complexes, Lipoproteins are immersed in the lipid phase and are held by hydrophobic bonds (integral proteins). Hydrophilic proteins (peripheral) are held on the inner and outer surfaces of membranes by electrostatic bonds, interacting with the hydrophilic heads of polar lipids. An important role in the formation of membranes is played by hydrophobic bonds: lipid - lipid, lipid - protein, protein - protein. Membranes include proteins that perform various functions: enzymes, pumps, carriers, ion channels, structural proteins and proteins - regulators. Depending on the composition of lipids and proteins that are part of the membrane, the nature of its structure is different.

The nucleus has a rounded, oval, elongated shape. A cell may have one or more nuclei. The core has a diameter of about Yumkm. Different cells have different sizes of nuclei. Large nuclei occur in young, meristematic cells, they can occupy up to% of the volume of the whole cell. Externally, the nucleus is covered with a shell, which consists of two membranes, between which there is a prenuclear space. The outer membrane has outgrowths that pass directly into the walls of the endoplasmic reticulum. CS provides constant contact between the nucleus and cytoplasm. Inside the nucleus is a granular basic substance (nuclear juice, or nucleoshgasm), which houses the chromosomes and nucleolus. Chromatin consists of DNA and histone and non-histone proteins, a small amount of RNA and lipids. In the nucleolus there is a synthesis of ribosome material and the formation of nuclear proteins. Chromosomes are made up of DNA that is connected to histone protein molecules. The shape of chromosomes is diverse and specific to this species. The length of chromosomes is up to 20 μm and it contains a compact DNA molecule up to 2 cm long. In certain areas of chromosomes (loci) there are certain genes that carry information for protein synthesis. The nuclear genome contains genetic information (recorded by the sequence of nucleotides in the DNA molecule) about the structure of all enzymes (about 10,000 of them): the structural proteins of RNA cells, as well as the regulatory mechanisms of their synthesis.

The nuclear envelope is permeated with pores with a diameter of 10-20 nm, through which nucleic acids and proteins are transported. The number of chromosomes for each species is constant. In the nucleoplasm of the nucleus are enzymes and cofactors that are necessary to ensure the processes of replication and transcription of DNA, various RNA molecules, enzymes.

The nucleus is the carrier of hereditary information of the cell.

Plastids are organelles that are unique to plant cells. There are three types of plastids: colorless - adhesive plasters, green - chloroplasts, painted yellow and red - chromoplasts. Possible transition from one plastid to another (greening of potatoes).

Chloroplasts have the shape of a biconvex lens, their size is about 4-6 microns. There may be 25-50 of them in the cell. Externally, the chloroplast is covered with a shell consisting of two lipoprotein membranes. There is a pereplastid space between them. The inner membrane forms thickened intussusception - thylakoids, which can be disk-shaped and are called granular thylakoids. Several such thylakoids are placed one above the other and form a stack - a face. The second thylakoids, which connect the faces, are called thylakoids of the stroma, there are also adjacent thylakoids.

The membranes that form the faces include the green pigment chlorophyll. This is where the light reactions of photosynthesis take place - the absorption of light rays by chlorophyll and the conversion of light energy into the energy of excited electrons.

Chloroplasts in the cell move, they are characterized by phototaxis. Chloroplasts have a certain autonomy in the cell system. They have their own ribosomes, DNA, enzymes that are involved in protein synthesis.

Mitochondria - small bodies of round and oblong shape, 0.5-1.5 microns in size. There can be from 100 to 3000 of them in a cell. Mitochondria are surrounded by a shell consisting of two lipoprotein membranes. There is a gap between them. The inner membrane has outgrowths called crosses. Between the crosses is a matrix. The inner membrane of the mitochondrial membrane and the crosses formed by it are built of ordered enzymes. Due to the crosses, the working surface of the membranes inside the mitochondria is very large. A number of enzymes are in the matrix. With the help of mitochondrial enzymes, intracellular respiration and energy storage is carried out, which is released in the form of ATP. In mitochondria, pyruvic acid is cleaved to CO2 and H2O. Mitochondria are the power stations of the cell. Mitochondria, like chloroplasts, are semi-autonomous genetic centers of the cell. They contain ribosomes, DNA and enzymes that are able to synthesize protein. Due to this, mitochondria can multiply.

The endoplasmic reticulum is a system of channels, tanks, surrounded by a membrane, 5-6 mm thick. EP can be smooth (agranular) and granular. Ribosomes are located on the outer surface of the channels of the granular reticulum. Enzymes are located on the membranes of the EP and therefore it is a conveyor for enzymatic conversion and synthesis of substances, as well as highways for the transport of substances through the cell. The reticulum begins from the outer membrane of the nuclear envelope, branches and approaches the various organelles of the cytoplasm, as well as the plasmolemma. Thus, it connects all parts of the cell. In addition, the channels of the endoplasmic reticulum pass through the plasmodesma, connecting the reticulum of neighboring cells. The membranes of the endoplasmic reticulum divide the cell into compartments, and biocurrents propagate through them, which are signals that change the selective permeability of the membranes and the activity of enzymes.

The Golgi apparatus is represented by dictyosomes. Each dictyosome is a system of membranes stacked. The cavities between the membranes have the appearance of narrow slits and flat bags - tanks, then bubbles. their shape changes during the work of the organelle and depends on the degree of filling of the intermembrane space with substances that are released and accumulate. Apparently, the numerous cellular vacuoles surrounded by the tonoplast are the product of the Golgi apparatus. They are vesicles that have detached from it and then increased in size. The Golgi apparatus is especially developed in secretory cells in which various substances are deposited or excreted. It synthesizes and secretes substances that form the cell membrane.

Peroxisomes and glyoxisomes - round organelles with a diameter of 0.2 - 1.5 μm are surrounded by a membrane and contain a granular matrix. Peroxisomes perform the function of oxidation of glycolic acid, which is synthesized in chloroplasts during photosynthesis and the amino acid glycine is formed, which in mitochondria is converted into serine.

In the leaves of higher plants peroxisomes are involved in photorespiration. Glyoxysomes convert fatty acids into sugars using the appropriate enzymes. During enzymatic transformations, hydrogen peroxide is formed in peroxisomes and glyoxisomes, which is cleaved by the enzyme catalase.

Spherosomes are spherical bodies that refract light well, with a diameter of 0.5 μm. They contain lipids and are therefore often called lipid droplets (oleosomes). Enzymes such as lipase and esterase were found in them. When oilseeds germinate, they function together with glyoxisomes and break down complex fats.

Ribosomes are rounded particles with a diameter of 20-30 nm. Some of them are attached to the outer surface of the membranes of the endoplasmic reticulum, some are in a free state in the hyaloplasm. There are up to 5 million ribosomes in the cell. They are devices for protein synthesis. Ribosomes are found in the nucleus, mitochondria and chloroplasts, where they synthesize the proteins from which organelles are made. Each ribosome consists of two nucleoprotein subunits. Ribosome subunits are formed in the nucleolus, and then enter the cytoplasm, where the formation of ribosomes on the mRNA molecule.

Microtubules are tubules with channels inside. Their outer diameter is 250A. Sometimes these are double tubes. The walls of microtubules are built of protein molecules. It is believed that microtubules are associated with the contractile activity of the cytoplasm and its formations. Spindle threads are formed from microtubules during cell division. In cells that do not have a dense shell, the microtubules perform a supporting function, forming the inner skeleton of the cell.

A vacuole is a formation typical of a plant cell, which is a cavity filled with cell sap and surrounded by a membrane (tonoplast). The vacuole is formed by tanks of the endoplasmic reticulum, which merge. The vacuole contains cell juice in which mineral salts, organic acids, sugars, amino acids, proteins are dissolved. In addition to these substances, the cell juice of vacuoles contains phenols, tannins, alkaloids, anthocyanins. The vacuoles contain many enzymes (mainly hydrolases). A vacuole is a place where nutrients accumulate and are stored in the cell, as well as harmful substances that are neutralized by enzymes.

Plasma inclusions include fat droplets, starch and aleurone grains. Basically, plasma inclusions act as reserve nutrients.

Section 4. Cellular regulation

The shape of the nuclei in different cells is different: more often the shape of the nucleus is spherical (especially in cells of round or cubic shape), but there are cells with bean-shaped, rod-shaped, multi-lobed, segmental nucleus. Most often, the shape of the nucleus corresponds to the shape of the cell.

The size of the nucleus usually varies from 5 to 10 microns in diameter.

In a nucleus not dividing (interphase) cells the following components come to light: a nuclear cover (karyolemma), chromatin, a nucleolus and a karyoplasm.

The nuclear envelope (karyolemma, nucleolemma) is practically undetectable at the optical level. Under the electron microscope it appears that it consists of two membranes - the external and internal membranes separated by a cavity 15-40 nm wide by the perinuclear tank.

The outer membrane is integral with the membranes grZPS: on its surface there are ribosomes, and the perinuclear tank communicates with the tank grZPS.

The inner membrane is smooth, its integral proteins are connected with a layer consisting of a network of intermediate filaments (laminates) - the so-called lamina, or nuclear plate. Lamina plays a major role in maintaining the shape of the nucleus, the formation of chromatin and the structural organization of porous complexes.

At certain points, the outer and inner membranes close, forming nuclear pores.

The nuclear pore is formed by two parallel rings with a diameter of 80 nm, each containing 8 protein granules, from which fibrils extend to the center of the pore, forming a diaphragm about 5 nm thick. In the middle of the diaphragm is the central granule. Nuclear granule protein granules are structurally related to nuclear lamina proteins. The set of components that make up a nuclear pore is called a nuclear pore complex. The nuclear envelope of the cell contains 2000-4000 pore complexes. The number of pore complexes increases with increasing functional activity: in cells with high synthetic activity, nuclear pores occupy up to 35% of the surface of the karyolema.

The nuclear hole complex provides selective transport of substances between the cytoplasm and the nucleus. Small water-soluble molecules and ions move along the channel formed by the pore complex (1); actively transferred to the nucleus proteins (2) 5 synthesized in the cytoplasm (proteins labeled as a special sequence of amino acids - NLS, recognized by NLS receptors in the pore complex); subunit ribosomes are transferred from the nucleus to the cytoplasm (3).

Chromatin in an interphase (non-dividing) cell corresponds to chromosomes and consists of a complex of DNA and protein. Accordingly, there are bottoms of chromatin: euchromatin and heterochromatin.

Euchromatin corresponds to areas of chromosomes that are despiralized and open for transcription. These areas are not stained and are not visible under a light microscope.

The heterochromatic corresponds to condensed segments of chromosomes, making them inaccessible for transcription. Heterochromatic is intensely stained with basic dyes, and in a light microscope has the appearance of small iranul and glnbok.

Thus, but the ratio of eu- and heterochromagna in the nucleus can assess the activity of transcription processes, and, consequently, the synthetic function of the cell. At its increase the ratio is changed in favor of zuchromatin, at decrease - the maintenance of hetroschromash increases. The ratio of zuchromatin to heterochromatin can, for example, be the basis for the differential diagnosis of benign and malignant tumor cells. With complete suppression of nuclear function in damaged and dying cells, it decreases in size and contains only heterochromatin. This phenomenon is called karyopyknosis.

Cells of each type have their own character distribution of heterochromatin, which helps to identify them both visually and with the help of automatic image analyzers. However, there are general patterns of distribution of heterochromatin in the nucleus: usually its accumulations are located under the karyolema and around the nucleolus.

Floor chromatin (Barr's body) is a cluster of heterochromatin corresponding to one of a pair of X chromosomes that is tightly twisted and inactive in the interphase. Detection of sex chromatin is used as a diagnostic test to determine the genetic female

sex, which is essential in the study of genetic abnormalities and, especially, in sports medicine. Epithelial cells of the oral mucosa are usually analyzed, where, as in most other cells, sex chromatin is found as a large deep heterochromatin lying adjacent to the nuclear envelope. In neutrophilic blood leukocytes, sex chromatin has the form of a small additional lobe of the nucleus ("drumstick").

Packaging of chromatin in the core. In the decondensed state, the length of one molecule (double helix) of DNA, forming one chromosome, is about 5 cm, and the total length of DNA molecules in the nucleus - more than 2 m. Such long strands of DNA are compactly and neatly packed in the nucleus with a diameter of only 5-10 μm . Compact packaging of DNA molecules is carried out due to the connection of DNA with special basic proteins - histones.

The initial level of chromatin packaging is a nucleosome with a diameter of 11 nm. The nucleosome consists of a block formed by a complex of 8 histone molecules, on which a double strand of DNA (a chain of 166 nucleotide pairs) is wound. Nucleosomes are separated by short sections of free DNA (48 base pairs). Nucleosomal filament has the form of a filament with beads, where each bead is a nucleosome. The second level of packing is also caused by histones and leads to twisting of a nucleosomal thread (a turn with 6 nucleosomes) with formation of a chromatin fibril with a diameter of 30 nm. Chromatin fibrils form loops with a diameter of 300 nm. At division of a cell as a result of even more compact packing and supercoiling of DNA there are chromosomes (diameter of 700 nm) visible under a light microscope. Compact DNA packaging in the nucleus provides an orderly arrangement of very long DNA molecules in a small volume of the nucleus, as well as functional control of gene activity.

In addition to histone proteins, DNA is associated with non-histone proteins that regulate gene activity.

The nucleolus is found in the interphase nucleus at the light-optical level as a small (~ 1 μm in diameter), dense spherical structure that is intensely stained with basic dyes. The nucleolus is formed by specialized sections of chromosomes - nuclear organizers, which are the synthesis of ribosomal RNA, as well as its assembly into the precursors of ribosomal subunits. In the electron microscope, you can distinguish three components, which make up the nucleolus:

The amorphous component, staining weakly, is the location of the nucleolar organizers: large loops of DNA, actively involved in the transcription of ribosomal RNA;

The fibrillar component consists of many strands with a diameter of 5-8 nm, mainly in the inner part of the nucleolus, and is a long rRNA molecule (primary transcripts);

The granular component is formed by the accumulation of dense small granular particles, which are maturing subunits of ribosomes. The ribosomal subunit is formed from rRNA synthesized in the nucleolus and proteins synthesized in the cytoplasm. Then the subunits of ribosomes are transported through the nuclear wells r cytoplasm,

The fibrous and granular components of the nucleolus form the nucleolus filament, the nucleolonema, which forms a loop network that is distinguished by a high density against the background of a less dense nuclear matrix. Normal nuclear,

surrounded by ichggroschromatin (yarinucleolar chromatin). The size and volume of the nucleoli increase with increasing functional activity of the cell. Particularly large nucleoli are characteristic of embryonic and actively synthesizing protein cells, as well as cells of rapidly growing malignant tumors.

The nucleolus disappears in the prophase of mitosis, as a result of inactivation of ribosomal genes by condensation of the corresponding chromosomes, and is re-formed in the late telophase.

Nuclear matrix

The nuclear matrix is the komnonesh of the nucleus, which contains chromatin and nucleolus. The nuclear matrix is formed by a karyoplasm and a karyoskeleton. Karyoplasm is a liquid component of the nucleus, it contains enzymes, metabolites dissolved in water, Kariosk-elet consists of lamina and other fibrillar proteins.

CELL CYCLE

Cell cycle - a set of processes occurring in the cell between two successive distributions or between its formation and death.

The cell cycle contains the inherently washed distribution and interphase - the interval between distributions.

Interphase occupies about 90% of the total time of the cell cycle and is divided into three periods:

presynthetic or postmitotic - G1 (from the English. gap - interval);

synthetic - S;

postsynthetic or gtremitotic - G2.

/ Iresintegmchny period - G1 - is characterized by active cell growth, protein and RNA synthesis, so the cell restores the required set of organelles and reaches normal size. G1 tricas period from a few days to several days. During this period, special "" proteins are synthesized, triggers - activators of the S period. They ensure that the cell reaches the point R (oblzezheish point), after which it enters the period-S-period. If the cell eats a point U, the warts leave the cycle and enter a period of reproductive rest (GO). Cells of some tissues under the influence of certain factors are able to return from the period GO in kditsyshgdat cycle, cells of other tissues lose this ability as differentiation. The vast majority of differentiated cells of Aryatism, which perform their specific functions, do not divide.

In the msiaphase, the chromosomes line up in the equatorial region of the yen (in equal divergence from the centrioles of opposite poles), and form a picture of the equatorial (metaphase) plate (side view) or the parent star (view from the poles). The sister chromatids are separated by a slit before the kidgpittigi phase, but are kept in the area of the central region.

Anaphase begins with the synchronous cleavage of all chromosomes on the sister of the chromagid (in the area of the centromere) and the movement of daughter chromosomes to opposite poles of the cells, which occurs

At the end of anaphase begins to form a cellular constriction, due to the reduction of aktkovymikrofkdamentov concentrated around the circumference of the cell.

Telophase is characterized by the reconstruction of the nuclei of daughter cells and the completion of their division. The nuclear envelope is restored, the chromosomes are gradually despiralized, being replaced by a picture of chromatin of the interphase

nucleus, and at the end of the telophase the nucleolus reappears. The deepening of the cell constriction is completed by a complete cygotomy with the formation of two daughter cells. At the same time there is a distribution organsl between daughter cells.

At damage of the mitotic device there can be atshshchny mitoses characterized by uneven distribution of genetic material between cells - anzutshoidiej. The disorder of normal mitotic cell division can be caused by chromosome abnormalities, which are called chromosomal aberrations. Chromosomal aberrations (chromosome adhesion, fragmentation, loss of regions, doubling of chromosome regions, etc.) are possible. ! i «i; ikchg: i spoigiiino, but often ipeihgchiiiinaiotsya due to the action of pa kditiigkmutsh'spio and ionizing radiation. Atypical mitoses are characteristic of malignant swollen and irradiated tissues.