MINISTRY OF SCIENCE AND HIGHER EDUCATION OF RUSSIAN FEDERATION
Federal State Autonomous Educational Institution of Higher Education
**Far Eastern Federal University**
(FEFU)
SCHOOL OF BIOMEDICINE

AGREED
Head of OP
_____
(Signed) (Full name)

CLAIM
Director of the Department of Medical Biology and Biotechnology
_____
(Signed) (Acting Name)
December 06, 2022

WORK PROGRAM OF THE DISCIPLINE
Molecular Biology of the Cell
Direction of training 06.04.01 Biology
(Molecular and Cell Biology )
Form of training: full-time

Course 1 semester 1
lectures 18 h.
practical exercises 18 hours.
laboratory work - hour.
total hours of classroom load 36 hours.
independent work 108 hours.
of these, 36 hours to prepare for the exam.
exam 1 semester

The work program is drawn up in accordance with the requirements of the Federal State Educational Standard in the direction of training 06.04.01 Biology, approved by the order of the Ministry of Scienceof the Republic of Russia dated 11.08.2020. № 934.
The work program was discussed at the meeting of the Department of Medical Biology and Biotechnology Protocol dated December 06, 2022 No. 2
Director of the Department of Implementing Structural Unit Ph.D., Associate Professor Kumeiko V.V.
Compiled by: Ph.D., Associate Professor Kumeiko V.V.

Vladivostok
2022

Reverse side of the RPD cover page

1. The work program was revised at the meeting of the Department / department / department (implementing the discipline) and approved at the meeting of the Department / department / department (issuing structural unit), the protocol from "_____ __ № _____

2.The work program was revised at the meeting of the Department / department / department (implementing the discipline) and approved at the meeting of the Department / department / department (issuing structural unit), the protocol from "__ № _____

3.The work program was revised at the meeting of the Department / Department / Department (implementing the discipline) and approved at the meeting of the Department / Department / Department (issuing structural unit), the protocol from "____ № _____

4.The work program was revised at the meeting of the Department / Department / Department (implementing the discipline) and approved at the meeting of the Department / Department / Department (issuing structural unit), the protocol from "_____ __ № _____

5.The work program was revised at the meeting of the Department / Department / Department (implementing the discipline) and approved at the meeting of the Department / Department / Department (issuing structural unit), the protocol from "_____ __ № _____

1. Goals and objectives of mastering the discipline:

Purpose: specialization of theoretical training and deepening of students' knowledge in the field of cellular molecular biology of the cell - a branch of biology, the subject of which is the cell, the elementary unit of the living. The cell is considered as a system that includes individual cellular structures, their participation in general cellular physiological processes, ways of regulating these processes, and also studying the basic properties and manifestations of life at the molecular level.

Tasks:

1) development of students' holistic view of the molecular level of cell organization;

2) obtaining modern knowledge about the structure, dynamics and functioning of molecular ensembles of cells, molecular mechanisms of cell development and functioning.

Professional competencies of graduates and indicators of their achievement:

| Task type | Code and name of professional competence (the result of mastery) | Code and name of the competency achievement indicator |
|---|---|---|
| research | PC-2 is able to apply the methodological foundations of design, perform laboratory biological, environmental research, use modern equipment and computing complexes in molecular and cell biology. | PC-2.1 Develops rules and algorithms for the design, implementation of laboratory biological and environmental research. |
| | | PC-2.2 Performs laboratory biological, environmental research using the scientific methodological foundations of fundamental research. |
| | | PK-2.3 Applies the methodological foundations of design, laboratory biological, environmental research, uses modern equipment and computing complexes in molecular and cellular biology. |
| | PC-3 is capable of conducting research on biopolymers, their components and complexes, the structure and function of genes and genomes. | PC-3.1 Studies the structure and functions of biopolymers, their components and complexes, mechanisms of storage, transmission and implementation of genetic information at the molecular level. |
| | | PC-3.2 Detailedly characterizes the main processes occurring in a living cell: the processes of replication, transcription, translation, recombination, repair, processing of RNA and proteins, protein folding and docking. |
| | | PC-3.3The study of the main methods of intermolecular interactions and mutual regulation of the processes of functioning of a living cell as part of a multicellular organism. |
| | | PC-3.4 Analyzes the structure and functions |

| | | |
|---|---|---|
| | | of genes and genomes, conducts structural and functional analysis of individual proteins and the proteome as a whole. |
| | PC-4 is capable of conducting scientific research in molecular and cellular biology in order to develop the scientific potential of the Russian Far East and the development of the resources of the World Ocean. | PP-4.1 Conducts substantiation of scientific research in molecular and cellular biology in order to develop the scientific potential of the Russian Far East and the development of the resources of the World Ocean. |
| | | PP-4.2 Performs applied and exploratory research and development in molecular and cellular biology aimed at developing the scientific potential of the Russian Far East and the development of the resources of the World Ocean. |
| | | PP-4.3 Interprets the results of scientific research in molecular and cellular biology aimed at developing the scientific potential of the Russian Far East and the development of the resources of the World Ocean. |
| | PC-5 Is able to conduct a systematic analysis of the relationship between cells, tissues and functional systems of organisms. | PC-5.1 Studies the relationship between cells, tissues and functional systems of organisms. |
| | | PC-5.2 Investigates the relationship between cells, tissues and functional systems of organisms. |
| | | PC-5.3 Conducts a systematic analysis of the relationship between cells, tissues and functional systems of organisms. |

| Code and name of the competency achievement indicator | Name of the assessment indicator (the result of training in the discipline) |
|---|---|
| PC-2.1 Develops rules and algorithms for the design, implementation of laboratory biological and environmental research. | Knows<br>– methodological foundations of design, implementation of field and laboratory biological, environmental studies<br>Can<br>– develop rules and algorithms for designing, performing laboratory biological and environmental studies<br>Owns<br>– skills in developing and improving new rules and algorithms for designing, performing laboratory biological and environmental studies |
| PC-2.2 Performs laboratory biological, environmental research using the scientific methodological foundations of fundamental research. | Knows<br>– modern classification of methods of scientific research, specifics and boundaries of their applicability;<br>– the specifics of research characteristic of various environmental disciplines, the main classes of models that are a reflection of real systems - objects of environmental research;<br>– the main methods of statistical analysis: correlation, regression and variance<br>Can<br>– use the methods of statistical analysis to assess the reliability of data, compare empirical and theoretical systems, find the relationship between the variables that characterize the state of the system<br>Owns<br>– the ability to independently analyze the available information, identify fundamental problems, set the task |

| | |
|---|---|
| PK-2.3 Applies the methodological foundations of design, laboratory biological, environmental research, uses modern equipment and computing complexes in molecular and cellular biology. | Knows<br>– the main modern field and laboratory methods of biology and ecology research<br>Can<br>– work on modern analytical equipment of a modern biological laboratory<br>Owns<br>– modern research methods in ecology and biology |
| PC-3.1 Studies the structure and functions of biopolymers, their components and complexes, mechanisms of storage, transmission and implementation of genetic information at the molecular level. | Knows<br>– structure and functions of biopolymers, their components and complexes, mechanisms for storing, transmitting and implementing genetic information at the molecular level<br>Can<br>– determine the structure and functions of biopolymers, their components and complexes, mechanisms for storing, transmitting and implementing genetic information at the molecular level<br>Owns<br>– a method for determining the structure and functions of biopolymers, their components and complexes, mechanisms for storing, transmitting and implementing genetic information at the molecular level |
| PC-3.2 Detailedly characterizes the main processes occurring in a living cell: the processes of replication, transcription, translation, recombination, repair, processing of RNA and proteins, protein folding and docking. | Knows<br>– processes of replication, transcription, translation, recombination, repair, processing of RNA and proteins, protein folding and docking<br>Can<br>– describe in detail and characterize the main processes occurring in a living cell<br>Owns<br>– methods of identification of the main processes occurring in the cell |
| PC-3.3The study of the main methods of intermolecular interactions and mutual regulation of the processes of functioning of a living cell as part of a multicellular organism. | Knows<br>– basic terms and concepts of molecular biology; objects of study, research methods, modern concepts, achievements and limitations of natural sciences<br>Can<br>– andto use molecular biological knowledge for a deeper understanding of modern problems of biology; to link advances in molecular biology with advances in modern genetics, immunology, genomics, proteomics and medicine<br>Owns<br>– skills in the operation of modern equipment and equipment for research and laboratory work; on the practical application of the issues considered in the course in protein and cell engineering, with use in biomedical research and in biotechnological production |
| PC-3.4 Analyzes the structure and functions of genes and genomes, conducts structural and functional analysis of individual proteins and the proteome as a whole. | Knows<br>– structure and function of genes and genomes<br>Can<br>– analyze the structure and function of genes and genomes<br>Owns<br>– skills of structural and functional analysis of individual proteins and the proteome as a whole |
| PP-4.1 Conducts substantiation of scientific research in molecular and cellular biology in order to develop the | Knows<br>– the current situation of development of the scientific potential of the Russian Far East and the development of the resources of |

| | |
|---|---|
| scientific potential of the Russian Far East and the development of the resources of the World Ocean. | the World Ocean<br>Can<br>– to characterize the achievements of modern science in the field of molecular and cell biology in order to develop the scientific potential of the Russian Far East and the development of the resources of the World Ocean<br>Owns<br>– the ability to substantiate scientific research in molecular and cell biology |
| PP-4.2 Performs applied and exploratory research and development in molecular and cellular biology aimed at developing the scientific potential of the Russian Far East and the development of the resources of the World Ocean. | Knows<br>– fundamental scientific research and developments in the field of molecular and cell biology aimed at developing the scientific potential of the Russian Far East and the development of the resources of the World Ocean<br>Can<br>– perform applied and exploratory research and development in molecular and cell biology<br>Owns<br>– skills in the use of applied and exploratory scientific research and development in molecular and cellular biology aimed at developing the scientific potential of the Russian Far East and the development of the resources of the World Ocean |
| PP-4.3 Interprets the results of scientific research in molecular and cellular biology aimed at developing the scientific potential of the Russian Far East and the development of the resources of the World Ocean. | Knows<br>– scientific research in molecular and cell biology, aimed atdeveloping the scientific potential of the Russian Far East and the development of the resources of the World Ocean<br>Can<br>– interpret the results of scientific research in molecular and cellular biology aimed at developing the scientific potential of the Russian Far East and the development of the resources of the World Ocean<br>Owns<br>– skills in analyzing the resultsof scientific research in molecular and cellular biology aimed at developing the scientific potential of the Russian Far East and the development of the resources of the World Ocean |
| PC-5.1 Studies the relationship between cells, tissues and functional systems of organisms. | Knows<br>– molecular, immunological and physiological aspects of the study of cells of multicellular, small cell and unicellular organisms<br>Can<br>– to conduct andinvestigate the adaptation of tissue elements to the action of various biological, physical, chemical and other factors<br>Owns<br>– skills with theanalysisof the relationship between cells, tissues and functional systems of organisms – representatives of all kingdoms |
| PC-5.2 Investigates the relationship between cells, tissues and functional systems of organisms. | Knows<br>– molecular, immunological and physiological aspects of the study of cells of multicellular, small cell and unicellular organisms<br>Can<br>– to conduct andinvestigate the adaptation of tissue elements to the action of various biological, physical, chemical and other factors<br>Owns |

| | |
|---|---|
| | – skills with theanalysisof the relationship between cells, tissues and functional systems of organisms – representatives of all kingdoms |
| PC-5.3 Conducts a systematic analysis of the relationship between cells, tissues and functional systems of organisms. | Knows<br>– a method of conducting a systematic analysis of the relationship between cells, tissues and functional systems of organisms<br>Can<br>– to conduct a systematic analysis of the relationship between cells, tissues and functional systems of organisms<br>Owns<br>– a method of conducting an analysis of the relationship between cells, tissues and functional systems of organisms |

1. Labor intensity of discipline and types of training sessions in the discipline

The total labor intensity of the discipline is 4 credited units (144 academic hoursa), (1 credit unit corresponds to 36 academic hours).

Types of training sessions and work of the student in the discipline are:

| Designation | Types of training sessions and work of the student |
|---|---|
| Lek | Lecture |
| Lek electr. | |
| Ave | Practical exercises |
| Pr electr. | |
| WED: | Independent work of the student during the period of theoretical training |
| including control | Independent work of the student and contact work of the student with the teacher during the period of intermediate certification |

Structure of the discipline:

The form of training is full-time.

| № | Name of the section Discipline | Se me ster | Number of hours by types of training sessions and work of the student | | | | | | Intermediate attestation forms |
|---|---|---|---|---|---|---|---|---|---|
| | | | Lek | Lab | Av e | OK | WE D | Cont rol | |
| 1. | Topic 1 | 1 | 2 | - | 2 | - | 10 | 5 | Exam Questions |
| 2. | Topic 2 | 1 | 2 | - | 2 | - | 10 | 5 | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 3. | Topic 3 | 1 | 3 | - | 3 | - | 10 | 5 | |
| 4. | Topic 4 | 1 | 3 | - | 3 | - | 12 | 5 | |
| 5. | Topic 5 | 1 | 3 | - | 3 | - | 10 | 5 | |
| 6. | Topic 6 | 1 | 3 | - | 3 | - | 10 | 6 | |
| 7. | Topic 7 | 1 | 2 | - | 2 | - | 10 | 5 | |
| | Total: | 1 | 18 | - | 18 | - | 72 | 36 | Exam |

## THE STRUCTURE AND CONTENT OF THE THEORETICAL PART OF THE COURSE

Lectures 18 hours.

**Topic 1. Structural hierarchy and molecular organization of the cell. Cells of prokaryotes and eukaryotes (2 hours).**

- Proteins.
- Nucleic acids.
- Lipids.
- Polysaccharides.

**Topic 2. Structure and molecular dynamics of cell membranes (2 hours).**

- Membrane organization.
- Transport functions.
- Heterogeneity and asymmetry.
- Membrane proteins.
- Glycoconjugates in membrane composition.
- Glycosaminoglycans.
- Glycolipids.
- Intercellular contacts.

**Topic 3. Chromatin structure, molecular mechanisms of DNA replication, repair and recombination (3 hours).**

– Chromosome structure.
– DNA-binding proteins. Chromosomal territories.
– Functioning of chromatin.
– DNA replication.
– DNA polymerases.
– Primers.
– Polymerase chain reaction.
– Spatio-temporal organization of replication.
– Replication of mitochondrial DNA.
– Features of telomeric DNA replication.
– Damage and mechanisms of DNA repair.
– DNA recombination.
– Mobile genetic elements.

**Topic 4. Transcription. Regulation of gene expression (3 hours).**

– The Central Dogma of Molecular Biology.
– Structural organization of the gene.
– RNA polymerases. Transcription factors.
– Post-transcriptional changes in mRNA.
– The effect of the position of genes.
– The main levels of regulation of gene activity.
– Regulation of gene activity by transcription activators.

**Topic 5. Genetic code. Translation mechanism (3 hours).**

– Properties of the genetic code.
– Structure and properties of transport RNAs.
– Aminoacyl-tRNA synthetase.
– Ribosomes of prokaryotes and eukaryotes.
– Stages of broadcasting.
– Post-translational modifications of proteins.

**Topic 6. Cytoskeleton (3 hours).**

– The main fibrillar structures of the cytoskeleton.
– Molecular motors.
– ATPase activity of myosin.
– Regulation of the striated muscles.
– Regulation of smooth muscle.
– Locking tone.

**Topic 7. Intercellular communications, signaling pathways, control of cell reproduction and differentiation (2 hours).**

– The concept of intercellular communication.
– Communicative processes of bacteria and yeast.
– The types and nature of the signals perceived by the cell.
– Receptors.
– Principles of intracellular mechanisms of signal transmission.
– Classification of signal pathways.
– Behavioral reactions of cells. Signaling molecules as morphogens.

## IV. STRUCTURE AND CONTENT OF THE PRACTICAL PART OF THE COURSE AND INDEPENDENT WORK

Practical training of 18 hours.

**Topic 1. Structure and molecular dynamics of cell membranes. (2 hours)**

– Organization of biological membranes.
– Transport functions of membranes.
– Horizontal heterogeneity and vertical asymmetry of membranes.
– Proteins that are part of biological membranes. Classification of membrane proteins by position relative to the lipid bilayer. Methods of fixation of proteins in the membrane.
– Carbohydrate-containing biopolymers (glycoconjugates) in the composition of membranes: glycoproteins and proteoglycans, glycolipids. The main classes of glycosaminoglycans in the body. Functions of carbohydrate-containing polypeptides and proteins in the body. Structure and function of glycolipids.
– Types of intercellular contacts (isolating - dense compounds; anchoring - adhesive contacts, desmosomes, focal contacts and semidesmosomes; communication - slotted contacts).

**Topic 2. Structure of chromatin. (2 hours)**

– Structure and classification of chromosomes. Euchromatin and heterochromatin. Coding and non-coding DNA.
– Major DNA-binding proteins and their role in the organization of the three-dimensional structure of chromatin. Histone proteins. Non-hystone chromatin proteins. Chromosomal territories and the nuclear matrix.
– Functional aspects of the structural organization of chromatin. Modifications of histones and their role in the functional activity of chromatin.

**Topic 3. Molecular mechanisms of DNA replication. (2 hours)**

– General principles of DNA replication. The structure of the replication fork, the main participants in the replication process.

– DNA polymerases of prokaryotes and eukaryotes: organization and features of functioning. 5'→3'- and 3'→5'- exonuclease activity of DNA polymerases. Nick-broadcast, polIE structure. coli, the Klenov fragment model, and the principle of autocorrection of replication errors. Processivity of DNA polymerases. The role of the PCNA protein and the β subunit of DNA polymerase III (PolIII) in ensuring the processivity of the enzymatic replication complex.

– Primers, primemaz activity of replication enzymes, features of replication initiation.

– The principle of polymerase chain reaction (PCR) and its significance for molecular biology. Thermostable DNA polymerases. Stages of the PCR cycle, PCR events occurring on different cycles. Varieties of PCR.

– Spatio-temporal organization of replication events. Leading and lagging chains, okazaki fragments. Directions of replication and implementation of replication difficulties in the spatial organization of the replication "machine".

– Features of mitochondrial DNA replication. Sites began replicating the leading and lagging chains, the D-loop.

– Features of telomeric DNA replication. Structure and functioning of telomerases, telomerase RNA, the principle of reverse transcription in the work of telomerase. L. Hayflick's limit and telomerase activity. Debatable questions about the role of telomerases in ensuring the "immortality of cells".

**Topic 4. Molecular mechanisms of DNA repair and recombination. (2 hours)**

– DNA damage and DNA repair mechanisms. The base removal mechanism and the nucleotide removal mechanism are the main repair pathways. Glycosilases and AP-endonucleases. DNA polymerases that provide DNA repair. Alternative mechanisms of direct chemical transformation of damaged DNA.

– General recombination of DNA is the recombination of homologous DNA (general recombination, homologous recombination). The role of total recombination in DNA repair. Meiotic recombination.

– Mobile genetic elements, transposition and site-specific recombination. DNA transposons. Retrotransposons: retroviral and nonretroviral type. Functioning of mammalian retrotransposons on the example of retrotransposonL1. Conservative site-specific recombination and bacteriophage λ.

**Topic 5. Transcription: Regulation of gene expression. (2 hours)**

– The Central Dogma of Molecular Biology. The concept of transcription. Gene, structural organization of the gene, transcribed and non-transcribed regions,

discontinuous gene structure (exons, introns). The role of promoters and consensus sequences in the transcription initiation mechanism.

– RNA polymerases of prokaryotes and eukaryotes: structural and functional features. The participation of transcription factors (TF) in the mechanism of transcription initiation, the role of TFIID and σ - a subunit of prokaryote RNA polymerase in the formation of the initiator complex. Participation of elongation factors in the provision of transcription. Transcription termination.

– Post-transcriptional changes in eukaryotic mRNA: capping, splicing, polyadenylation. Alternative splicing.

– The effect of the position of genes. Inactivation of the X chromosome of mammals.

– The main levels of regulation of gene activity. Acetylation of histones.

– The main levels of regulation of gene activity. DNA methylation, varieties.

– The main levels of regulation of gene activity. Post-transcriptional level of regulation.

– Regulation of gene activity by transcription activators.

**Topic 6. Genetic code. Broadcast mechanism (2 hours)**

– Discovery, decoding and properties of the genetic code.

– Adaptor hypothesis of the implementation of the genetic code. Structure and properties of transport RNAs (tRNAs): acceptor peduncle, dihydrouridin, pseudouridin and anticodone loops, variable handle, inosine and its role in codon recognition, primary, secondary and tertiary structure of tRNA.

– Aminoacylation ofRNA, aminoacyl-tRNA synthetase, selectivity and accuracy of translation.

– Organization and assembly of ribosomes of prokaryotes and eukaryotes. Synthesis and processing of ribosomal RNAs (rRNA). Ribosome proteins. Sites of the active center of ribosomes: mRNA-binding site, A-, P-, E-sites.

– Stages of translation: initiation, elongation, termination. The mechanism of formation of the initiator complex, factors of initiation of prokaryote translation (IF). Eukaryote initiation factors. Elongation factors (EF), termination factors (RF). Participation of GTF in the broadcast.

– Post-translational modifications of proteins, control of the functional activity of proteins using post-translational processing.

**Topic 7. Cytoskeleton: Architecture, Transport and Molecular Dynamics (2 hours)**

– The main fibrillar structures of the cytoskeleton, their molecular composition and tissue specificity.

– Classification, structure and properties of molecular motors. Properties of myosins, dynein and kinesin as the main molecular motors of the cell.

– Mechanochemical conjugation and actin-activated ATPase activity of myosin.

– Actin-linked regulation of muscle work on the example of the cycle of skeletal striated muscles of mammals. The role of Ca2+ and the troponin complex in triggering the reduction.

– Myosin-related regulation of muscle work on the example of the cycle of smooth muscle in mammals. The role of Ca2+, calmodulin and its kinase in the mechanism of contraction. Actin-mediated regulation of mammalian smooth muscle. The functioning of specialized smooth muscles of animals with a state of locking tone (catchstate).

**Topic 8. Intercellular communications, signaling pathways, control of cell reproduction and differentiation. (2 hours)**

– The concept of communication between cells. Communicative processes of bacteria and yeast. The types and nature of the signals perceived by the cell. The concepts of a signal-feeding cell and a target cell. The concepts of ligand and receptor. Principles of intracellular signal transmission mechanisms (secondary messengers and effector molecules). Types of effector molecules and possible signaling results.

– General classification of signaling pathways depending on the distance of the ligand from the cell secreting the signaling molecule. Contact-dependent signaling. Behavioral reactions of cells in the microenvironment of signaling molecules. Signaling molecules as morphogens.

**Topic 9. Methods of cell reproduction. Cell response to damage (2 hours)**

– The concept of the cell cycle. Phases and cue points. Events occurring in each of the periods

– Methods of cell division. Mitosis. Meiosis.

– Morphofunctional characteristics of the processes of growth and differentiation, the period of active functioning, aging and cell death.

**Questions for self-control**

1. Give a diagram of the structure and characterize the composition of the nucleotide molecule. Through what bonds are nucleotides connected into a polynucleotide chain?

2. To give a comparative description of the structure of DNA and RNA molecules. What connections form the DOUBLE HELIX of DNA? Explain the principle of complementarity in the construction of a double helix, name complementary pairs of nucleotides.

3. To define the concept of "transcription", to explain the molecular mechanism of transcription: what is the matrix, what enzyme is used, where do the precursors for synthesis come from?

4. Define the concept of "broadcasting". Give a diagram and explain the mechanism of ribosomes. Determine the role of each form of RNA in protein synthesis.

5. Give a brief answer to the question: what does the genetic code express? Why is the code triplet? Which molecules act as a decoding mechanism?

6. Give a brief definition and formula of the central dogma of molecular biology. What are the functions of DNA in a cell? What syntheses and why are they called matrix?

7. Based on the formula of the central dogma of molecular biology, explain what is the molecular basis of the genotype and phenotype.

8. To define the concept of "replication", to explain the molecular mechanism and purpose of DNA replication.

9. General orthological characteristics of the nuclear apparatus of eukaryotic and prokaryotic cells.

10. The essence of the concept of chromosome continuity in the life cycle of the cell.

11. Chemical composition of chromatin. What is DNP?

12. Levels of structural organization of chromatin. Eu- and heterochromatin. What levels of chromatin organization are characteristic of the interphase nucleus?

13. What manifestations of mRNA transcription can be seen in a light and electron microscope?

14. The structure of chromosomes such as lamp brushes and polythene chromosomes, the correspondence of their details to the chromatin structures of conventional nuclei.

15. Structure and functions of the nucleus. Explain the essence of rRNA processing.

16. Structure of eukaryotic ribosome: subunits, parameters of RNA molecules, proteins.

17. What is nucleus DNA amplification? Where is it known and what is it for?

18. Nuclear matrix and nuclear envelope: their structure and importance in the organization of chromatin work.

19. Structure and functions of nuclear pores.

20. What is the pathway by which ribosome subunits are transferred from the nucleus to the cytoplasm?

## V. EDUCATIONAL AND METHODOLOGICAL SUPPORT OF INDEPENDENT WORK OF STUDENTS

### Recommendations for independent work of students

The purpose of the independent work of the student is to work meaningfully and independently first with educational material, then with scientific information, to lay the foundations of self-organization and self-education in order to instill the ability to further continuously improve their professional qualifications.

The process of organizing the independent work of the student includes the following stages:

- preparatory (setting goals, drawing up a program, preparing methodological support, preparing equipment);
- basic (implementation of the program, the use of methods of information retrieval, assimilation, processing, application, transfer of knowledge, fixation of results, self-organization of the work process);
- final (assessment of the significance and analysis of the results, their systematization, assessment of the effectiveness of the program and methods of work, conclusions on the directions of labor optimization).

In the process of independent work, the student acquires the skills of self-organization, self-control, self-government, self-reflection and becomes an active independent subject of educational activity. Independent work of students should have an important impact on the formation of the personality of the future specialist, it is planned by the student independently. Each student independently determines the mode of his work and the measure of work spent on mastering the educational content in each discipline. He performs extracurricular work according to a personal individual plan, depending on his preparation, time and other conditions.

### Methodical recommendations for independent work of students

As the material on the subject of the discipline is mastered, it is planned to perform independent work of students on the collection and processing of literary material to expand the field of knowledge in the discipline under study, which allows you to deepen and consolidate specific practical knowledge gained in classroom classes. To study and fully master the program material on the

discipline, educational, reference and other literature recommended by this program, as well as specialized periodicals, are used.

When independently preparing for classes, students take notes on the material, independently study the issues on the topics covered, using the educational literature from the proposed list, periodicals, scientific and methodological information, databases of information networks.

Independent work consists of such types of work as the study of material on textbooks, reference books, videos and presentations, as well as other reliable sources of information; preparation for the zechet. To consolidate the material, it is enough, flipping through the notes or reading it, mentally restore the material. If necessary, refer to the recommended educational and reference literature, write down incomprehensible moments in the questions to understand them in the upcoming lesson.

Preparation for practical exercises. This type of independent work consists of several stages:

1) Repetition of the studied material. For this purpose, lecture notes, recommended basic and additional literature are used;

2) Deepening knowledge on the proposed topics. It is necessary to differentiate the available material in lectures, textbooks in accordance with the points of the plan of the practical lesson. Separately write out unclear questions, terms. It is better to do this in the margins of the lecture notes or textbook. Clarification should be carried out with the help of reference literature (dictionaries, encyclopedic publications, etc.);

3) Drawing up a detailed plan for the speech, or conducting calculations, solving problems, exercises, etc. In preparation for practical exercises, students take notes on the material, prepare answers to the above questions on the topics of practical exercises. In addition to the practical material, students independently study questions on the proposed topics, using educational literature from the proposed list, periodicals, scientific and methodological information, databases of information networks (Internet, etc.).

Requirements for the presentation and design of the results of independent work

There are no special requirements for the provision and design of the results of this independent work.

Control over the implementation of the plan of independent work of students is carried out by the teacher in practical classes by interviewing and by including in the final tasks specified in the lesson from the plan of independent work.

## VI. MONITORING THE ACHIEVEMENT OF COURSE OBJECTIVES

| No p/n | Supervised sections / topics of the discipline | Achievement indicator code and name | Learning outcomes | Assessment tools | |
|---|---|---|---|---|---|
| | | | | current control | Intermediate-accurate certification |
| 1. | Topic 1. Structural hierarchy and molecular organization of the cell. Prokaryote and eukaryotic cells | PC-2.1 Develops rules and algorithms for the design, implementation of laboratory biological and environmental research.<br>PK-2.3 Applies the methodological foundations of design, laboratory biological, environmental research, uses modern equipment and computing complexes in molecular and cellular biology.<br>PC-3.1 Studies the structure and functions of biopolymers, their components and complexes, mechanisms of storage, transmission and implementation of genetic information at the molecular level.<br>PC-3.2 Detailedly characterizes the main processes occurring in a living cell: the processes of replication, transcription, translation, recombination, repair, processing of RNA and proteins, protein folding and docking.<br>PC-3.4 Analyzes the structure and functions of genes and | Knows<br>– methodological foundations of design, implementation of field and laboratory biological, environmental studies<br>Can<br>– develop rules and algorithms for designing, performing laboratory biological and environmental studies<br>Owns<br>– skills in developing and improving new rules and algorithms for designing, performing laboratory biological and environmental studies | test | Exam Questions |
| 2. | Topic 2. Structure and molecular dynamics of cell membranes | | Knows<br>– the main modern field and laboratory methods of biology and ecology research<br>Can<br>– work on modern analytical equipment of a modern biological laboratory<br>Owns<br>– modern research methods in ecology and biology | colloquium | |
| 3. | Topic 3. Chromatin structure, molecular mechanisms of DNA replication, repair and recombination | | Knows<br>– structure and functions of biopolymers, their components and complexes, mechanisms for storing, transmitting and implementing genetic information at the molecular level<br>Can<br>– determine the structure and functions of biopolymers, their components and complexes, mechanisms for storing, transmitting and implementing genetic information at the molecular level<br>Owns<br>– a method for determining the structure and functions of biopolymers, their components and complexes, mechanisms for storing, transmitting and implementing genetic information at the | test | |

| | | | | | |
|---|---|---|---|---|---|
| | | genomes, conducts structural and functional analysis of individual proteins and the proteome as a whole.<br>PP-4.1 Conducts substantiation of scientific research in molecular and cellular biology in order to develop the scientific potential of the Russian Far East and the development of the resources of the World Ocean.<br>PP-4.2 Performs applied and exploratory research and development in molecular and cellular biology aimed at developing the scientific potential of the Russian Far East and the development of the resources of the World Ocean.<br>PC-5.1 Studies the relationship between cells, tissues and functional systems of organisms.<br>PC-5.2 Investigates the relationship between cells, tissues and functional systems of organisms.<br>PC-5.3 Conducts a systematic analysis of the relationship between cells, tissues and functional systems of organisms. | molecular level | | |
| 4. | Topic 4. Transcription. Regulation of gene expression | | Knows<br>– processes of replication, transcription, translation, recombination, repair, processing of RNA and proteins, protein folding and docking<br>Can<br>– describe in detail and characterize the main processes occurring in a living cell<br>Owns<br>– methods of identification of the main processes occurring in the cell | test | |
| 5. | Topic 5. Genetic code. Translation engine | | Knows<br>– structure and function of genes and genomes<br>Can<br>– analyze the structure and function of genes and genomes<br>Owns<br>– skills of structural and functional analysis of individual proteins and the proteome as a whole | test | |
| 6. | Topic 6. Cytoskeleton | | Knows<br>– the current situation of development of the scientific potential of the Russian Far East and the development of the resources of the World Ocean<br>Can<br>– to characterize the achievements of modern science in the field of molecular and cell biology in order to develop the scientific potential of the Russian Far East and the development of the resources of the World Ocean<br>Owns<br>– the ability to substantiate scientific research in molecular and cell biology | colloquium | |

| | | | | | |
|---|---|---|---|---|---|
| 7. | Topic 7. Intercellular communications, signaling pathways, control of cell reproduction and differentiation | | Knows<br>– fundamental scientific research and developments in the field of molecular and cell biology aimed at developing the scientific potential of the Russian Far East and the development of the resources of the World Ocean<br>Can<br>– perform applied and exploratory research and development in molecular and cell biology<br>Owns<br>– skills in the use of applied and exploratory scientific research and development in molecular and cellular biology aimed at developing the scientific potential of the Russian Far East and the development of the resources of the World Ocean | | |
| | | | Knows<br>– molecular, immunological and physiological aspects of the study of cells of multicellular, small cell and unicellular organisms<br>Can<br>– to conduct andinvestigate the adaptation of tissue elements to the action of various biological, physical, chemical and other factors<br>Owns<br>– skills with theanalysisof the relationship between cells, tissues and functional systems of organisms – representatives of all kingdoms | test | |
| | | | Knows<br>– molecular, immunological and physiological aspects of the study of cells of multicellular, small cell and unicellular organisms<br>Can<br>– to conduct andinvestigate the adaptation of tissue elements to the action of various biological, physical, chemical and other factors<br>Owns<br>– skills with theanalysisof the relationship between cells, tissues and functional systems of organisms – representatives of all kingdoms | test | |

| | | | | | |
|---|---|---|---|---|---|
| | | | Knows<br>– a method of conducting a systematic analysis of the relationship between cells, tissues and functional systems of organisms<br>Can<br>– to conduct a systematic analysis of the relationship between cells, tissues and functional systems of organisms<br>Owns<br>– a method of conducting an analysis of the relationship between cells, tissues and functional systems of organisms | colloquium | |

## VII. LIST OF REFERENCES AND INFORMATION AND METHODOLOGICAL SUPPORT OF THE DISCIPLINE

Main literature


1. Alekseev, V.I. Applied molecular biology: a textbook for universities / V.I. Alekseev, V.A. Kaminsky. – Vladivostok: Dalrybvtuz, 2011. – 238 p. http://lib.dvfu.ru:8080/lib/item?id=chamo:425474&theme=FEFU

2. Andrusenko, S.F. Biochemistry and molecular biology [Electronic resource]: uchebno-metodicheskoe posobie / Andrusenko S.F., Denisova E.V. – Electron. text data. – Stavropol: North Caucasus Federal University, 2015. – 94 p. – Access mode: http://www.iprbookshop.ru/63077.html . – EBS «IPRbooks»

3. Jaxon, M.B. Molecular and cellular biophysics. – M.: Mir; BINOMIAL. Laboratory of Knowledge, 2009. – 551 p. http://lib.dvfu.ru:8080/lib/item?id=chamo:277656&theme=FEFU

4. Molecular Biology of the Cell [in 3 vols.]: vol. 1 / Bruce Alberts, Alexander Johnson, Julian Lewis et al.; with the tasks of J. S. Wilson, T. Hunt; trans. with English by A. A. Svetlova, O. V. Karlova. – Moscow, Izhevsk: Institute of Computer Research: Regular and Chaotic Dynamics, 2013. p. 773. http://lib.dvfu.ru:8080/lib/item?id=chamo:772792&theme=FEFU

5. Molecular Biology of the Cell [in 3 vols.]: vol. 2 / Bruce Alberts, Alexander Johnson, Julian Lewis et al.; with the tasks of J. S. Wilson, T. Hunt; trans. with English by A. A. Svetlova, O. V. Karlova. – Moscow, Izhevsk: Computer Research Institute: Regular and Chaotic Dynamics, 2013. p.775-1736. http://lib.dvfu.ru:8080/lib/item?id=chamo:772794&theme=FEFU

6. Molecular Biology of the Cell [in 3 vol.]: vol. 3 / Bruce Alberts, Alexander Johnson, Julian Lewis et al.; with the tasks of J. S. Wilson, T. Hunt; trans. with English by A.A. Svetlova, O.V. Karlova. – Moscow, Izhevsk: Institute of Computer Research: Regular and Chaotic Dynamics, pp. 1737-2764. []http://lib.dvfu.ru:8080/lib/item?id=chamo:772786&theme=FEFU

7. Molecular Biology: A Textbook / V.V. Ivanishchev. – M.: RIOR: INFRA-M, 2018. – 225 p. http://znanium.com/catalog/product/916275

8. Spirin, A.S. Molecular Biology. Ribosomes and protein biosynthesis: a textbook for universities on biological specialties / A.S. Spirin. – Moscow: Akademiya, 2011. – 496 p. http://lib.dvfu.ru:8080/lib/item?id=chamo:669007&theme=FEFU

9. Steminskaya, N.S. Tsitologiya [Elektronnyi resurs]: uchebnik / N.S. Stokinskaya. –Electron. text data. – M.: Prometheus, 2012. – 238 c. http://www.iprbookshop.ru/18637.html

Further reading

1. Brown, T.A. Genoms / Terry A. Brown, trans. with A.A. Svetlova; ed. by A.A. Mironov. – Moscow: Publishing House of the Institute of Computer Research, 2011. – 921 p. http://lib.dvfu.ru:8080/lib/item?id=chamo:660961&theme=FEFU

2. Genes and genomes in 2 vols.: vol. 1 / M. Singer, P. Berg; ed. by N. K. Yankovsky; trans. with English T. S. Ilyina, Y. M. Romanova. – Moscow: Mir, 1998. – 373 c. http://lib.dvfu.ru:8080/lib/item?id=chamo:23576&theme=FEFU

3. Histology, embryology, cytology: a textbook for higher professional education / Yu.I. Afanasyev, N.A. Yurina, B.V. Aleshin et al.] ed. by Yu.I. Afanasyev, N.A. Yurina. – Moscow: GEOTAR-Media, 2013. – 798 p. [http://lib.dvfu.ru:8080/lib/item?id=chamo:695450&theme=FEFU

4. Zhimulev, I.F. General and molecular genetics: a textbook. / I.F. Zhimulev – Novosibirsk: Sibirskoe universitetskoe izd-vo, 2006. – 479 c. http://lib.dvfu.ru:8080/lib/item?id=chamo:349217&theme=FEFU

5. Zengbush, P. Molecular and Cellular Biology: in 3 vols. Vol.2 / P. Zengbush; per. s nem. G. I. Loydina.– Moscow: Mir, 1982. – 438 c. http://lib.dvfu.ru:8080/lib/item?id=chamo:3337&theme=FEFU

6. Zengbush, P. Molecular and Cellular Biology: in 3 vols. Vol.3 / P. Zengbush; trans. with German. L.V. Alekseeva. – Moscow: Mir, 1982. – 344 c. http://lib.dvfu.ru:8080/lib/item?id=chamo:46167&theme=FEFU

7. Sengbusch, Peter. Molecular and Cellular Biology: in 3 vols. Vol.1 / P. Zengbush; trans. with German. L.V. Alekseeva, L.S. Shlyakhtenko. – Moscow: Mir, 1982. – 367 c. http://lib.dvfu.ru:8080/lib/item?id=chamo:3337&theme=FEFU

8. Konichev, A.S. Molecular biology: a textbook for universities. / A.S. Konichev, G.A. Sevastyanova. – Moscow: Akademiya , 2005. – 397 p. http://lib.dvfu.ru:8080/lib/item?id=chamo:290949&theme=FEFU

9. Lenindzher, A. Biochemistry. Molecular bases of cell structure and functions: trans. with English / A. Leninger. – Moscow: Mir, 1974. – 957 c. http://lib.dvfu.ru:8080/lib/item?id=chamo:57029&theme=FEFU

10. Lewin B. Genes / B. Lewin; trans. from the English by A.L. Gunzburg. [etc.]. – Moscow: Mir, 1987. – 544 c. http://lib.dvfu.ru:8080/lib/item?id=chamo:54059&theme=FEFU

11. Molecular biology [Elektronnyi resurs]: uchebnoe posobie / O.V. Kriger [i dr.]. –Electron. dan. – Kemerovo: KemGU, 2017. – 93 p. https://e.lanbook.com/book/103922

12. Osnovy kelatskoi biologii [Elektronnyi resurs]: uchebnoe posobie / N.G. Paleev, I.I. Besschetnovred. T.P. Shkurat. –Electron. text data. – Rostov-on-Don:

Southern Federal University, 2011. – 246 c. http://www.iprbookshop.ru/47054.html

13. Polevoy, V.V. Living state of the cell and biology of aging / V.V. Polevoy, T.S. Salamatova. – SPb: Izd-vo Sankt-Peterburgskogo universiteta, 2004. – 134 p. http://lib.dvfu.ru:8080/lib/item?id=chamo:235720&theme=FEFU

14. Regenerative potential of mesenchymal stem cells / B.V. Popov. – St. Petersburg: Medkniga «ELBI», 2015. – 287 p. http://lib.dvfu.ru:8080/lib/item?id=chamo:803153&theme=FEFU

15. Spirin, A.S. Molecular biology: structure and biosynthesis of nucleic acids: a textbook for biological specialties of universities / V.I. Agol, A.A. Bogdanov, V.A. Gvozdev [et al.]; ed. by A.S. Spirin. – Moscow: Vysshaya shkola, 1990. – 352 c. http://lib.dvfu.ru:8080/lib/item?id=chamo:106918&theme=FEFU

16. Stepanov V.M. Molecular Biology. Structure and function of proteins: Ucheb. for biol. Special. vuzov / Pod red. A.S. Spirina. M.: Vyssh. Shk., 1996. – 335 p. http://lib.dvfu.ru:8080/lib/item?id=chamo:20639&theme=FEFU

17. Stepanov V.M. Molecular Biology. Structure and function of proteins [Electronic resource]: uchebnik/ Stepanov V.M. – Electron. text data. – M.: Moskovskiy gosudarstvennyi universitet imeni M.V. Lomonosova, 2005. – 336 p. – Access mode: http://www.iprbookshop.ru/13144.html . – EBS «IPRbooks»

List of resources of the information and telecommunication network "Internet"

1. http://elementy.ru/ – scientific electronic library
2. http://zhelezyaka.com/
3. http://science.km.ru/ - electronic resource on different sections of biology
4. http://molbiol.ru/ - Electronic Resource on Molecular Biology
5. http://humbio.ru/humbio/cytology/00000d33.htm
6. http://biology-of-cell.narod.ru/
7. http://webembryo.narod.ru/cel_biol.htm
8. http://tsitologiya.ru/
9. http://www.ncbi.nlm.nih.gov/sites/entrez?db=books

List of information technologies and software

1. Microsoft Office Professional Plus 2010.

2. An office suite that includes software for working with various types of documents (texts, spreadsheets, databases, etc.).

3. 7Zip 9.20 is a free file archiver with a high degree of data compression.

4. ABBYY FineReader 11 – software for optical character recognition.

5. Adobe Acrobat XI Pro – a software package for creating and viewing electronic publications in PDF format.

6. ESET Endpoint Security – comprehensive protection for Windows-based workstations. Virtualization support + new technologies.

7. WinDjView 2.0.2 – a software to recognize and view the files with the same format DJV and DjVu.

8. Auslogics Disk Defrag – a software to optimize the PC and fine-tune the operating system.

## VIII.METHODICAL INSTRUCTIONS FOR MASTERING THE DISCIPLINE

In the process of studying the discipline "Molecular Biology of the Cell" , a variety of methods and means of mastering the educational content are offered: lectures, seminars-colloquia, testing, independent work of students.

**The lecture** is the main active form of classroom classes, explanations of the fundamental theoretical sections, which involves intensive mental activity of the student. The lecture is cognitive, developmental, educational and organizing in nature. The lecture notes help to assimilate the theoretical material of the discipline. When listening to the lecture, it is necessary to note its rubrication, terminology, keywords, definitions, formulas, graphic schemes.

When working at home with lecture notes, it is necessary to use the main textbook and additional literature that are recommended for this discipline.

When presenting a lecture course, the following are used as forms of interactive learning: lecture-conversation, lecture-visualization, which are built on the basis of previous knowledge, including related disciplines. Presentations, an interactive whiteboard, tables, and diagrams are used to illustrate. In the course of the presentation of the lecture material, problematic and provoking questions are raised, elements of discussion are included.

**Lecture-visualization.** The lecture is accompanied by a computer presentation with basic texts (headings, formulations, keywords and terms), illustrations of microscopic and ultramicroscopic images of cells, drawing diagrams and writing formulas on an interactive whiteboard, visual tables and slides are demonstrated, which contributes to a better perception of the material presented.

**Lecture-conversation** - "dialogue with the audience" - is a common form of interactive learning and allows you to involve students in the educational process, as it creates direct contact of the teacher with the audience. Students are asked questions of a problematic, provoking or informational nature. Students themselves

can also ask questions. Any of the students can offer his answer, another can supplement it. This form of lecture allows you to involve all students in the work, activate their attention, thinking, gain collective experience, learn to formulate questions.

**Seminar-colloquium.** Colloquium is a collective form of consideration and consolidation of educational material. Colloquiums are one of the types of practical classes designed for in-depth study of the discipline, are held in an interactive mode. In classes on the topic of the colloquium, issues are analyzed, together with the teacher, their discussion is held, which is aimed at consolidating the material, forming the skills to conduct polemics, developing independence and critical thinking, the ability of students to discuss them. navigate in large information flows, develop and defend their own position on problematic issues of the academic discipline.

As methods of interactive learning at colloquia, the following are used: a detailed conversation, discussion, press conference.

**A detailed conversation** involves the preparation of students for each issue of the lesson plan with a single list of recommended mandatory and additional literature for all. Reports are prepared by students on a pre-proposed topic.

**Discussion** in a group has a number of advantages. Discussion can be caused by the teacher during the lesson or planned in advance by him.

**Control tests.** Blank or computer testing is used in the mode of selecting the correct answers, establishing the correspondence of concepts, marking details on diagrams, etc.

**Methodical instructions for working with literature**

An initial list of sources should be compiled. The basis may be the list of references recommended in the work program of the course. For the convenience of work, you can make your own file cabinet of selected sources (surname of the authors, title, characteristics of the publication) in the form of a working file in the computer. Such a file cabinet has an advantage, because it allows you to add sources, replace one with another if necessary, the Initial list of references can be supplemented using the electronic catalog of the FEFU library.

Working with literature on a particular topic, it is necessary not only to read, but also to learn the method of its study: make a brief summary, an algorithm, a scheme of the material read, which allows you to quickly understand it, remember it. It is not recommended to rewrite the text verbatim.

## IX. MATERIAL AND TECHNICAL SUPPORT OF DISCIPLINE

Training sessions on the discipline are held in rooms equipped with appropriate equipment and software.

The list of material and technical and software of the discipline is given in the table.

### Logistics and Software Discipline

| Name of special premises and premises for independent work | Equipment special premises and rooms for independent work | List of licensed software. Details of the supporting document |
|---|---|---|
| Laboratory auditorium equipped with a multimedia complex Vladivostok, Russky Island, Ajax village, 10, aud. M420, area 74,6 m² | Screen with electric drive 236 * 147 cm Trim Screen Line; Projector DLP, 3000 ANSI Lm, WXGA 1280x800, 2000:1 EW330U Mitsubishi; Subsystem of specialized fasteners of equipment CORSA-2007 Tuarex; Video switching subsystem: DVI DXP 44 DVI Pro Extron matrix switch; DVI twisted pair extender DVI 201 Tx/Rx Extron; Subsystem of audio switching and sound amplification; acoustic system for ceiling mounting SI 3CT LP Extron; digital audio processor DMP 44 LC Extron; extension for IPL T CR48 control controller<br>Aqua distiller PE-2205 (5l/h); Analytical scales Acculab ATL-2200d2-I; Laboratory scale Vibra SJ-6200CE (LSE=6200 g/0,1 g); Moisture meter AGS100; Dual-beam spectrophotometer UV-1800 manufactured by Shimadzu; Rotary evaporator Hei-VAP Advantage ML/G3B; Magnetic stirrer PE-6100 (10 pcs); Magnetic stirrer PE-6110 M with heating (5pcs); Electric heating tiles; Infrared spectrophotometer IRAffinity-1S with Fourier; Form for the formation of suppositories for 100 cells; Pharmaceutical refrigerator; Liquid chromatograph LC-20 Prominence with spectrophotometric and refractometric detector; Laboratory centrifuge PE-6926 with a rotor of 10×5 ml, a set of automatic dosers Ecochem, a set of porcelain mortars, manual machines for packing capsules in size "0", "00", "1". | - |
| Reading rooms of the FEFU Scientific Library with open access to the fund (building A – level 10) | HP All-in-One 400 All-in-One 19,5 (1600x900), Core i3-4150T, 4GB DDR3-1600 (1x4GB), 1TB HDD 7200 SATA, DVD+/-RW,GigEth,Wi-Fi,WT,usb kbd/mse,Win7Pro (64-bit)+Win8.1Pro(64-bit),1-1-1 Wty Internet access speed 500 Mbps. Workplaces for people with disabilities are equipped with Braille displays and printers; equipped with: portable | - |

| | | |
|---|---|---|
| | devices for reading flat-printed texts, scanning and reading machines video magnifier with the ability to regulate color spectra; magnifying electronic magnifiers and ultrasonic markers | |
| Laboratory auditorium Vladivostok, Russky Island, Ajax village, 10, aud. L406, area 30 m² | Aqua distiller PE-2205 (5l/h); mixer; Laboratory scale AGN100; Magnetic stirrer PE-6100 (5 pcs); Magnetic stirrer PE-6110 M with heating (2 pcs); Electric heating tiles; a set of laboratory utensils, a set of porcelain mortars with pistils. | - |

# X. VALUATION FUNDS

| Code and name of the competency achievement indicator | Name of the assessment indicator (the result of training in the discipline) |
|---|---|
| PC-2.1 Develops rules and algorithms for the design, implementation of laboratory biological and environmental research. | Knows<br>– methodological foundations of design, implementation of field and laboratory biological, environmental studies<br>Can<br>– develop rules and algorithms for designing, performing laboratory biological and environmental studies<br>Owns<br>– skills in developing and improving new rules and algorithms for designing, performing laboratory biological and environmental studies |
| PC-2.2 Performs laboratory biological, environmental research using the scientific methodological foundations of fundamental research. | Knows<br>– modern classification of methods of scientific research, specifics and boundaries of their applicability;<br>– the specifics of research characteristic of various environmental disciplines, the main classes of models that are a reflection of real systems - objects of environmental research;<br>– the main methods of statistical analysis: correlation, regression and variance<br>Can<br>– use the methods of statistical analysis to assess the reliability of data, compare empirical and theoretical systems, find the relationship between the variables that characterize the state of the system<br>Owns<br>– the ability to independently analyze the available information, identify fundamental problems, set the task |
| PK-2.3 Applies the methodological foundations of design, laboratory biological, environmental research, uses modern equipment and computing complexes in molecular and cellular biology. | Knows<br>– the main modern field and laboratory methods of biology and ecology research<br>Can<br>– work on modern analytical equipment of a modern biological laboratory<br>Owns<br>– modern research methods in ecology and biology |
| PC-3.1 Studies the structure and functions of biopolymers, their components and complexes, mechanisms of storage, transmission and implementation of genetic information at the molecular level. | Knows<br>– structure and functions of biopolymers, their components and complexes, mechanisms for storing, transmitting and implementing genetic information at the molecular level<br>Can<br>– determine the structure and functions of biopolymers, their |

| | |
|---|---|
| | components and complexes, mechanisms for storing, transmitting and implementing genetic information at the molecular level<br>Owns<br>– a method for determining the structure and functions of biopolymers, their components and complexes, mechanisms for storing, transmitting and implementing genetic information at the molecular level |
| PC-3.2 Detailedly characterizes the main processes occurring in a living cell: the processes of replication, transcription, translation, recombination, repair, processing of RNA and proteins, protein folding and docking. | Knows<br>– processes of replication, transcription, translation, recombination, repair, processing of RNA and proteins, protein folding and docking<br>Can<br>– describe in detail and characterize the main processes occurring in a living cell<br>Owns<br>– methods of identification of the main processes occurring in the cell |
| PC-3.3The study of the main methods of intermolecular interactions and mutual regulation of the processes of functioning of a living cell as part of a multicellular organism. | Knows<br>– basic terms and concepts of molecular biology; objects of study, research methods, modern concepts, achievements and limitations of natural sciences<br>Can<br>– andto use molecular biological knowledge for a deeper understanding of modern problems of biology; to link advances in molecular biology with advances in modern genetics, immunology, genomics, proteomics and medicine<br>Owns<br>– skills in the operation of modern equipment and equipment for research and laboratory work; on the practical application of the issues considered in the course in protein and cell engineering, with use in biomedical research and in biotechnological production |
| PC-3.4 Analyzes the structure and functions of genes and genomes, conducts structural and functional analysis of individual proteins and the proteome as a whole. | Knows<br>– structure and function of genes and genomes<br>Can<br>– analyze the structure and function of genes and genomes<br>Owns<br>– skills of structural and functional analysis of individual proteins and the proteome as a whole |
| PP-4.1 Conducts substantiation of scientific research in molecular and cellular biology in order to develop the scientific potential of the Russian Far East and the development of the resources of the World Ocean. | Knows<br>– the current situation of development of the scientific potential of the Russian Far East and the development of the resources of the World Ocean<br>Can<br>– to characterize the achievements of modern science in the field of molecular and cell biology in order to develop the scientific potential of the Russian Far East and the development of the resources of the World Ocean<br>Owns<br>– the ability to substantiate scientific research in molecular and cell biology |
| PP-4.2 Performs applied and exploratory research and development in molecular and cellular biology aimed at developing the scientific potential of the Russian Far East and | Knows<br>– fundamental scientific research and developments in the field of molecular and cell biology aimed at developing the scientific potential of the Russian Far East and the development of the resources of the World Ocean |

| | |
|---|---|
| the development of the resources of the World Ocean. | Can<br>– perform applied and exploratory research and development in molecular and cell biology<br>Owns<br>– skills in the use of applied and exploratory scientific research and development in molecular and cellular biology aimed at developing the scientific potential of the Russian Far East and the development of the resources of the World Ocean |
| PP-4.3 Interprets the results of scientific research in molecular and cellular biology aimed at developing the scientific potential of the Russian Far East and the development of the resources of the World Ocean. | Knows<br>– scientific research in molecular and cell biology, aimed atdeveloping the scientific potential of the Russian Far East and the development of the resources of the World Ocean<br>Can<br>– interpret the results of scientific research in molecular and cellular biology aimed at developing the scientific potential of the Russian Far East and the development of the resources of the World Ocean<br>Owns<br>– skills in analyzing the resultsof scientific research in molecular and cellular biology aimed at developing the scientific potential of the Russian Far East and the development of the resources of the World Ocean |
| PC-5.1 Studies the relationship between cells, tissues and functional systems of organisms. | Knows<br>– molecular, immunological and physiological aspects of the study of cells of multicellular, small cell and unicellular organisms<br>Can<br>– to conduct andinvestigate the adaptation of tissue elements to the action of various biological, physical, chemical and other factors<br>Owns<br>– skills with theanalysisof the relationship between cells, tissues and functional systems of organisms – representatives of all kingdoms |
| PC-5.2 Investigates the relationship between cells, tissues and functional systems of organisms. | Knows<br>– molecular, immunological and physiological aspects of the study of cells of multicellular, small cell and unicellular organisms<br>Can<br>– to conduct andinvestigate the adaptation of tissue elements to the action of various biological, physical, chemical and other factors<br>Owns<br>– skills with theanalysisof the relationship between cells, tissues and functional systems of organisms – representatives of all kingdoms |
| PC-5.3 Conducts a systematic analysis of the relationship between cells, tissues and functional systems of organisms. | Knows<br>– a method of conducting a systematic analysis of the relationship between cells, tissues and functional systems of organisms<br>Can<br>– to conduct a systematic analysis of the relationship between cells, tissues and functional systems of organisms<br>Owns<br>– a method of conducting an analysis of the relationship between cells, tissues and functional systems of organisms |

| No p/n | Supervised sections / topics of the discipline | Achievement indicator code and name | Learning outcomes | Assessment tools | |
|---|---|---|---|---|---|
| | | | | current control | Intermediate-accurate certification |
| 1. | Topic 1. Structural hierarchy and molecular organization of the cell. Prokaryote and eukaryotic cells | PC-2.1 Develops rules and algorithms for the design, implementation of laboratory biological and environmental research.<br>PK-2.3 Applies the methodological foundations of design, laboratory biological, environmental research, uses modern equipment and computing complexes in molecular and cellular biology.<br>PC-3.1 Studies the structure and functions of biopolymers, their components and complexes, mechanisms of storage, transmission and implementation of genetic information at the molecular level.<br>PC-3.2 Detailedly characterizes the main processes occurring in a living cell: the processes of replication, transcription, translation, recombination, repair, processing of RNA and proteins, protein folding and docking.<br>PC-3.4 Analyzes the structure and functions of genes and genomes, conducts structural and functional analysis of individual proteins and the proteome as a whole. | Knows<br>– methodological foundations of design, implementation of field and laboratory biological, environmental studies<br>Can<br>– develop rules and algorithms for designing, performing laboratory biological and environmental studies<br>Owns<br>– skills in developing and improving new rules and algorithms for designing, performing laboratory biological and environmental studies | test | Exam Questions |
| 2. | Topic 2. Structure and molecular dynamics of cell membranes | | Knows<br>– the main modern field and laboratory methods of biology and ecology research<br>Can<br>– work on modern analytical equipment of a modern biological laboratory<br>Owns<br>– modern research methods in ecology and biology | colloquium | |
| 3. | Topic 3. Chromatin structure, molecular mechanisms of DNA replication, repair and recombination | | Knows<br>– structure and functions of biopolymers, their components and complexes, mechanisms for storing, transmitting and implementing genetic information at the molecular level<br>Can<br>– determine the structure and functions of biopolymers, their components and complexes, mechanisms for storing, transmitting and implementing genetic information at the molecular level<br>Owns<br>– a method for determining the structure and functions of biopolymers, their components and complexes, mechanisms for storing, transmitting and implementing genetic information at the molecular level | test | |

| | | | | | |
|---|---|---|---|---|---|
| 4. | Topic 4. Transcription. Regulation of gene expression | PP-4.1 Conducts substantiation of scientific research in molecular and cellular biology in order to develop the scientific potential of the Russian Far East and the development of the resources of the World Ocean.<br>PP-4.2 Performs applied and exploratory research and development in molecular and cellular biology aimed at developing the scientific potential of the Russian Far East and the development of the resources of the World Ocean.<br>PC-5.1 Studies the relationship between cells, tissues and functional systems of organisms.<br>PC-5.2 Investigates the relationship between cells, tissues and functional systems of organisms.<br>PC-5.3 Conducts a systematic analysis of the relationship between cells, tissues and functional systems of organisms. | Knows<br>– processes of replication, transcription, translation, recombination, repair, processing of RNA and proteins, protein folding and docking<br>Can<br>– describe in detail and characterize the main processes occurring in a living cell<br>Owns<br>– methods of identification of the main processes occurring in the cell | test | |
| 5. | Topic 5. Genetic code. Translation engine | | Knows<br>– structure and function of genes and genomes<br>Can<br>– analyze the structure and function of genes and genomes<br>Owns<br>– skills of structural and functional analysis of individual proteins and the proteome as a whole | test | |
| 6. | Topic 6. Cytoskeleton | | Knows<br>– the current situation of development of the scientific potential of the Russian Far East and the development of the resources of the World Ocean<br>Can<br>– to characterize the achievements of modern science in the field of molecular and cell biology in order to develop the scientific potential of the Russian Far East and the development of the resources of the World Ocean<br>Owns<br>– the ability to substantiate scientific research in molecular and cell biology | colloquium | |
| 7. | Topic 7. Intercellular communications, signaling pathways, control of cell reproduction and differentiation | | Knows<br>– fundamental scientific research and developments in the field of molecular and cell biology aimed at developing the scientific potential of the Russian Far East and the development of the resources of the World Ocean<br>Can<br>– perform applied and exploratory research and development in molecular and cell biology | | |

| | | | | | |
|---|---|---|---|---|---|
| | | | Owns<br>– skills in the use of applied and exploratory scientific research and development in molecular and cellular biology aimed at developing the scientific potential of the Russian Far East and the development of the resources of the World Ocean | | |
| | | | Knows<br>– molecular, immunological and physiological aspects of the study of cells of multicellular, small cell and unicellular organisms<br>Can<br>– to conduct andinvestigate the adaptation of tissue elements to the action of various biological, physical, chemical and other factors<br>Owns<br>– skills with theanalysisof the relationship between cells, tissues and functional systems of organisms – representatives of all kingdoms | test | |
| | | | Knows<br>– molecular, immunological and physiological aspects of the study of cells of multicellular, small cell and unicellular organisms<br>Can<br>– to conduct andinvestigate the adaptation of tissue elements to the action of various biological, physical, chemical and other factors<br>Owns<br>– skills with theanalysisof the relationship between cells, tissues and functional systems of organisms – representatives of all kingdoms | test | |
| | | | Knows<br>– a method of conducting a systematic analysis of the relationship between cells, tissues and functional systems of organisms<br>Can<br>– to conduct a systematic analysis of the relationship between cells, tissues and functional systems of organisms<br>Owns<br>– a method of conducting an analysis of the relationship between cells, tissues and functional systems of organisms | colloquium | |

The following assessment tools are used for discipline:

1. Seminar-Colloquium
2. Testing

**A seminar-colloquium** can serve as a form not only of testing, but also of increasing the knowledge of students. At colloquia, all or individual topics, issues of the course being studied can be discussed.

The evaluation criteria for speeches (reports) at colloquia are the same as for oral response.

## Topics and questions of seminars-colloquia

### Topic 1. Structural hierarchy and molecular organization of the cell.

– To give a comparative characteristic of the cells of prokaryotes and eukaryotes: structural plan, compartmentalization, evolutionary dynamics.

– Explain the molecular structure and dynamics of proteins.

– Explain the molecular organization of nucleic acids.

– Molecular types of lipids and their role in the organization of cell membranes.

– To characterize the structure and properties of glycopolymers.

### Topic 2.3. Structure and molecular dynamics of cell membranes.

– Organization of biological membranes.

– Transport functions of membranes.

– Horizontal heterogeneity and vertical asymmetry of membranes.

– Proteins that are part of biological membranes. Classification of membrane proteins by position relative to the lipid bilayer. Methods of fixation of proteins in the membrane.

– Carbohydrate-containing biopolymers (glycoconjugates) in the composition of membranes: glycoproteins and proteoglycans, glycolipids. The main classes of glycosaminoglycans in the body. Functions of carbohydrate-containing polypeptides and proteins in the body. Structure and function of glycolipids.

– Types of intercellular contacts (isolating - dense compounds; anchoring - adhesive contacts, desmosomes, focal contacts and semidesmosomes; communication - slotted contacts).

### Topic 4, 5, 6. Chromatin structure, molecular mechanisms of DNA replication, repair and recombination.

– Structure and classification of chromosomes. Euchromatin and heterochromatin. Coding and non-coding DNA.

– Major DNA-binding proteins and their role in the organization of the three-dimensional structure of chromatin. Histone proteins. Non-hystone chromatin proteins. Chromosomal territories and the nuclear matrix.

– Functional aspects of the structural organization of chromatin. Modifications of histones and their role in the functional activity of chromatin.

– General principles of DNA replication. The structure of the replication fork, the main participants in the replication process.

– DNA polymerases of prokaryotes and eukaryotes: organization and features of functioning. 5'→3'- and 3'→5'- exonuclease activity of DNA polymerases. Nick-broadcast, polIE structure. coli, the Klenov fragment model, and the principle of autocorrection of replication errors. Processivity of DNA polymerases. The role of the PCNA protein and the β subunit of DNA polymerase III (PolIII) in ensuring the processivity of the enzymatic replication complex.

– Primers, primemaz activity of replication enzymes, features of replication initiation.

– The principle of polymerase chain reaction (PCR) and its significance for molecular biology. Thermostable DNA polymerases. Stages of the PCR cycle, PCR events occurring on different cycles. Varieties of PCR.

– Spatio-temporal organization of replication events. Leading and lagging chains, okazaki fragments. Directions of replication and implementation of replication difficulties in the spatial organization of the replication "machine".

– Features of mitochondrial DNA replication. Sites began replicating the leading and lagging chains, the D-loop.

– Features of telomeric DNA replication. Structure and functioning of telomerases, telomerase RNA, the principle of reverse transcription in the work of telomerase. L. Hayflick's limit and telomerase activity. Debatable questions about the role of telomerases in ensuring the "immortality of cells".

– DNA damage and DNA repair mechanisms. The base removal mechanism and the nucleotide removal mechanism are the main repair pathways. Glycosilases and AP-endonucleases. DNA polymerases that provide DNA repair. Alternative mechanisms of direct chemical transformation of damaged DNA.

– General recombination of DNA is the recombination of homologous DNA (general recombination, homologous recombination). The role of total recombination in DNA repair. Meiotic recombination.

– Mobile genetic elements, transposition and site-specific recombination. DNA transposons. Retrotransposons: retroviral and nonretroviral type. The functioning of mammalian retrotransposons on the example of the L1 retrotransposon. Conservative site-specific recombination and bacteriophage λ.

**Topic 7, 8, 9. Transcription. Regulation of gene expression.**

– The Central Dogma of Molecular Biology. The concept of transcription. Gene, structural organization of the gene, transcribed and non-transcribed regions, discontinuous gene structure (exons, introns). The role of promoters and consensus sequences in the transcription initiation mechanism.

– RNA polymerases of prokaryotes and eukaryotes: structural and functional features. The participation of transcription factors (TF) in the mechanism of transcription initiation, the role of TFIID and σ - a subunit of prokaryote RNA polymerase in the formation of the initiator complex. Participation of elongation factors in the provision of transcription. Transcription termination.

– Post-transcriptional changes in eukaryotic mRNA: capping, splicing, polyadenylation. Alternative splicing.

– The effect of the position of genes. Inactivation of the X chromosome of mammals.

– The main levels of regulation of gene activity. Acetylation of histones.

– The main levels of regulation of gene activity. DNA methylation, varieties.

– The main levels of regulation of gene activity. Post-transcriptional level of regulation.

– Regulation of gene activity by transcription activators.

**Topic 10, 11, 12. Genetic code. Translation mechanism.**

– Discovery, decoding and properties of the genetic code.

– Adaptor hypothesis of the implementation of the genetic code. Structure and properties of transport RNAs (tRNAs): acceptor peduncle, dihydrouridin, pseudouridin and anticodone loops, variable handle, inosine and its role in codon recognition, primary, secondary and tertiary structure of tRNA.

– Aminoacylation ofRNA, aminoacyl-tRNA synthetase, selectivity and accuracy of translation.

– Organization and assembly of ribosomes of prokaryotes and eukaryotes. Synthesis and processing of ribosomal RNAs (rRNA). Ribosome proteins. Sites of the active center of ribosomes: mRNA-binding site, A-, P-, E-sites.

– Stages of translation: initiation, elongation, termination. The mechanism of formation of the initiator complex, factors of initiation of prokaryote translation (IF). Eukaryote initiation factors. Elongation factors (EF), termination factors (RF). Participation of GTF in the broadcast.

– Post-translational modifications of proteins, control of the functional activity of proteins using post-translational processing.

**Topic 13, 14, 15. Cytoskeleton: Architecture, Transport and Molecular Dynamics.**

– The main fibrillar structures of the cytoskeleton, their molecular composition and tissue specificity.

– Classification, structure and properties of molecular motors. Properties of myosins, dynein and kinesin as the main molecular motors of the cell.

– Mechanochemical conjugation and actin-activated ATPase activity of myosin.

– Actin-linked regulation of muscle work on the example of the cycle of skeletal striated muscles of mammals. The role of Ca2+ and the troponin complex in triggering the reduction.

– Myosin-related regulation of muscle work on the example of the cycle of smooth muscle in mammals. The role of Ca2+, calmodulin and its kinase in the mechanism of contraction. Actin-mediated regulation of mammalian smooth muscle. The functioning of specialized smooth muscles of animals with a state of locking tone (catchstate).

**Topic 16, 17, 18. Intercellular communications, signaling pathways, control of cell reproduction and differentiation.**

– The concept of communication between cells. Communicative processes of bacteria and yeast. The types and nature of the signals perceived by the cell. The concepts of a signal-feeding cell and a target cell. The concepts of ligand and receptor. Principles of intracellular signal transmission mechanisms (secondary messengers and effector molecules). Types of effector molecules and possible signaling results.

– General classification of signaling pathways depending on the distance of the ligand from the cell secreting the signaling molecule. Contact-dependent signaling. Behavioral reactions of cells in the microenvironment of signaling molecules. Signaling molecules as morphogens.

**Testing.**

Testing is the most effective and objective form of assessing knowledge, skills and abilities, which allows to identify not only the level of educational achievements, but also the structure of knowledge, the degree of its deviation from the norm. Testing involves a standardized, verified procedure for collecting and processing data, as well as their interpretation, allows you to check the knowledge of students on a wide range of issues. Testing excludes the subjectivity of the teacher, both in the process of control and in the process of assessment.

**Test 1**

**Topic: "Structure, properties and functions of proteins"**

1) Compare the solubility of the three pentapeptides at pH =7. Arrange them in order of increasing hydrophilic properties:

1) ley – fen – ile – gli – shaft;

2) glu – asp – ser – fen – ile.

3) arg – liz – tre – gis – cis.

2) Arrange the elements of the structure of the protein molecule in the sequence in which they arise during protein synthesis and the formation of its native conformation.

1. Combining protomers into an oligomeric protein.

2. Formation of α spirals and β-folded areas.

3. Formation of peptide bonds.

4. Formation of hydrophobic, hydrogen and ionic bonds between amino acid radicals.

3) Write the structural formula of the pentapeptide of the following structure:

Gis – Glu – Pro – Fen – Ser.

4) The interaction of subunits in an oligomeric protein and proteins with ligands is due to .....

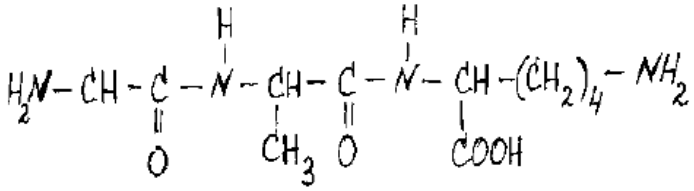
5) Amino acids serine, tyrosine and threonine, according to the classification by the chemical nature of the radical, belong to the ..... amino acids and in the formation of the tertiary structure can form ..... ..... communication.

6) Aspartic and glutamine amino acids, according to the classification by the chemical nature of the radical, belong to the ..... amino acids and in the formation of the tertiary structure can form ..... bonds with radicals of the following amino acids.....

7) The separation of proteins by electrophoresis is based on their difference in .....

8) The hemodialysis method is based on the separation of high-molecular compounds from low molecular weight impurities using .....

9) Name this tripeptide:



10) What properties of the protein are due to the presence of carboxy- and amino groups in their structure?

1. hydrophilicity and aggregate instability;
2. thermolability and solubility;
3. Ability to electrophoresis and precipitation reactions;
4. Amphotericity and electrophoresis ability.

11) To study the primary structure of the protein, the following method is used:

1. Chromatography;
2. X-ray diffraction analysis;
3. determination of the coefficient of translational friction;
4. Determination of characteristic viscosity.

12) What is the peculiarity of acidic proteins?

1. predominance of dicarboxylic amino acids;
2. equal ratio of diamin- and dicarboxylic amino acids;
3. predominance of diaminomonocarboxylic acids;
4. The protein consists of monoamine and monocarboxylic acids.

13) Proteins are characterized by:

1. amphoteric properties;
2. lack of specific molecular organization;
3. preservation of the structure of the molecule during boiling;
4. inability to crystallize.

14) Secondary structure is:

1. Alpha helix, beta folding and amorphous areas
2. polypeptide chain configuration;
3. protomer formation;
4. The way several protomers interact in space.

15) The tertiary structure of the protein is the highest stage of organization for:

1. oligomeric proteins;
2. monomeric proteins;
3. Domain proteins.

16) Connections that stabilize the α spiral:

1. hydrogen;
2. hydrophobic;
3. peptide;
4. Ionic

17) The Quaternary structure is:

1. Spatial stacking of the protomer;
2. spatial stacking of several protomers;
3. α spiral and β structure;

4. formation of domains.

18) The isoelectric point of hemoglobin is 6.8. Where does this protein migrate in an environment with a pH = 3.0 during electrophoresis?

1. migrates to the cathode;
2. remains on the start line;
3. forms a bipolar ion;
4. Migrates to the anode.

## Test 2.
## Theme: "The Central Dogma of Molecular Biology. Structure and functions of the cell nucleus"

Choose one correct answer:

1. A participant in what process is DNA:

(a) Replication only;
b) replication and translation;
c) translations and transcriptions;
d) transcriptions only;
e) transcription and replication;
(e) Broadcasts only.

2. At what level of DNA compactification is transcription possible:

(a) Chromosomal;
b) nucleosomal;
c) on uncompacted DNA;
d) chromomeric;
e) nucleomeric.

3. The translation process occurs:

(a) In the nucleus on chromatin filaments;
b) in the cytoplasm on the ribosomes;
c) on the plasmalemma in the receptors;
d) in chromosomes during cell division.

4. Which molecule is engaged in the direct translation of the language of nucleotides into the language of amino acids:

(a) DNA;
b) t-RNA;
c) protein;
d) r-RNA;
e) iRNA.

5. The molecular basis of the genotype is:

(a) DNA;
b) protein;
c) RNA;
d) glucose aminoglycans.
Choose all the correct answers:
6. Isolate the components of the DNA nucleotide:
(a) Deoxyribose:
b) glucose;
c) guanosine;
d) phosphoric acid;
e) ribose;
(e) Glutamate;
g) nitrogenous base.
7. Mark the properly formed complementary pairs of DNA nucleotides:
(a) C-D;
b) U-A;
c) A-D;
d) A-T;
e) U-C
8. What components are necessarily necessary for transcription:
(a) Ribosome;
b) DNA;
c) DNA polymerase;
d) glucose;
e) RNA polymerase;
(e) Ribonucleotides;
g) deoxyribonucleotides.
Establish a match:
9. Establish a correspondence between the level of compactification of DNA and the corresponding proteins:

| Level of DNA compactification | Protein involved in organizing this level of compactification |
|---|---|
| 1. Chromonem | (a) Histone H1 |
| 2. Nucleosomal | b) histone H3 |
| 3. Nuclear | c) matrixins |
| | d) histone H4 |

10. Establish a correspondence between the type of nucleic acid and its characteristic:

| Nucleic acid type: | Characteristics of nucleic acid: |
|---|---|
| 1. DNA | (a) Generally single-chain |

| | |
|---|---|
| 2. RNA | b) the following nitrogenous bases are found in the composition of nucleotides: A, T, G, C |
| | c) the composition of the nucleotide includes ribose |
| | d) usually double-stranded |
| | e) occurs only in bacteria |

**Test Evaluation Criteria**

| evaluation | 50-60 points (unsatisfactory) | 61-75 points (satisfactory) | 76-85 points (good) | 86-100 points (excellent) |
|---|---|---|---|---|

**Methodological recommendations that determine the procedures for assessing the results of mastering the discipline**

**Assessment tools for intermediate attestation**

Intermediate certification of students in the discipline is carried out in accordance with local fefu regulations and is mandatory. The form of reporting on the discipline is an exam.

**Methodical instructions for passing the exam**

The exam is taken by the leading teacher (associate professor, professor), for whom this type of educational load is assigned in an individual plan. The form of the exam is oral.

The time allowed to the student to prepare for the answer to the exam should be no more than 40 minutes. After this time, the student should be ready to respond.

The presence at the examination of unauthorized persons (except for persons carrying out the inspection) without the permission of the relevant persons (rector or vice-rector for academic affairs, director of the School, head of the OBOR or director of the department) is not allowed. Disabled persons and persons with disabilities who do not have the opportunity to move independently are allowed to take the exam with accompanying persons.

With an intermediate assessment, students are given a grade of "excellent", "good", "satisfactory" or "unsatisfactory". If the student does not appear for the exam, an entry "did not appear" is made in the statement.

**Exam Questions**

1. To give a comparative characteristic of the cells of prokaryotes and eukaryotes: structural plan, compartmentalization, evolutionary dynamics.

2. Molecular structure and dynamics of proteins.

3. Molecular types of lipids and their role in the organization of cell membranes. Transport functions of membranes.

4. Proteins that are part of biological membranes. Classification of membrane proteins by position relative to the lipid bilayer. Methods of fixation of proteins in the membrane.

5. Carbohydrate-containing biopolymers (glycoconjugates) in the composition of membranes: glycoproteins and proteoglycans, glycolipids. The main classes of glycosaminoglycans in the body. Functions of carbohydrate-containing polypeptides and proteins in the body. Structure and function of glycolipids.

6. Types of intercellular contacts (isolating - dense compounds; anchoring - adhesive contacts, desmosomes, focal contacts and semidesmosomes; communication - slotted contacts).

7. Structure and classification of chromosomes. Euchromatin and heterochromatin. Coding and non-coding DNA.

8. Major DNA-binding proteins and their role in the organization of the three-dimensional structure of chromatin. Histone proteins. Non-hystone chromatin proteins. Chromosomal territories and the nuclear matrix.

9. Functional aspects of the structural organization of chromatin. Modifications of histones and their role in the functional activity of chromatin.

10. General principles of DNA replication. The structure of the replication fork, the main participants in the replication process. DNA polymerases of prokaryotes and eukaryotes. Primers, primemaz activity of replication enzymes, features of replication initiation.

11. Features of mitochondrial DNA replication. Sites began replicating the leading and lagging chains, the D-loop.

12. Features of telomeric DNA replication. Structure and functioning of telomerases. L. Hayflick's limit and telomerase activity.

13. DNA damage and repair mechanisms.

14. Total DNA recombination is the recombination of homologous DNA. The role of total recombination in DNA repair. Meiotic recombination.

15. Mobile genetic elements, transposition and site-specific recombination. DNA transposons. Retrotransposons of retroviral and nonretroviral type.

16. The Central Dogma of Molecular Biology. The concept of transcription. The structural organization of the gene, transcribed and non-transcribed regions, the discontinuous structure of the gene. The role of promoters and consensus sequences in the transcription initiation mechanism.

17. RNA polymerases of prokaryotes and eukaryotes: structural and functional features. Participation of transcription factors (TF) in the mechanism of transcription initiation. Participation of elongation factors in providing transcription. Termination of transcription.

18. Post-transcriptional changes in eukaryotic mRNA: capping, splicing, polyadenylation. Alternative splicing.

19. The main levels of regulation of gene activity. Acetylation of histones. DNA methylation, varieties.. Post-transcriptional level of regulation. Regulation of gene activity by transcription activators.

20. Discovery, decoding and properties of the genetic code. Adaptor hypothesis of the implementation of the genetic code.

21. Structure and properties of transport RNAs (tRNAs): acceptor peduncle, dihydrouridin, pseudouridin and anticodone loops, variable handle, inosine and its role in codon recognition, primary, secondary and tertiary structure of tRNA.

22. Aminoacylation of tRNA, aminoacyl-tRNA synthetase, selectivity and accuracy of translation.

23. Organization and assembly of ribosomes of prokaryotes and eukaryotes. Synthesis and processing of ribosomal RNAs (rRNA). Ribosome proteins. Sites of the active center of ribosomes.

24. Stages of translation: initiation, elongation, termination. The mechanism of formation of the initiator complex, factors of initiation of translation of prokaryotes and eukaryotes. Factors of elongation and termination. Participation of GTF in the broadcast.

25. Post-translational modifications of proteins, control of the functional activity of proteins using post-translational processing.

26. Cytoskeleton: Architecture, Transport and Molecular Dynamics. Classification, structure and properties of molecular motors.

27. Actin-linked regulation of the work of striated and smooth muscles of mammals. The role of Ca2+, troponin complex, calmodulin and its kinase in the mechanism of contraction. Actin-mediated regulation of mammalian smooth muscle.

28. Mechanisms of communication between cells. The types and nature of the signals perceived by the cell. The concepts of a signal-feeding cell and a target cell.

29. The concepts of ligand and receptor. Principles of intracellular signal transmission mechanisms (secondary messengers and effector molecules). Types of effector molecules and possible signaling results.

30. Classification of signaling pathways depending on the distance of the ligand from the cell secreting the signaling molecule. Contact-dependent signaling.

Behavioral reactions of cells in the microenvironment of signaling molecules. Signaling molecules as morphogens.

## Criteria for grading a student on the exam

| Evaluation of the test | Requirements for the formed competencies |
|---|---|
| "Excellent" | The "excellent" grade is given to the student if he has deeply and firmly mastered the program material, exhaustively, consistently, clearly and logically coherently presents it, is able to closely link the theory with practice, freely copes with tasks, questions and other types of application of knowledge, and does not find it difficult to answer when modifying tasks, uses the material of monographic literature in the answer, correctly justifies the decision made, has versatile skills and techniques implementation of practical tasks on the methodology of scientific research. |
| "Good" | The "good" grade is given to the student if he firmly knows the material, correctly and substantively presents it, avoiding significant inaccuracies in the answer to the question, correctly applies theoretical provisions when solving practical questions and problems, possesses the necessary skills and techniques for their implementation. |
| "satisfactory" | The grade "satisfactory" is given to the student if he has knowledge only of the basic material, but has not mastered its details, admits inaccuracies, insufficiently correct wording, violations of the logical sequence in the presentation of the program material, has difficulties in performing practical work. |
| "unsatisfactory" | The grade "unsatisfactory" is given to a student who does not know a significant part of the program material, makes significant mistakes, uncertainly, with great difficulties performs practical work. As a rule, the grade "unsatisfactory" is given to students who cannot continue their studies without additional classes in the relevant discipline. |