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 Bioengineering
Direction of training 06.04.01 Biology
(Molecular and Cell Biology)
Form of training: full-time

Course 1 semester 2
lectures 18 h.
practical exercises - hour.
lab work 6 hours
total hours of classroom load 36 hours.
independent work 72 hours.
including 27 hours to prepare for the exam.
exam 2 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 Education and Science of Russia dated 11.08.2020 No. 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: Assistant Zhmen V.M.

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:

Organizationof modern ideas about the basic principles and methods of bioengineering, experimental and practical implementation of artificially created biosystems.

Tasks:

1) to consider the current state and prospects for the development of bioengineering;

2) to study the basic principles, methods of bioengineering and ethical problems and issues of biological safety related to this area of research and practical use;

3) teach the ability to independently search and analyze information, use it in the process of scientific and practical activities.

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-7 Is able to develop new drugs, conduct biomedical research using living organisms and biological systems of various levels of organization.	PP-7.1 Provide a rationale for biomedical research to develop medicines using living organisms and biological systems at various levels of organization.
		PP-7.2 Defines the goals and objectives of biomedical drug research and development. Plans biomedical research, carries out the selection of the design of scientific research in accordance with the goals and objectives.
		PP-7.3 Conducts biomedical research using living organisms and biological systems of various levels of organization, analyzes the results obtained.
		PC-7.4Interprets the obtained results of biomedical research and development in order to elucidate the molecular mechanisms of biochemical processes.

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 the basic rules and algorithms for designing, performing laboratory biological, environmental studies. - Able to apply the basic rules and algorithms for designing laboratory biological, environmental studies. - Has the skills to develop rules andalgorithms for laboratory biological and environmental research.
PC-2.2 Performs laboratory biological, environmental research using the scientific methodological foundations of fundamental research.	- Knows the scientific and methodological foundations of fundamental research. - Able to use mathematical and computer tools and methods to analyze the material. - Owns modern methods of computational biology for the correct interpretation of the results of field collections, experiments, etc.
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 the basics of designing, performing laboratory biological, environmental research. - Able to learnthe methodological foundations of design, laboratory biological and environmental research. - Has the skills to use modern equipment and computational complexes in molecular and cell 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 the structure and functions of biopolymers, their components and complexes, mechanisms for storing, transmitting and implementing genetic information at the molecular level. - Able to analyze the structure and functions of biopolymers, their components and complexes. - Vladis skilled in analyzing information about the structure and properties of biopolymers, transmission and reproduction of hereditary information, protein synthesis, regulation of these processes.
PC-3.2 Detailedly characterizes the main processes occurring in a living cell: the processes of replication,	- Knows about thenatural processes occurring in a living cell: the processes of replication, transcription, translation,

transcription, translation, recombination, repair, processing of RNA and proteins, protein folding and docking.	recombination, repair, processing of RNA and proteins, protein folding and docking. - Be able to adaptthe basic processes occurring in a living cell. - Possesses the skills of analyzing the main x processes occurringx in a living 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 the interaction of the self and the mutual regulation of the processes of functioning of a living cell as part of a multicellular organism. - Able to analyze the interaction of the self and the mutual regulation of the processes of functioning of a living cell as part of a multicellular organism. - Has the skills to study the basic processes of intermolecular interactionand regulation of processes in living cells.
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 the structure and function of genes and genomes. - It is able to lick the structure and function of genes and genomes. - Has the skills to conduct structural and functional analysis of individual proteins and the proteome as a whole.
PP-7.1 Provide a rationale for biomedical research to develop medicines using living organisms and biological systems at various levels of organization.	- Knows the basic compositionof drugs (active ingredient), as well as different types of living organisms and biological systems applicable for drug testing. - I know how to conduct biomedical research for the purpose of drug development. - Possesses the skills of the methodology of drug development using living organisms and biological systems of various levels of organization.
PP-7.2 Defines the goals and objectives of biomedical drug research and development. Plans biomedical research, carries out the selection of the design of scientific research in accordance with the goals and objectives.	- Knows about the types of biomedical research. - He is able to limit the goals and objectives, tostudy biomedical research. - Possesses the skills of designing scientific research in accordance with the goals and objectives.
PP-7.3 Conducts biomedical research using living organisms and biological systems of various levels of organization, analyzes the results obtained.	- Knows the types of living organisms and biological systems of various levels of organizations, their application in biomedical research. - Able to analyze the results of biomedical research. - Possesses the skills of conducting biomedical research using living organisms and biological systems of various levels of organization.
PC-7.4Interprets the obtained results of biomedical research and development in order to elucidate the molecular mechanisms of biochemical processes.	- Knows the basic molecular mechanismsof biochemical processes. - Able andinterpret the results of biomedical research and development. - Has the skills to conduct biomedical researchto elucidate the molecular mechanisms of biochemical processes.

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

The total labor intensity of the discipline is 3 credited units (108 academic hours), (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.	
Lab	Labs
Lab 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	Semester	Number of hours by types of training sessions and work of the student						Intermediate attestation forms
			Lek	Lab	Ave	OK	WED	Control	
1.	Section No1 Introduction. History. Types of bioengineering. Objects of bioengineering.	2	1	-	-	-	5		Exam Questions
2.	Section No2 Introduction to Molecular Bioengineering and Molecular Engineering. Methods of bioengineering.	2	3	3	-	-	5		Exam Questions
3.	Section No3 Cell engineering. Application of cell engineering in medicine and science.	2	2	2	-	-	5		Exam Questions
4.	Section No4 Engineering enzymology. The main tasks of enzymology. Application.	2	2	1	-	-	5		Exam Questions
5.	Section No5 Basic principles of tissue engineering.	2	2	4	-	-	5		Exam Questions
6.	Section No6 Bioengineering technologies in medicine.	2	2	2	-	-	5		Exam Questions
7.	Section No7 Genetic engineering. Basic methods of genetic engineering. Gene therapy.	2	2	4	-	-	5	27	Exam Questions
8.	Section No8 Nanotechnology in medicine.	2	2	-	-	-	5		Exam Questions

9.	Section No9 Bioengineering methods of preserving the gene pool of organisms. Ethical Issues in Bioengineering	2	2	2	-	-	5		Exam Questions
	Total:	2	18	18	-	-	45	27	Exam

THE STRUCTURE AND CONTENT OF THE THEORETICAL PART OF THE COURSE

Lectures 18 hours.

Pazdel No1 Introduction. History of origin. Types of bioengineering. Objects of bioengineering.

Modern problems of bioengineering. Definition and tasks of bioengineering. Types of bioengineering. Stages of development. The current stage in the development of bioengineering. Prospects and significance of purposeful change of biological objects. Objects of bioengineering.

Section No. 2 Introduction to Molecular Bioengineering and Molecular Engineering. Methods of bioengineering.

Objects of research of bioengineering of molecules and molecular bioengineering. Basic methods of molecular bioengineering and molecular bioengineering.

Section No3 Cell Engineering. Application of cell engineering in medicine and science.

Methods of cell engineering. Application of cell engineering in medicine and science.

Section No4 Engineering Enzymology. The main tasks of enzymology. Application.

Enzymology. Engineering enzymology. The main tasks of enzymology. Application.

Section No5 Basic principles of tissue engineering.

Principles of Tissue Engineering. Approaches to solving the problems of organ transplantation. Problems and prospects of modern transplantology. Technologies of organ and tissue transplantation. Principles of creation of artificial biocompatible materials. Bioengineering methods in the creation of artificial organs.

Section No6 Bioengineering technologies in medicine.

Reproductive technology of IVF and PE. Therapeutic and reproductive cloning, technological difficulties and limitations. Legislation prohibiting human cloning. Gene cloning. DNA diagnostics. Genetic testing. Genetic diagnosis (determination of predisposition, selection of drug therapy).

Section 7 Genetic Engineering. Basic methods of genetic engineering. Gene therapy.

Gene therapy (treatment of immunodeficiencies, some monogenic diseases, some forms of cancer and AIDS). The main approaches to eliminating gene defects through gene therapy (introduction of a normal copy of the gene, inhibition of excessive gene expression, strengthening the body's immune response). Methods of delivery of a normal gene into the body, vector systems.

Section No8 Nanotechnologies in medicine.

Prospects for implantation of nanodevices into the human body. The use of nanoparticles for the targeted delivery of drugs, heat, light to specific types of cells. Transfection of genes into mutant cells (trachea, bronchi, eye structures) using gelatin nanoparticles. The use of nanorobots in diagnostic operations. Prospects for the integrated application of nano- and bioengineering technologies in cardiology, hematology, traumatology, dentistry and implantology. Nanomaterials in the technology of manufacturing intracardiac and intravascular implants.

Section No. 9 Bioengineering methods of preserving the gene pool of organisms. Ethical issues of bioengineering.

Preservation of the gene pool of organisms (collections and gene banks). Preservation of unique genotypes of plants and producer strains in cell culture. The need for cryopreservation of cell cultures. Factors determining the success of low-temperature cryopreservation. Cryoprotectors. Cooling programs. Fast and slow cooling of cells. Stages of cell cooling. Principles of cell defrosting. Features of defrosting of different cell lines.

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

Laboratory work 18 hours.

Laboratory work No.1 section No.2 "Basic methods of bioengineering. Their application"

- Acquaintance with the main methods of bioengineering and their application in practice.

Laboratory work No2 section No3 "Cell engineering"

- Application of cell engineering methods in practice. (Cell culture and transfer).

Laboratory work No3 section No4 "Engineering enzymology"

- Methods of Engineering Enzymology. Basic methods. Application.

Laboratory work No4–5 section No5 "Tkanevaya engineeringya"

- Methods of tissue engineering. Practical application.

Laboratory work No6section No6 "Bioengineering technologies in medicine"

- Principles of application of bioengineering technologies in medicine.

Laboratory work No7–8 section No7 "Basic methods of genetic engineering"

- Methods of genetic engineering their application (genetic constructions, restriction, ligation, etc.). e.)

Laboratory work No9 section No9 "Bioengineering methods of preserving the gene pool of organisms"

- Freezing and storage of cell lines. Stages. Features of defrosting cell lines.

Independent work

Section 1: "Introduction. History. Types of bioengineering. Objects of bioengineering."

1. Objectives of the lesson: introductory lesson.

2.Objectives of the lesson:

1. Get acquainted with the methodology and organizational provisions of the practical and credit classes.

2. Familiarize yourself with the safety rules for molecular bioengineering.

3. Familiarize yourself with the recommended mandatory and additional literature, the right basis of molecular bioengineering.

4 Learn about the type of bioengineering.

5. To discuss current ideas about the definition and tasks of bioengineering.

6. To study the stages of development of molecular bioengineering.

3. The basic concepts that must be mastered by the masters in the process of studying the topic: bioengineering, molecular bioengineering, cell bioengineering.

4. Questions for the lesson

1. Types of bioengineering.

2.Modern problems and methods of bioengineering.

3.Definition and tasks of bioengineering.

4.Types of bioengineering. Stages of development.

5.The current stage in the development of bioengineering. The main methods of research.

6.Ways to create bioengineering structures.

7.Prospects and significance of targeted changes in biological objects.

5. Questions for self-control.

Master should know: Polymerase chain reaction, types of bioengineering

Section No2. Introduction to Molecular Bioengineering and Molecular Engineering. Bioengineering Methods.

1. Objectives of the lesson: To study the goals, objectives, methods of molecular engineering

2.Objectives of the lesson:

1. To study the basic concepts and sections of molecular bioengineering.

2. The place of genetic engineering in modern biotechnology

3. Molecular Engineering Methods

3. **Basic concepts that must be mastered by masters in the process of studying the topic;** recombinant DNA technology, proteomics technologies, protein and genetic engineering

4.Questions for the lesson

1.Basic concepts of molecular bioengineering.

2.Bioengineering of molecules - protein and genetic engineering.

3.Genetic engineering as an integral part of biotechnology, the main directions and prospects for development.

4. Advantages and differences of gene-5 engineering methods for improving biological objects in comparison with classical methods of mutagenesis and selection.

5. Creation of fundamentally new biological objects by methods of genetic engineering (recombinant DNA technology).

6.The sequence of operations carried out by the genetic engineer.

7.The use of recombinant microorganisms for the production of commercial products (amino acids, vitamins, antibiotics, natural biopolymers). The use of transgenic animals and plants for the production of medicinal and other biologically active substances.

8.Potential hazards when working with recombinant and transgenic organisms. Control of research in the field of genetic engineering.

9.Polymerase chain reaction.

10.The principle of the PCR method.

11.Modern methods of DNA sequencing, approaches to the identification of genes in genomic sequences and the determination of their functions

12.Proteomics and modern problems of protein engineering. Proteomics and DNA array technologies.

13.Hybrid proteins and toxins. Recombinant antibodies and vaccines.

14.Modern approaches to modeling the structure and function of proteins.

15.Diagnostics engineering.

16.Prospects of diagnostics engineering.

17. Enzyme immunoassay. Immunodiagnostics.

18.Metabolomics. Basic concepts, goals and methods of metabolic engineering.

19.Stages and methods of studying metabolism with the aim of its directed modification and further practical use.

20. Fluxomics.

21.Experimental work in metabolic engineering.

5. Questions for self-control.

The Master must know:

Enzyme immunoassay, 5 engineering methods for improving biological objects, proteomics technology

Section3: Cell Engineering: Applications of Cell Engineering in Medicine and Science.

1. Objectives of the lesson: familiarization with cell engineering

2.Objectives of the lesson:

1. Master the basic concepts of cell engineering

2. Get insights into plant cellular engineering

3. To study the features of animal cell culture technology

4. Animal cloning

3. Basic concepts that must be mastered by masters in the process of studying the topic: Cultures of somatic cells, Differentiation of plant cells, Characteristics of primary cultures

5**. Questions for the lesson**

1. The cell is the basis of the life of biological objects.

2.Introduction to Cell Engineering.

3.Goals, objectives, objects of cell engineering.

4.A brief history of the study of cell and tissue culture.

5.Modern methods used in cell engineering.

6.Isolation, separation, fractionation, cultivation (cloning), activation of primary cell cultures.

7.Obtaining and preservation of cell lines, creation of cell banks. Modern tasks and problems of cell engineering.

8.Cellular engineering of plants.

9.Cell cultures of higher plants.

10.Areas of application of plant cell cultures.

11.Immobilization of plant cells.

12.Somatic hybridization based on the fusion of plant protoplasts. The construction of cells by the introduction of various cellular organelles.

13.Genetic transformation at the chromosomal and gene levels.

14.Cultures of somatic cells.

15.Totipotency is the main property underlying the cultivation of plant cells.

16.Requirements of plant cells for cultivation conditions.

17.Callus is the main type of cultured plant cell.

18.Types of callus fabrics.

19.Features of cultivation of callus tissues.

20. Differentiation of plant cells.

21.Suspension culture as a model system.

22.Morphological alignment of cells.

23.Features of growth of suspension cultures.

24.Cultivation of individual cells as a model for the comparative study of physiological processes in tissue and isolated cell.

25.Haploid cell cultures.

26.Methods of obtaining haploids.

27.Distant hybridization as a classical method of obtaining haploid cells. In vitro cultivation from unfertilized germ cells with a reduced set of chromosomes.

28. Digaploids, their production. Advantages of haploids.

29.Culture of plant tissues is a source of secondary metabolites.

30.Immobilized plant cell cultures.

31.Cultivation systems.

32.Advantages of immobilized cells.

33.Protoplasts of plant cells. Methods of obtaining and culturing protoplasts. Methods of fusion of protoplasts.

34.Parasexual hybridization. Hybrids, cybrids, asymmetric hybrids. Plants are regenerated.

35.Clonal micropropagation of plants. The essence and stages of 6 microclonal reproduction.

36.Association of cell culture of a higher plant with a microorganism.

37.Endo and exosymbiotic associations. Objectives of associations. Cultures of animal cells.

59.Features of animal cell culture.

60.Characteristics of primary crops.

61.Passivation - as a method of prolonging the life of cell culture.

62.Transformation into a permanent cell line.

63.Cell culture.

64.Characteristics of cells cultured in vitro.

65.Nutrient media and cultivation conditions.

66.Cell culture systems.

67.Cultures of human fibroblasts.

68.Features of the culture of human fibroblasts.

69.Organ cultivation. Organ culture and its features.

70. Hybridization of animal cells.

71. Discovery of heterocarions.

72.The first interspecific chimeras.

73.Farm chimeric animals.

74.Cell fusion and its stages.

75.Formation of hybridomas, their significance.

76. Monoclonal antibodies. Functional structure of antibodies.

77.Animal cloning. Methods of nuclear transplantation. Mammalian cloning.

78.Modern approaches to the creation and conservation of new breeds of animals. Cultivation of germ cells, in vitro fertilization and embryo transplantation. Regulation of reproduction of farm animals.

6. Questions for self-control

Master's degree should know: Nutrient media and culture conditions**,** Cell culture systems, Cell fusion and its stages.

Section No.4: Engineering Enzymology

1. Objectives of the lesson: To master the basic ideas about the goals and methods of engineering enzymology

2.Objectives of the lesson:

1. Engineering enzymology-determination

2. Basics of enzyme immobilization

3. Material and technical support of engineering enzymology

4. Design and mathematical modeling of biocatalysts

5. Technologies of engineering enzymology

3. Basic concepts that should be mastered by students in the process of studying the topic: Extremozyms, thermozymes, bioluminescent microanalysis,

4. Questions for the lesson.

79.Fundamental and applied aspects of engineering enzymology. Connection with other disciplines. The main directions of development. Sources of enzymes.

80.Extremisms, thermozymes, basic functioning and use in biotechnology. Immobilization of enzymes.

81.Commercial preparations of immobilized enzymes and their use. Enzyme microcalorimetric sensors.

82.Enzyme electrodes and bioluminescent microanalysis.

83.Use of enzymes to create bioelectrochemical energy converters.

84.Prospects for the use of bioelectrocatalysis.

85.Enzymes in the pharmaceutical industry.

86.Preparation of 6-aminopenicillonic acid by penicillinamidase. Technological scheme of production.

87.Enzymes in the food industry.

88.Preparation of glucose-fructose syrups by glucose isomerase.

89. Technological scheme of production.

90.Use in the food industry of proteinases, amylases, lipases, pectinases, β-galactosidase, cellulase.

91.Enzymes as components of detergents.

92.Enzymatic modification of nucleic acids, synthesis of oligo- and polynucleotides. Enzymatic synthesis of sugars.

93.Design of biocatalysts and their use in biotechnology.

94.Methods and concepts for the creation of enzymes with specified properties.

95.Modeling and construction of 3D structures of enzymes and active sites. Construction of artificial polyenzyme systems.

96.Computer visualization of the spatial structure of enzymes.

97.Catalytic antibodies (abzymes).

98.Similarities and differences between abzymes and enzymes.

99.Methods of obtaining abzymes and their practical significance. Enzymatic activity of RNA.

100.Methods for the selection of ribozymes with the required properties.

101.Use of ribozymes for mRNA repair.

102. Deoxyribozymes.

6. Questions for self-control

Master must know: abzymas, ribozymes, deoxyribozymes

Section No.5: Basic Principles of Tissue Engineering

1. **Objectives of the lesson:** Study of the main stages of life periods and the mechanism of human embryogenesis.

2.Objectives of the lesson:

1. The biological meaning of meiosis.

2. To study the features of progenesis and the mechanism of fertilization

3. Features of the structure of the egg and the mechanism of crushing.

3. The basic concepts that must be mastered by the masters in the process of studying the topic: organoids, embryoids, graft.

4. Questions for the lesson.

1.Principles of tissue engineering.

2.Approaches in solving the problems of organ transplantation.

3.Problems and prospects of modern transplantology.

4.Organ and tissue transplantation technologies.

5.Principles of creation of artificial biocompatible materials.

6.Bioengineering methods in the creation of artificial organs.

7.Growing organs to compensate for reduced or lost physiological functions.

8.Artificial organs.

9.Development of artificial joints, bioengineered skin prostheses, renal dialysis, artificial circulation devices.

5. **Questions for self-control**

Master should know**:** immune complex of histocompatibility, immunological tolerance, artificial circulation apparatus, hemodialysis.

Section No6: Bioengineering technologies in medicine.

1. Objectives of the lesson: Study of the application of bioengineering technologies in medicine

2.Objectives of the lesson:

1. Goals and objectives of molecular medical bioengineering

2. The main directions of molecular medical bioengineering

3. Basic concepts that must be mastered by masters in the process of studying the topic: cloning, reproductive medicine, genetic testing

4. Questions for the lesson

1.Reproductive technology of IVF and PE.

2.Therapeutic and reproductive cloning, technological difficulties and limitations.

3.Legislation prohibiting human cloning.

4.Gene cloning.

5.DNA diagnostics.

6.Genetic testing.

7. Genetic diagnosis (determination of predisposition, selection of drug therapy).

8.Selection of individual norms and methods of treatment, taking into account the genetic profile of the patient.

9.Identification of individual exposure to occupational and environmental risk factors.

5. Questions for self-control

Master must know: Legislation prohibiting human cloning

Section 7: Genetic Engineering. Basic Methods of Genetic Engineering. Gene Therapy.

1. Objectives of the lesson: Master the characteristics

2.Objectives of the lesson:

1. Gene therapy of infectious diseases

2. The principle of operation of vector systems

3. Treatment of hereditary diseases

3. The basic concepts that must be mastered by the masters in the process of studying the topic: a normal copy of the gene, the transfer of the nucleus of the donor myoblast into the myofibril

4. Questions for the lesson:

1.Gene therapy (treatment of immunodeficiencies, some monogenic diseases, some forms of cancer and AIDS).

2.The main approaches to the elimination of gene defects through gene therapy (introduction of a normal copy of the gene, inhibition of excessive gene expression, strengthening the body's immune response).

3.Methods of delivery of a normal gene to the body, vector systems. The method of chimeroplasty and specific activation of normal genes - mutant homologues. The method of transferring the nucleus of the donor's myoblast into the myofibril of the patient with a defect in the dystrophin gene.

4. Bioethical problems of gene therapy.

5. Questions for self-control

Master must know: Bioethical problems of gene therapy

Section No8: Nanotechnologies in medicine.

1. Objectives of the lesson: To study the main nanotechnologies in modern medicine

2.Objectives of the lesson:

1. Features of molecular machines

2. Prospects for the application of nanotechnology in medicine

3.Basic concepts that must be mastered by masters in the process of studying the topic: nanoparticles for targeted drug delivery, nanorobots, molecular machines

Questions to the topic.

1.Prospects for implantation of nanodevices in the human body.

2.The use of nanoparticles for the targeted delivery of drugs, heat, light to specific cell types.

3. Transfection of genes into mutant cells (trachea, bronchi, eye structures) using gelatin nanoparticles.

4.The use of nanorobots in diagnostic operations.

5.Prospects for the integrated application of nano- and bioengineering technologies in cardiology, hematology, traumatology, dentistry and implantology. Nanomaterials in the technology of manufacturing intracardiac and intravascular implants.

6.Nanobiotechnology to create new classes of blood substitutes, devoid of defects in donor blood.

7.Methods of bone tissue regeneration based on the use of nanomaterials. Issues of safety of nanomaterials and nanotechnology for human health. Legal aspects of nanomaterials testing.

4. Questions for self-control.

Master should know: Nanomaterials, legal aspects of nanomaterial testing, gene transfection.

Section No. 9: Bioengineering methods of preserving the gene pool of organisms.

1. Objectives of the lesson: Basic concepts and goals of preserving the gene pool of organisms

2.Objectives of the lesson:

1. The main directions of ways to preserve the gene pool of organisms

2. Cryobiology of cells

3.Basic concepts that must be mastered by masters in the process of studying the topic: collections and gene banks, cryopreservation

4. Questions to the topic.

1. Preservation of the gene pool of organisms (collections and gene banks).

2.Preservation of unique genotypes of plants and producer strains in cell culture. The need for cryopreservation of cell cultures.

3.Factors determining the success of low-temperature cryopreservation.

4.Cryoprotectors.

5.Cooling programs.

6.Fast and slow cooling of cells.

7.Stages of cell cooling.

8.Principles of cell defrosting.

9.Features of cryopreservation of cell lines.

10. Cryopreservation of germ cells and embryos.

11. Cryopreservation of seeds.

5.Questions for self-control.

Master should know: Cryoprotectors, etaps of cell cooling.

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.	Section No1 Introduction. History. Types of bioengineering. Objects of bioengineering.	PC-2.1; PC-2.2; PC-2.3	- Knows the basic rules and algorithms for designing, performing laboratory biological, environmental studies. - Able to apply the basic rules and algorithms for designing laboratory biological, environmental studies. - Has the skills to develop rules andalgorithms for laboratory biological and environmental research. - Knowsthe scientific and methodological foundations of fundamental research. - Able to use mathematical and computer tools and methods to analyze the material. - Owns modern methods of computational biology for the correct interpretation of the results of field collections, experiments, etc. - Knows the basics of designing, performing laboratory biological, environmental research. - Able to learnthe methodological foundations of design, laboratory biological and environmental research. - Has the skills to use modern equipment and computational	Oral questioning	Exam

			complexes in molecular and cell biology.		
2.	Section No2 Introduction to Molecular Bioengineering and Molecular Engineering. Methods of bioengineering.	PC-2.1; PC-2.2; PC-2.3	- Knows the basic rules and algorithms for designing, performing laboratory biological, environmental studies. - Able to apply the basic rules and algorithms for designing laboratory biological, environmental studies. - Has the skills to develop rules andalgorithms for laboratory biological and environmental research. - Knowsthe scientific and methodological foundations of fundamental research. - Able to use mathematical and computer tools and methods to analyze the material. - Owns modern methods of computational biology for the correct interpretation of the results of field collections, experiments, etc. - Knows the basics of designing, performing laboratory biological, environmental research. - Able to learnthe methodological foundations of design, laboratory biological and	Test	Exam

			environmental research. - Has the skills to use modern equipment and computational complexes in molecular and cell biology.		
3.	Section No3 Cell engineering. Application of cell engineering in medicine and science.	PC-3.1; PC-3.2; PC-3.3; PC-3.4	- Knows the structure and functions of biopolymers, their components and complexes, mechanisms for storing, transmitting and implementing genetic information at the molecular level. - Able to analyze the structure and functions of biopolymers, their components and complexes. - Has the skills to analyze information about the structure and properties of biopolymers, the transfer and reproduction of hereditary information, protein synthesis, regulation of these processes. - Knows 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. - Able to characterize the main processes occurring in a living cell.	Oral questioning	Exam

			- Has the skills to analyze the basic processes occurring in a living cell. - Knows the intermolecular interactions and mutual regulation of the processes of functioning of a living cell as part of a multicellular organism. - Able to analyze intermolecular interactions and mutual regulation of the processes of functioning of a living cell as part of a multicellular organism. - Has the skills to study the basic processes of intermolecular interaction and regulation of processes in living cells. - Knows the structure and function of genes and genomes. - Able to analyze the structure and function of genes and genomes. - Has the skills to conduct structural and functional analysis of individual proteins and the proteome as a whole.		
4.	Section No4 Engineering enzymology. The main tasks of enzymology. Application.	PC-3.1; PC-3.2; PC-3.3; PC-3.4	- Knows the structure and functions of biopolymers, their components and complexes, mechanisms for storing, transmitting and implementing genetic information	Oral questioning	Exam

			at the molecular level. - Able to analyze the structure and functions of biopolymers, their components and complexes. - Has the skills to analyze information about the structure and properties of biopolymers, the transfer and reproduction of hereditary information, protein synthesis, regulation of these processes. - Knows 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. - Able to characterize the main processes occurring in a living cell. - Has the skills to analyze the basic processes occurring in a living cell. - Knows the intermolecular interactions and mutual regulation of the processes of functioning of a living cell as part of a multicellular organism. - Able to analyze intermolecular interactions and mutual regulation of the processes of functioning of a living cell as part of		

			a multicellular organism. - Has the skills to study the basic processes of intermolecular interaction and regulation of processes in living cells. - Knows the structure and function of genes and genomes. - Able to analyze the structure and function of genes and genomes. - Has the skills to conduct structural and functional analysis of individual proteins and the proteome as a whole.		
5.	Section No5 Basic principles of tissue engineering.	PC-7.1; PC-7.2; PC-7.3; PC-7.4	- Knows the types of living organisms and biological systems of various levels of organizations, their application in biomedical research. - Able to analyze the results of biomedical research. - Possesses the skills of conducting biomedical research using living organisms and biological systems of various levels of organization.	Test	Exam
6.	Section No6 Bioengineering technologies in medicine.	PC-7.1; PC-7.2; PC-7.3; PC-7.4	- Knows the basic molecular mechanismsof biochemical processes. - Able andinterpret the results of biomedical research and development. - Has the skills to conduct biomedical researchto elucidate the molecular	Oral questioning	Exam

			mechanisms of biochemical processes.		
7.	Section No7 Genetic engineering. Basic methods of genetic engineering. Gene therapy.	PC-3.1; PC-3.2; PC-3.3; PC-3.4	- Knows the structure and function of genes and genomes. - Able to analyze the structure and function of genes and genomes. - Has the skills to conduct structural and functional analysis of individual proteins and the proteome as a whole.	Oral questioning	Exam
8.	Section No8 Nanotechnology in medicine.	PC-7.1; PC-7.2; PC-7.3; PC-7.4	- Knows the types of living organisms and biological systems of various levels of organizations, their application in biomedical research. - Able to analyze the results of biomedical research. - Possesses the skills of conducting biomedical research using living organisms and biological systems of various levels of organization.	Test	Exam
9.	Section No9 Bioengineering methods of preserving the gene pool of organisms. Ethical Issues in Bioengineering	PC-7.1; PC-7.2; PC-7.3; PC-7.4	- Knows the basic molecular mechanismsof biochemical processes. - Able andinterpret the results of biomedical research and development. - Has the skills to conduct biomedical researchto elucidate the molecular mechanisms of biochemical processes. - Knows the types of living organisms and biological systems of various levels of organizations, their	Oral questioning	Exam

			application in biomedical research. - Able to analyze the results of biomedical research. - Possesses the skills of conducting biomedical research using living organisms and biological systems of various levels of organization.		

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

Main literature

1. Ivanishchev, V. V. Molecular biology : textbook / V.V. Ivanishchev. — Moscow : RIOR : INFRA-M, 2019. – (Higher education). — 225 p. — DOI: https://doi.org/10.12737/1731-9. - ISBN 978-5-369-01731-9. - Text : electronic. - URL: https://znanium.com/catalog/product/1019421

2. Myandina, G. I. Osnovy molecular'noi biologii : uchebnoe posobie / G. I. Myandina. — Moscow : Russian University of Friendship of Peoples, 2011. — 156 c. — ISBN 978-5-209-03956-3. — Text : electronic // Digital educational resource IPR SMART : [site]. — URL: https://www.iprbookshop.ru/11572.html

3. Andrusenko, S. F. Biochemistry and molecular biology : educational and methodical manual / S. F. Andrusenko, E. V. Denisova. — Stavropol ' Severo-Kavkazskii federal'nyi universitet, 2015. — 94 p. — Text : elektronnyi // Fillektsi obrazovatel'nyi resurs IPR SMART : [site]. — URL: https://www.iprbookshop.ru/63077.html

4. Yakupov, T. R. Molecular biotechnology / T. R. Yakupov, T. Kh. Faizov. — Kazan : Kazan State Academy of Veterinary Medicine named after N.E. Bauman, 2018. — 279 p. — Text : elektronnyi // Fillektsi obrazovatel'nyi resurs IPR SMART : [site]. — URL: https://www.iprbookshop.ru/104846.html

5. Satkeeva, A. B. Molecular biotechnology : uchebnoe posobie / A. B. Satkeeva, K. A. Sidorova. — Tyumen : State Agrarian University of the Northern Trans-Urals, 2020. — 116 p. — Text : electronic // Digital educational resource IPR SMART : [site]. — URL: https://www.iprbookshop.ru/107596.html

6. Prikhodko, N. A. Osnovy bioinzhenerie : uchebno-metodicheskoe posobie / N. A. Prikhodko, A. M. Yesimova, Zh. K. Nadarova. — Almaty : Nur-Print, 2014. — 146 c. — ISBN 9965-894-20-5. — Text : electronic // Digital educational resource IPR SMART : [site]. — URL: https://www.iprbookshop.ru/69157.html

7. Subbotina, T. N. Molecular biology and gennaya engineering : practicum / T. N. Subbotina, P. A. Nikolaeva, A. E. Kharesekina. - Krasnoyarsk : Sib. feder. un-t, 2018. - 60 p. - ISBN 978-5-7638-3857-2. - Text : electronic. - URL: https://znanium.com/catalog/product/1032111

Further reading

1. Abramova Z.I. Introduction to genetic engineering.Textbook for independent work of students.Kazan. KFU. -2008. .

2. Vechkanov E. M., Sorokina I. A. Osnovy kelskoi engineeringii: Uchebnoe posobie. Rostov-on-Don. 2012. .

3. Glick B., J.Pasternak. Molecular biotechnology. Principles and applications. Moscow "Mir". 2002.

4. Tikhonov I.V. Biotechnology. St. Petersburg. 2005..

5. Shevelukha V.S. Agricultural biotechnology.Moscow, 2003.

6. Shchelkunov S.N. Geneticheskaya engineering. Novosibirsk. 2004.

7. Glick B., Pasternak D. Molecular biotechnology. Principles and application. – M.: Mir, 2002.

8. Biotechnology. Ucheb. Posobie dlya vuzov. V 8 kn. / Pod red. N.S. Egorova, V.D. Samuilova. Kn.7: Immobilized ferments / I.V. Berezin, N.L. Klyachkr, A.V. Levashev et al. – M.: Vyssh. shk., 1987.

9. Martinovich G.G., Sazanov L.A., Cherenkovich S.N. Cellular bioenergetics: Physico-chemical and molecular foundations: Uchebnoe posobie. M.: LENAND, 2017.

10. Facci P. Biomolecular Electronics. – Publishing, Oxford, 2014.

11. Biotechnology. Ucheb. Posobie dlya vuzov. V 8 kn. / Pod red. N.S. Egorova, V.D. Samuilova. Kn.8: Inzhenernaya enzymologiya / I.V. Berezin, A.A. Klesov, V.K. Shvyados et al. – M.: Vyssh. shk., 1987.

12. Biotechnology. Ucheb. Posobie dlya vuzov. V 8 kn. / Pod red. N.S. Egorova, V.D. Samuilova. Kn.3: Kletochnaya engineering / R.G. Butenko, M.V. Gusev, A.F. Kirkin et al. – M.: Vyssh. shk., 1987.

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

1. http://www.elibrary.ru/defaultx.asp - Scientific Electronic Library, the largest
2. Russian information portal in the field of science, technology, medicine and education;
3. www.ncbi.nlm.nih.gov/PubMed - Free access to the largest database of scientific data in the field of biomedical sciences MedLine;

4. www.molbiol.ru - Textbooks, scientific monographs, reviews, laboratory workshops in free access on the website of practical molecular biology;
5. onlinehttp://www.rcsb.org/pdb/ - Protein 3D Structure database (PDB)
6. http://gmo.ru/ genetically modified organisms
7. http://www.dmb.biophys.msu.ru - Information System "Dynamic Models in Biology";
8. http://www.6years.net/index.php - a portal of free medical information, contains a large number of books, textbooks of biochemical orientation
9. http://e.lanbook.com/ -Lan Publishing House Electronic Library System
10. http://www.rucont.ru/ Rukont Electronic Library
11. EBS "Ibooks". http://ibooks.ru access address
12. EBS "Yurait". Access address: http://biblio.ru/

List of information technologies and software)

1. - Microsoft Office Professional Plus 2010; office suite, including software for working with various types of documents (texts, spreadsheets, databases, etc.);
2. - 7Zip 9.20 – free file archiver with a high degree of data compression;
3. - ABBYY FineReader 11 – software for optical character recognition;
4. - Adobe Acrobat XI Pro – a software package for creating and viewing electronic publications in PDF format;
5. - Mega is an integrated tool for automatic and manual alignment of sequences, construction of phylogenetic trees.

VIII.METHODICAL INSTRUCTIONS FOR MASTERING THE DISCIPLINE

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 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 the basic rules and algorithms for designing, performing laboratory biological, environmental studies. - Able to apply the basic rules and algorithms for designing laboratory biological, environmental studies. - Has the skills to develop rules andalgorithms for laboratory biological and environmental research.
PC-2.2 Performs laboratory biological, environmental research using the scientific methodological foundations of fundamental research.	- Knows the scientific and methodological foundations of fundamental research. - Able to use mathematical and computer tools and methods to analyze the material. - Owns modern methods of computational biology for the correct interpretation of the results of field collections, experiments, etc.
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 the basics of designing, performing laboratory biological, environmental research. - Able to learnthe methodological foundations of design, laboratory biological and environmental research. - Has the skills to use modern equipment and computational complexes in molecular and cell biology.
PC-3.1 Studies the structure and functions of biopolymers, their components and complexes, mechanisms of storage, transmission	- Knows the structure and functions of biopolymers, their components and complexes, mechanisms for storing, transmitting and implementing genetic information at the molecular level.

and implementation of genetic information at the molecular level.	- Able to analyze the structure and functions of biopolymers, their components and complexes. - Vladis skilled in analyzing information about the structure and properties of biopolymers, transmission and reproduction of hereditary information, protein synthesis, regulation of these processes.
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 about thenatural processes occurring in a living cell: the processes of replication, transcription, translation, recombination, repair, processing of RNA and proteins, protein folding and docking. - Be able to adaptthe basic processes occurring in a living cell. - Possesses the skills of analyzing the main x processes occurringx in a living 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 the interaction of the self and the mutual regulation of the processes of functioning of a living cell as part of a multicellular organism. - Able to analyze the interaction of the self and the mutual regulation of the processes of functioning of a living cell as part of a multicellular organism. - Has the skills to study the basic processes of intermolecular interactionand regulation of processes in living cells.
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 the structure and function of genes and genomes. - It is able to lick the structure and function of genes and genomes. - Has the skills to conduct structural and functional analysis of individual proteins and the proteome as a whole.
PP-7.1 Provide a rationale for biomedical research to develop medicines using living organisms and biological systems at various levels of organization.	- Knows the basic composition of drugs (active ingredient), as well as different types of living organisms and biological systems applicable for drug testing. - I know how to conduct biomedical research for the purpose of drug development. - Possesses the skills of the methodology of drug development using living organisms and biological systems of various levels of organization.
PP-7.2 Defines the goals and objectives of biomedical drug research and development. Plans biomedical research, carries out the selection of the design of scientific research in accordance with the goals and objectives.	- Knows about the types of biomedical research. - He is able to limit the goals and objectives, tostudy biomedical research. - Possesses the skills of designing scientific research in accordance with the goals and objectives.
PP-7.3 Conducts biomedical research using living organisms and biological systems of various levels of organization, analyzes the results obtained.	- Knows the types of living organisms and biological systems of various levels of organizations, their application in biomedical research. - Able to analyze the results of biomedical research. - Possesses the skills of conducting biomedical research using living organisms and biological systems of various levels of organization.
PC-7.4Interprets the obtained results of biomedical research and development in order to elucidate the molecular mechanisms of biochemical processes.	- Knows the basic molecular mechanismsof biochemical processes. - Able andinterpret the results of biomedical research and development. - Has the skills to conduct biomedical researchto elucidate the molecular mechanisms of biochemical processes.

The following assessment tools are used for discipline:

1. Poll
2. Testing

Oral questioning.

Oral questioning allows you to assess the knowledge and logic of the student, the ability to use terminology, speech skills and other communication skills.

The training function is to identify details that for some reason were not sufficiently understood during the training sessions and in preparation for the test.

A survey is a means of control, organized as a special conversation of the teacher with the student on topics related to the discipline being studied, and designed to clarify the amount of knowledge of the student on a certain section, topic, problem, etc.

1. Analyze the significance and prospects for the development of bioengineering in Russia
2. Areas of application of bioengineering in various sectors of the economy.
3. Methods for studying the structure and functions of genes
4. Diagnostics engineering using atomic force microscopy
5. Immunodiagnostics.
6. Scheme of the experiment and problems of molecular bioengineering
7. Characterization of industrial processes using immobilized enzymes.
8. Methods of obtaining transgenic plant vaccines
9. Features of manipulation with animal embryos of monoclonoal antibodies.
11. Features of the use of cytoplasts and karyoplasts in bioengineering
12. Animal cloning.
13. Plant cell cultures
14. Cryopreservation of cell cultures.
15. General characteristics and directions of development of biocatalysis in organic synthesis
16. Immobilized enzymes as medicines
17. Enzyme microcalorimetric sensors – characteristics, directions of use
18. Bioluminescent microanalysis.
19. Biosensors
20. Classic experiments of Hayflick and Moorhead.
21. Construction of plant cells.
22. Somatic hybridization of animal cells
23. Modeling and construction of 3D structures of enzymes and active sites
24. Mechanisms of cell fusion and unification of their genomes

25. Principles of creation of artificial biocompatible materials.

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.

Examples of test tasks

1. To obtain recombinant DNA, plasmids are isolated from E. coli and part of the circular DNA molecule is removed from them using enzymes:

(a) Restriction; b) polymerase; c) ligas; d) reverse transcriptase

2. What enzymatic activities allow DNA polymerase I from E. coli to play an active role in repairing DNA damage in vivo:

a) 5'— 3' polymerase activity, 3'- 5' exonuclease activity, 5'-3' exonuclease activity; b) 5'—3' polymerase activity, 3'- 5' endonuclease activity, 5'—3' exonuclease activity; c) 5'—3' polymerase activity, 3'- 5' exonuclease activity, 5'—3' endonuclease activity; d) 5'—3' polymerase activity, 3'- 5' exonuclease activity, 5'—3' ligase activity

3. Multiplex polymerase chain reaction is used:

(a) To quickly measure the amount of certain DNA, cDNA or RNA in a sample; b) to accurately measure the amount of reaction product as it accumulates; c) in some sequencing and hybridization analysis techniques; d) to amplify, isolate or identify a known sequence from an RNA library

4. When creating and using a cloning vector, the following criteria are met:

a) the vector must be up to 15,000 nucleotide pairs (i.e.) and higher for efficient transformation of host cells; b) the vector should contain a minimum number of unique restriction sites into which heterologous DNA can be inserted; c) the vector must have one or more selective markers (genes) that make it easy to distinguish the cells carrying the vector from the untransformed cells; d) the ideal vector must further comprise a marker that can be activated or inactivated by cutting out fragments of heterologous DNA.

5. Plasmid is:

a) bacterial i-RNA, b) c-DNA, c) double-stranded circular DNA, d) restriction enzyme

6. The use of linkers makes sense if the destruction of 2 types of DNA by restriction enzymes forms the ends:

a) eponymous sticky, b) differently named sticky, c) blunt

7. Foreign DNA trapped in cells in nature, as a rule, does not show activity, as it is destroyed by the enzyme

a) ligase, b) methylase, c) restriction enzyme, d) transcriptase

8. Components of the CRISPR-Cas 9 system include:

a) transcription-activating protein, b) secondary protein messengers, c) guiding RNA, b) protospacers

9. Thecomponent of chimeric guide RNA (guide RNA) is:

a) activation RNA, b) spacer DNA, c) tracer DNA, d) chimeric RNA

10. The main disadvantages of the CRISPR-Cas 9 system include:

a) possibility of off-target effect, b) high specificity, c) high cost, d) immunogenicity

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. Types of bioengineering. Prospects and significance of purposeful change biological objects. Ethical issues.

2. Approaches to the creation of fundamentally new biological objects by methods of genetic engineering (recombinant DNA technology).

3. List the enzymes of genetic engineering, explain the features and methods of their application.

4. To talk about the methods of selection and analysis of recombinant DNA molecules.

5. The use of recombinant organisms to produce medicinal and other biologically active substances.

6. Proteomics and modern problems of protein engineering. Modern approaches to modeling the structure and function of proteins.

7. Metabolomics. Basic concepts, goals and methods of metabolic engineering.

8. Fluxomics. Experimental work in metabolic engineering.

9. Diagnostics engineering. Modern approaches to engineering diagnosticums

10. Vaccine engineering. Types of vaccines. Methods of enhancing the action of the vaccine

11. Set out the goals, objectives, objects of cell engineering. Higher cell cultures

Plants.

12. Types of callus fabrics. Features of the cultivation of callus tissues.

13. Suspension culture as a model system. Features of growth suspension cultures.

14. Haploid cell cultures. Methods of obtaining haploids. Distant hybridization as a classical method of obtaining haploid cells.

15. Somatic hybridization based on the fusion of plant protoplasts. Mechanisms of cell fusion and unification of their genomes.

16. Parasexual hybridization. Hybrids, cybrids, asymmetric hybrids. Plants are regenerated.

17. Preparation of plant cell fragments and their use in cell engineering.

18. Clonal micropropagation of plants. The essence and stages of the microclonal

Breeding.

19. Association of cell culture of a higher plant with a microorganism. Endo and

exosymbiotic associations. Objectives of associations.

20. Transgenic plants and assessment of potential genetic risk

plant transformations

21. Features of animal cell culture. Characteristics of primary crops.

Passivation - as a method of prolonging the life of cell culture.

22. Transformation into a permanent cell line. Characteristics of cells,

cultivated in vitro. Nutrient media and cultivation conditions.

Cell culture systems.

23. Stem cells as the main source of cellular material.

Stem cell differentiation.

24. Stem cell transplantation. Therapeutic use of stem

Cells.

25. Hybridization of animal cells. Discovery of heterocarions. First interspecific

Chimera. Farm chimeric animals.

26. Formation of hybridomas, their significance. Monoclonal antibodies.

Functional structure of antibodies.

27. Technology of production of monoclonal antibodies. Application

monoclonal antibodies in immune diagnostics, as medicinal

preparations and highly specific catalysts.

28. Cultures of human fibroblasts. Features of the culture of fibroblasts

Person.

29. Principles and methods of animal cloning. Smith and Wilmut's experience in

sheep cloning

30. Embryoengineering. Methods used in embryo transplantation

31. Reproductive IVF technology, technological difficulties and limitations.

Legislation prohibiting human cloning.

32. Principles and methods of obtaining transgenic animals. Regulation

reproduction of farm animals.

33. Engineering enzymology. Fundamental and applied aspects of engineering

enzymology. Extremisms, thermozymes, the basics of functioning and

use in biotechnology.

34. Design of biocatalysts and their use in biotechnology.
Methods and concepts of creating enzymes with specified properties.
Modeling and construction of 3D structures of enzymes and active sites.
35. Construction of artificial polyenzyme systems. Computer visualization of the spatial structure of enzymes.
36. Enzyme microcalorimetric sensors. Enzyme electrodes and bioluminescent microanalysis.
37. Using enzymes to create bioelectrochemical energy converters. Prospects for the use of bioelectrocatalysis.
38. Enzymes in the pharmaceutical industry. Obtaining 6-aminopenicillanoic acid with penicillinamidase.
39. Enzymes in the food industry. Production of glucose-fructose syrups with glucose isomerase.
40. Enzymatic modification of nucleic acids, synthesis of oligo- and polynucleotides.
41. Enzymatic production of glucose from cellulose-containing raw materials.
42. Catalytic antibodies (abzymas). Similarities and differences of abzims and Enzymes. Methods of obtaining abzymes and their practical significance.
43. Enzymatic activity of RNA. Methods of selection of ribozymes with the required
Properties. Use of ribozymes for mRNA repair. Deoxyribozymes
44. Principles of tissue engineering. Approaches to solving transplantation problems
Bodies. Problems and prospects of modern transplantology.
45. Artificial organs. Role in solving transplantation problems
46. Construction of tissues and organs from human epithelial cells
47. Growing human tissues from stem cells. The problem of creating organs human stem cells
48. Principles of creation of artificial biocompatible materials.
49. Technologies and examples of growing organs outside the body.
50. Basic principles of cryobiology. Mechanisms of cell damage in Cooling. Cryoprotectors**.**

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.