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

INSTITUTE OF LIFE SCIENCES AND BIOMEDICINE (SCHOOL)

AGREED	CLAIM
Head of Educational Program	Director of the Production Company Structural subdivision
_____ V.V. Kumeiko	_____ V.V. Kumeiko
(Signed) (Surname)	(Signed) (Surname)
	April 12, 2023

WORK PROGRAM OF THE DISCIPLINE
Bioinformatics
Area of study 06.03.01 Biology
Form of training: full-time

The work program is drawn up in accordance with the requirements of the Federal State Educational Standard in the field of training 06.03.01 Biology, approved by the order of the Ministry of Education and Science of the Russian Federation dated 07.08.2020 No. 9 20

The work program was discussed at the meeting of the Department of Medical Biology and Biotechnology, Minutes No. 3 dated April 12, 2023.

Director of the Department of Medical Biology and Biotechnology V.V. Kumeiko

Compiled by: Ph.D. Kumeiko V.V.

Vladivostok
2022

Back of the title page of the RPD

1. The work program was revised at the meeting of the Department/Department/Division (implementing the discipline) and approved at the meeting of the Department/Department/Division (graduating structural unit), minutes of "
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2. The work program was revised at the meeting of the Department/Department/Division (implementing the discipline) and approved at the meeting of the Department/Department/Division (graduating structural unit), minutes of "
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3. The work program was revised at the meeting of the Department/Department/Division (implementing the discipline) and approved at the meeting of the Department/Department/Division (graduating structural unit), minutes of "
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5. The work program was revised at the meeting of the Department/Department/Division (implementing the discipline) and approved at the meeting of the Department/Department/Division (graduating structural unit), minutes of "
_____ *202 No.*

Abstract of the discipline

Bioinformatics

The total labor intensity of the discipline is 3 credit units / 108 academic hours a. It is a discipline of the compulsory part of the EP, studied in the 3 r d year and ends *with a test.* The curriculum provides for lectures in the amount of *18* hours, *practical 36* hours, and also allocated hours for independent work of the student - *54 hours.*

The language of the program is Russian.

The purpose of the discipline is to teach the student to apply methods based on modern information technologies to solve problems that arise in biomedicalpractice and scientific research.

Objectives of the discipline:

– to acquaint the student with the current state of bioinformatics as a science and to identify its current tasks, main successes and prospects for today;

– explain the basic principles of storing and retrieving scientific information;

– To teach the student to use information resources and bioinformatics approaches to solve problems of medical practice, biomedical scientific research, molecular biology, evolutionary and medical genetics.

For successful study of the discipline, students should have the following preliminary competencies:

- acquiresnew mathematical and natural science knowledge using modern educational and information technologies;

•searches and collects information using computer technologies;

-develops information products for processing and analyzing information, following the principles of critical assessment and verification of sources.

Competencies are obtained as a result of studying the disciplines of technology in *professional activities*, the *basics of digital literacy*, in *the highest mathematics*, the student should be ready to study such disciplines as programming in biomedicine, bioengineering, molecularmodeling of biostructures that form competencies:

- Abilityto build mathematical models of physical processes of living organisms, set parameters and simulate physical problems in common programming languages, including Python;

- solvesscientific and practical problems in the fields of genetics, breeding, genomics, proteomics, in technologies for the production of pharmaceutical substances, medicines and nanotechnologies;

-Ability to build mathematical models of chemical processes to solve biomedical problems, set parameters and model chemical problems in common programming languages, including Python;

- implementsmodern methods of processing and analysis of scientific and technical information, statistical analysis of biomedical data, including the use of the R language.

Professional competencies of graduates and indicators of their achievement:

Code and name of professional competence (result of mastering)	Code and name of the competency indicator
PC-5 Able to build mathematical models of physical, chemical and biological processes to solve biomedical problems, possess basic programming skills, use modern methods and resources of bioinformatics and biostatistics	PC-5.1 Able to build mathematical models of physical processes of living organisms, set parameters and simulate physical problems in common programming languages, including Python
	PC-5.2 Able to build mathematical models of chemical processes to solve biomedical problems, set parameters and model chemical problems in common programming languages, including Python
	PC-5.3 Able to build mathematical models of biological processes, set parameters and simulate biological problems in common programming languages, including Python
	PC-5.4 Applies modern information technologies and software tools in solving professional problems
	PC-5.5 Applies modern methods of processing and analysis of scientific and technical information, statistical analysis of biomedical data, including the use of the R language

Code and name of the competency indicator	Name of the assessment indicator (the result of learning in the discipline)
PC-5.1 Able to build mathematical models of physical processes of living organisms, set parameters and simulate physical problems in common programming languages, including Python	Knows Mathematical Models of Physical Processes of Living Organisms. Can build mathematical models of physical processes of living organisms, set parameters and conduct modeling. Owns skills in creating mathematical models of physical processes of living organisms, setting parameters and modeling physical problems in common programming languages, including Python
PC-5.2 Able to build mathematical models of chemical processes to solve biomedical problems, set parameters and model	Knows Mathematical Models of Chemical Processes for Solving Biomedical Problems. Can build mathematical models of chemical processes to solve

chemical problems in common programming languages, including Python	biomedical problems, set parameters and simulate chemical problems in common programming languages, including Python. Owns skills in building mathematical models of chemical processes to solve biomedical problems, setting parameters and modeling chemical problems in common programming languages, including Python.
PC-5.3 Able to build mathematical models of biological processes, set parameters and simulate biological problems in common programming languages, including Python	Knows Mathematical Models of Biological Processes. Can build mathematical models of biological processes, set parameters and simulate biological problems in common programming languages, including Python. Owns skills in building mathematical models of biological processes, setting parameters and modeling biological problems in common programming languages, including Python.
PC-5.4 Applies modern information technologies and software tools in solving professional problems	Knows modern information technologies and software tools for solving professional problems. Can apply modern information technologies and software tools in solving professional problems. Owns skills in the use of modern information technologies and software tools in solving professional problems.
PC-5.5 Applies modern methods of processing and analysis of scientific and technical information, statistical analysis of biomedical data, including the use of the R language	Knows modern methods of processing and analysis of scientific and technical information, statistical analysis of biomedical data, including the use of the R language. Can apply methods of processing and analysis of scientific and technical information, statistical analysis of biomedical data, including the use of the R language. Owns skills in the use of modern methods of processing and analysis of scientific and technical information, statistical analysis of biomedical data, including the use of the R language.

To form the above competencies within the framework of the discipline "Bioinformatics", the following educational technologies and methods of active/interactive learning are used: a business game, work in small groups, a round table.

I. Goals and objectives of mastering the discipline:

Objective : To teach the student to apply methods based on modern information technologies to solve problems that arise in biomedical practice and scientific research.

Tasks:

– to acquaint the student with the current state of bioinformatics as a science and to identify its current tasks, main successes and prospects for today;

– explain the basic principles of storing and retrieving scientific information;

– To teach the student to use information resources and bioinformatics approaches to solve problems of medical practice, biomedical scientific research, molecular biology, evolutionary and medical genetics.

The learning outcomes of the discipline (module) should be correlated with the indicators of competence achievement established in the BRI.

The totality of the planned learning outcomes in the discipline (module) should ensure the formation of all the competencies established by the BRI in the graduate.

Professional competencies of graduates and indicators of their achievement:

Code and name of professional competence (result of mastering)	Code and name of the competency indicator
PC-5 Able to build mathematical models of physical, chemical and biological processes to solve biomedical problems, possess basic programming skills, use modern methods and resources of bioinformatics and biostatistics	PC-5.1 Able to build mathematical models of physical processes of living organisms, set parameters and simulate physical problems in common programming languages, including Python
	PC-5.2 Able to build mathematical models of chemical processes to solve biomedical problems, set parameters and model chemical problems in common programming languages, including Python
	PC-5.3 Able to build mathematical models of biological processes, set parameters and simulate biological problems in common programming languages, including Python
	PC-5.4 Applies modern information technologies and software tools in solving professional problems
	PC-5.5 Applies modern methods of processing and analysis of scientific and technical information, statistical analysis of biomedical data, including the use of the R language

Code and name of the competency indicator	Name of the assessment indicator (the result of learning in the discipline)

PC-5.1 Able to build mathematical models of physical processes of living organisms, set parameters and simulate physical problems in common programming languages, including Python	Knows Mathematical Models of Physical Processes of Living Organisms. Can build mathematical models of physical processes of living organisms, set parameters and conduct modeling. Owns skills in creating mathematical models of physical processes of living organisms, setting parameters and modeling physical problems in common programming languages, including Python
PC-5.2 Able to build mathematical models of chemical processes to solve biomedical problems, set parameters and model chemical problems in common programming languages, including Python	Knows Mathematical Models of Chemical Processes for Solving Biomedical Problems. Can build mathematical models of chemical processes to solve biomedical problems, set parameters and simulate chemical problems in common programming languages, including Python. Owns skills in building mathematical models of chemical processes to solve biomedical problems, setting parameters and modeling chemical problems in common programming languages, including Python.
PC-5.3 Able to build mathematical models of biological processes, set parameters and simulate biological problems in common programming languages, including Python	Knows Mathematical Models of Biological Processes. Can build mathematical models of biological processes, set parameters and simulate biological problems in common programming languages, including Python. Owns skills in building mathematical models of biological processes, setting parameters and modeling biological problems in common programming languages, including Python.
PC-5.4 Applies modern information technologies and software tools in solving professional problems	Knows modern information technologies and software tools for solving professional problems. Can apply modern information technologies and software tools in solving professional problems. Owns skills in the use of modern information technologies and software tools in solving professional problems.
PC-5.5 Applies modern methods of processing and analysis of scientific and technical information, statistical analysis of	Knows modern methods of processing and analysis of scientific and technical information, statistical analysis of biomedical data, including the use of the R language. Can

biomedical data, including the use of the R language	apply methods of processing and analysis of scientific and technical information, statistical analysis of biomedical data, including the use of the R language. Owns skills in the use of modern methods of processing and analysis of scientific and technical information, statistical analysis of biomedical data, including the use of the R language.

II. Labor intensity of the discipline and types of training in the discipline

The total labor intensity of the discipline is 2 credits (72 academic hours), (1 credit corresponds to 36 academic hours).

III. Structure of the discipline:

The form of study is full-time.

№	Section Name Discipline	Semester	Number of hours by type of training and work of the student						Forms of intermediate attestation
			Mild	Lab	Ave	OK	WED	Control	
1.	Class 1-2	5	3	-	6	-	9	-	Questions for the test
2.	Class 3		3	-	6	-	9	-	Questions for the test
3.	Class 4		3	-	6	-	9	-	Questions for the test
4.	Class 5-6		3	-	6	-	9	-	Questions for the test
5.	Class 7-8		3	-	6	-	9	-	Questions for the test
6.	Class 9		3	-	6	-	9	-	Questions for the test
	Total:	8	18	-	36	-	54	-	Credit

IV. CONTENT OF THE THEORETICAL PART OF THE COURSE

Lectures 18 hours.

Topic 1. Module 1. Introduction to Bioinfomatics Lecture Session:
Subject, Tasks and Objects of Bioinformatics. The latest achievements in the field

of molecular biology and genetics, which have necessitated the development of bioinformatics. Information technologies that have found application in bioinformatics. Systems Approach in Bioinformatics.

Topic 2. Module 2. Structural and Comparative Genomics, lecture:

Comparative genomics. Bioinformatics databases. Species and search. Integrated Databases Methods for comparing the primary structures of biopolymer molecules. Comparison algorithms. Alignment, Local, Global. Multiple alignment. Phylogenetic analysis Problems of phylogeny of genomic sequences. Gene ontologies. Information content of genetic sequences. Recognition of areas of hidden periodicity, repetitions, areas of statistical heterogeneity. Ancestral Recognition genes in the primary structures of biopolymer molecules and the study of their functionality and evolution.

Topic 3. Module 3. Proteomics, lecture:

Spatial Structure of Proteins Methods for predicting the spatial structures of proteins. Mechanisms of Formation of Spatial Structures of Biological Macromolecules. Protein Structure Banks Computer Simulation of Biological Molecule Interaction Methods for Comparing Spatial Structures of Biological Macromolecules. Methods for modeling interactions between macromolecular complexes. Molecular graphics.

V. CONTENT OF THE PRACTICAL PART OF THE COURSE AND INDEPENDENT WORK

Practical training 36 hours.

Class 1. Theory and Practice of Information Retrieval

1. Principles of indexing information and searching on the Internet.
2. Practical use of search operators, compilation of effective queries.

Class 2. Bibliographic Information Management Systems *The lesson is conducted using the "round table" method of active learning*

1. Use of citation manager programs. EndNote, Mendeley, Docear, Reference Manager.
2. Integration of local bibliographic information management software with online research systems and citation databases.
3. Creation and organization of personal databases on scientific literature.
4. Joint integration of various systems on scientific literature, export and conversion of data.

Class 3. Alignment of biomolecule sequences

1. Software for the analysis of nucleotide and polypeptide sequences. Software for phylogenetic analysis.

2. Use of software to align biological sequences.

3. Use of software to design gene-specific and degenerate oligonucleotide probes (primers).

Class 4. Phylogenetic analysis

1. Remote Sensing Method for Constructing Phylogenetic Trees.

2. Methods of Discrete Feature Analysis.

3. Statistical evaluation of the tree, bootstrap analysis.

Class 5. Analysis of nucleic acid sequencing results

1. Genome analysis.

2. Genome-wide association studies.

Class 6. Modeling the spatial structure of biomolecules

1. Molecular editors and visualizers.

2. Modeling the structure of low-molecular-weight compounds.

3. Modeling the structure of biopolymers.

4. Modeling of the structure of proteins by homology. Automatic modeling of protein structure according to homology.

5. *De novo* modeling of the structure of proteins.

6. Methods for assessing the quality of models.

Class 7. Molecular docking

1. Molecular docking software.

2. Protein-ligand docking. "Hard" and "flexible" docking.

3. Protein-protein docking.

4. Analysis of molecular docking results. Ranking molecular docking solutions using estimation functions.

Class 8 - 9. Molecular Dynamics

1. Linux operating system. Console Basics.

2. Software for molecular dynamic experiments.

3. The GROMACS software package.

4. Preparation of the spatial structure of the protein.

5. Preparation of the system for starting calculations.

6. Performing a molecular-dynamic experiment.

7. Trajectory analysis.

Self-study 18 hours.

Sample Essay Topics

1. Genomic information.

2. Genetic mapping and genome mapping.

3. Main Types of DNA Markers Used in Mapping Genome.

4. Determination of nucleotide sequences, DNA sequencing.

5. Determine the sequence of the clone.

6. Use of EST sequences.

7. Methods of Multiple Gene Expression Analysis.

8. Protein sequencing.

9. Analysis of protein expression by two-dimensional phoresis in polyacrylamide gel.

10. Global alignment of sequences.

11. Local sequence alignment.

12. Multiple sequence alignment.

13. A measure of similarity of biological sequences.

14. Hamming and Loewenstein distances

VI. EDUCATIONAL AND METHODOLOGICAL SUPPORT OF STUDENTS' INDEPENDENT WORK

Recommendations for students' independent work

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

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

- preparatory (definition of goals, preparation of a program, preparation of methodological support, preparation of equipment);
- the main one (implementation of the program, the use of techniques for searching for information, assimilation, processing, application, transfer of knowledge, recording the 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-management, 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 students 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 students' independent work

In the course of mastering the material on the subject of the discipline, 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 being studied, which allows you to deepen and consolidate specific practical knowledge obtained in classroom classes. For the study and full mastering of the program material in the discipline, educational, reference and other literature recommended by this program is used, as well as specialized periodicals.

In the course of independent preparation for classes, students take notes of the material, independently study questions on the topics covered, using educational literature from the proposed list, periodicals, scientific and methodological information, databases of information networks.

Independent work consists of such types of work as studying material from textbooks, reference books, video materials and presentations, as well as other reliable sources of information; Preparation for Zechet. To consolidate the material, it is enough to mentally reconstruct the material while flipping through the synopsis or reading it. If necessary, refer to the recommended educational and reference literature, write down incomprehensible points in the questions to clarify them in the upcoming lesson.

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

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

2) Deepening of knowledge on the proposed topics. It is necessary to differentiate the available material in lectures and manuals in accordance with the points of the practical lesson plan. Write down unclear questions and terms separately. It is better to do this in the margins of a lecture outline or a study guide. Clarification should be carried out with the help of reference literature (dictionaries, encyclopedic publications, etc.);

3) Drawing up a detailed plan of speech, or calculations, solving problems, exercises, etc. In preparation for practical classes, students take notes of the material, prepare answers to the given questions on the topics of practical classes. In addition to the practical material, students independently study the 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 submission and registration 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 means of a survey and by including in the final data set in the lesson from the plan of independent work.

VII. MONITORING THE ACHIEVEMENT OF THE COURSE OBJECTIVES

Item No.	Supervised sections/topics of the discipline	Code and name of the indicator of achievement	Learning Outcomes	Evaluation Tools	
				Current control	Intermediate Certification
1.	Class 1-2	PC-5.1 Able to build mathematical models of physical processes of living organisms, set parameters and simulate physical problems in common programming languages, including Python	Knows Mathematical Models of Physical Processes of Living Organisms. Can build mathematical models of physical processes of living organisms, set parameters and conduct modeling. Owns skills in creating mathematical models of physical processes of living organisms, setting parameters and modeling physical problems in common programming languages, including Python	Poll	Questions for the test
2.	Class 3-4	PC-5.2 Able to build mathematical models of chemical processes to solve biomedical problems, set parameters and model chemical problems in common programming languages, including Python	Knows Mathematical Models of Chemical Processes for Solving Biomedical Problems. Can build mathematical models of chemical processes to solve biomedical problems, set parameters and simulate chemical problems in common programming languages, including Python. Owns skills in building mathematical models of chemical processes to solve biomedical problems, setting parameters and	Quiz	Questions for the test

			modeling chemical problems in common programming languages, including Python.		
3.	Class 5-6	PC-5.3 Able to build mathematical models of biological processes, set parameters and simulate biological problems in common programming languages, including Python	Knows Mathematical Models of Biological Processes. Can build mathematical models of biological processes, set parameters and simulate biological problems in common programming languages, including Python. Owns skills in building mathematical models of biological processes, setting parameters and modeling biological problems in common programming languages, including Python.	Poll	Questions for the test
4.	Class 7-8	PC-5.4 Applies modern information technologies and software tools in solving professional problems	Knows modern information technologies and software tools for solving professional problems. Can apply modern information technologies and software tools in solving professional problems. Owns skills in the use of modern information technologies and software tools in solving professional problems.	Poll	Questions for the test
5.	Class 9	PC-5.5 Applies modern methods of processing and analysis of scientific and technical information, statistical analysis of biomedical data, including the use of the R language	Knows modern methods of processing and analysis of scientific and technical information, statistical analysis of biomedical data, including the use of the R language. Can apply methods of processing and analysis of scientific and technical information, statistical analysis of biomedical data,	Quiz	Questions for the test

			including the use of the R language. Owns skills in the use of modern methods of processing and analysis of scientific and technical information, statistical analysis of biomedical data, including the use of the R language.		

VIII. LIST OF REFERENCES AND INFORMATIONAL AND METHODOLOGICAL SUPPORT OF THE DISCIPLINE

Reference citations

1. Grigoriev A.A., Isaev E.A., Tarasov P.A. Transfer, storage and processing of large volumes of scientific data: textbook. Moscow: INFRA-M, 2021. — 207 p. — (Higher education: Bachelor's degree). — DOI 10.12737/1073525. - ISBN 978-5-16-015985-0. - Text : electronic. - URL: https://znanium.com/catalog/product/1073525

2. Fedotova E.L., Portnov E.M. Prikladnye informatsionnye tekhnologii: uchebnoe posobie [Applied Information Technologies: Textbook]. — Moscow : FORUM : INFRA-M, 2021. — 335 p. — (Secondary vocational education). - ISBN 978-5-8199-0897-6. - Text : electronic. - URL: https://znanium.com/catalog/product/1189340

3. Abrahamyan, M.E. Tools and Methods for the Development of Electronic Educational Resources in Computer Science: Monograph / M.E. Abramyan; Southern Federal University. — Rostov-on-Don; Taganrog: Publishing House of the Southern Federal University, 2018. — 260 p.- ISBN 978-5-9275-2785-4. - Text : electronic. - URL: https://znanium.com/catalog/product/1039686

4. Gupal V. M. Matematicheskie metody analiza discretenykh struktury geneticheskogo koda [Mathematical methods of analysis of discrete structures of genetic code: monograph]. - Moscow: IC RIOR, NITS INFRA-M, 2015. - 334 p. (Scientific Thought). - ISBN 978-5-369-01462-2. - Text : electronic. - URL: https://znanium.com/catalog/product/516085

5. Stefanov, V. E. V. E. Stefanov, A. A. Tulub, G. R. Mavropulo-Stolyarenko. - Moscow: Yurayt Publishing House, 2023. — 252 p. — (Higher education). — ISBN 978-5-534-00860-9. — Text : electronic // Educational platform Urait [site]. — URL: https://urait.ru/bcode/511736

6. Agapov E. P. Sotsial'naya informatika: uchebnoe posobie [Social Informatics: Textbook]. - Moscow: RIOR: INFRA-M, 2021. - 144 p. - (Higher education: Bachelor's degree). - ISBN 978-5-369-01456-1. - Text : electronic. - URL: https://znanium.com/catalog/product/1231016

7. Ignasimutu S. Osnovy bioinformatiki [Fundamentals of bioinformatics] / S. Ignasimutu ; translated by A. A. Chumichkin. Moscow, Izhevsk: Regular and Chaotic Dynamics, Institute for Computer Research, 2019. — 324 c. — ISBN 978-5-4344-0646-8. — Text : electronic // Digital educational resource IPR SMART : [site]. — URL: https://www.iprbookshop.ru/91970.html

8. Volodchenkova L. A. Bioinformatika: uchebnoe posobie [Bioinformatics: textbook]. — Omsk: Omsk State University Publishing House, 2018. — 44 c. — ISBN 978-5-7779-2214-4. — Text : electronic // Digital educational resource IPR SMART : [site]. — URL: https://www.iprbookshop.ru/108109.html

Further reading

1. Allergy Bioinformatics [Electronic resource] / Ailin Tao, Eyal Raz; Издатель: Springer Netherlands; Год: 2015. http://link.springer.com/openurl?genre=book&isbn=978-94-017-7444-4

2. NGS high-throughput sequencing / D.V. Rebrikov, D.O. Korostin, E.S. Shubina [et al.]; ed. by D.V. Rebrikova. Moscow , Binom Publ., 2015. 232 p. (In Russian). Available at: http://lib.dvfu.ru:8080/lib/item?id=chamo:797569&theme=FEFU

3. NBIC technologies. Innovative Civilization of the XXI Century / A.K. Kazantsev, V.N. Kiselev, D.A. R. Ubwalter [et al.]; ed. A.K. Kazantseva, D. A. Rubwalter. Moscow: Infra-M Publ., 2014. 384 p. (in Russian). http://lib.dvfu.ru:8080/lib/item?id=chamo:753195&theme=FEFU

4. Human Biochemistry. / R. Marri, D. Grenner, P. Mayes // Moscow: Mir BINOM, 2009. 414 p. (In Russian). Mode of access: http://lib.dvfu.ru:8080/lib/item?id=chamo:277694&theme=FEFU

5. Introduction to Computational Biology: EvolutionaryApproach: Translated from English / Haubold B., Vie T. // Moscow: Publishing House of the Institute of Computer Research "Regular and Chaotic Dynamics", 2011. 455 p. (In Russian). Available at: http://lib.dvfu.ru:8080/lib/item?id=chamo:673149&theme=FEFU

6. Molecular biology. Ribosomes and protein biosynthesis. Textbook for Higher Educational Institutions on Biological Specialties / A. S. Spirin / Moscow: Akademiya, 2011. 498 p. (In Russian). Mode of access: http://lib.dvfu.ru:8080/lib/item?id=chamo:669007&theme=FEFU

7. Molecular Evolution and Population Genetics: Textbook for Higher Educational Institutions / Yu.F. Kartavtsev // Vladivostok: izd-vo Dalnevostochnogo universiteta, 2009. 277 p. (In Russian). Mode of access: http://lib.dvfu.ru:8080/lib/item?id=chamo:292844&theme=FEFU

8. Principles and Methods of Biochemistry and Molecular Biology / K.Wilson, J.Walker // Moscow: Binom, 2012. 848 p. (In Russian). Available at: http://lib.dvfu.ru:8080/lib/item?id=chamo:705602&theme=FEFU

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

1. http://elibrary.ru/ - Scientific Electronic Library
2. http://molbiol.ru/ - Molecular Biology Information Resource
3. http://macroevolution.narod.ru/ is an electronic resource on evolutionary biology.
4. http://science.km.ru/ - electronic resource on different sections of biology
5. http://elementy.ru/ is an informational and educational resource dedicated to natural sciences.
6. http://www.iprbookshop.ru/ is the IPRbooks electronic library system.
7. http://znanium.com/ - EBS "Znanium".
8. https://nplus1.ru/ - N+1, a popular science online publication about science, engineering and technology
9. http://antropogenez.ru/ is a popular science information resource about human evolution
10. http://web.a.ebscohost.com/ehost/search/basic?sid=851485f8-6200-4b3e-aaab-df4ba7be3576@sessionmgr4008&vid=1&tid=2003EB is a collection of books on various sections from the EBSCOhost database.
11. http://rosalind.info/problems/locations/- resource for self-study of bioinformatics Rosalind.
12. http://www.ncbi.nlm.nih.gov/ website of the- National Center for Biotechnology Information (NCBI).
13. http://www.mendeley.com/- *Mendeley*: Free reference manager and PDF organizer; Librarian Program.
14. http:// www.ebi.ac.uk- website of the European Bioinformatics Institute
15. http:// www.scopus.com – Scopus bibliographic database and citation index
16. http://thomsonreuters.com/thomson-reuters-web-of-science/ Web of Science bibliographic database and citation index

List of information technologies and software

1. Microsoft Office Professional Plus 2013 is an office suite that includes software for working with various types of documents (texts, spreadsheets, databases, etc.);
2. 7Zip 16.04 - free file archiver with high data compression ratio;
3. Adobe Acrobat XI Pro is a software package for creating and viewing electronic publications in PDF format;
4. AutoCAD Electrical 2015 - three-dimensional computer-aided design and drafting system;

5. ESET Endpoint Security 5 is a comprehensive protection solution for Windows-based workstations. Virtualization support + new technologies;
6. WinDjView 2.0.2 is a program for recognizing and viewing files with the same DJV and DjVu formats; SolidWorks 2016 is a CAD software package for automating the work of an industrial enterprise at the stages of design and technological preparation of production
7. Compass-3D LT V12 - Three-Dimensional Simulation System
8. Notepad++ 6.68 – Text Editor

IX. METHODICAL INSTRUCTIONS FOR MASTERING THE DISCIPLINE

Lecture

The lecture is the- main active form of classroom classes, the explanation of the fundamental and most difficult theoretical sections of molecular biology and the theory of genetic engineering, which involves intensive mental activity of the student and is especially important for mastering the subject. A lecture should always be cognitive, developmental, educational and organizing. Lecture notes help to assimilate the theoretical material of the discipline. When listening to a lecture, you need to take notes main information, preferably with your own wording, which allows you to better remember the material. An outline is useful when it is written by the student independently.

In the lecture, the teacher gives only a small part of the material on certain topics that are presented in the textbooks. In addition, the instructor informs students about what additional information can be obtained on the topics discussed, and from what sources. Therefore, when working with lecture notes, it is always necessary to use the main textbooks, additional literature and other recommended sources on this discipline. It is this serious work of the student with the lecture material that allows him to achieve success in mastering new knowledge.

To present a lecture course on the discipline "Neurobiology", the following forms of active learning are used: lecture-conversation, lecture-visualization, which are built on the basis of knowledge received by students in the framework of subjects preceding the course. Electronic presentations, tables, video files, and blackboard diagrams are used to illustrate verbal information. In the course of the lecture material, problematic questions or questions with elements of discussion are posed.

Lecture – visualization

The lecture is accompanied by the demonstration of tables, electronic presentations, video files - such a combination of ways of presenting information significantly simplifies its mastering by students. Verbal presentation of the material

should be accompanied and combined with the visual form. The information presented in the form of diagrams on the board, tables, slides allows you to form problematic questions, and contribute to the development of professional thinking of future specialists.

Lecture-conversation

Lecture-conversation, "dialogue with the audience", is the most common form of active learning and allows students to be involved in the educational process, since there is direct contact between the teacher and the audience. Such contact is achieved during the lecture, when students are asked questions of a problematic or informational nature, or when they are invited to ask the teacher questions themselves. Questions are offered to the entire audience, and any of the students can offer their own answer; another can complement it. In the course of the educational process, this allows you to identify the most active students and activate those who do not participate in the work. This form of lecture allows you to involve students in the work process, attract their attention, stimulate thinking, gain collective experience, and learn how to form questions. The advantage of a lecture-conversation is that it allows you to draw students' attention to the most important issues of the topic, determine the content and pace of the presentation of educational material, as well as determine the topics that are most interesting to students, in order to possibly adjust the form of the material taught.

Labs

They are used for conducting experiments, observations of phenomena and processes by students mainly in special laboratories, classrooms and with the use of technical means. This method stimulates action both in the preparation for research and in the process of its implementation. Laboratory work improves the quality of education, contributes to the development of cognitive activity in students, their logical thinking and creative independence. In the process of laboratory work, theoretical knowledge is deepened and concretized, and the ability to apply it in practice is developed. Skills in working with microscopes, tables and atlases are acquired. The student learns to analyze the data obtained, identify the norm and deviation from it, acquires the skills of working with a living object and physiological measuring devices, performing operations, conducting a comparative analysis, summarizing the material obtained and drawing conclusions. All this allows for a deeper understanding of the mechanisms of the functioning of a living organism and the principles of its interaction with the environment. Research skills and professional competencies are formed.

Traditionally, laboratory classes are the main type of training aimed at experimental confirmation of theoretical positions. In the course of a laboratory lesson, students perform one or more laboratory works (tasks) under the guidance of

a teacher in accordance with the content of the educational material being studied. Students perform laboratory work aimed at:

- generalization, systematization, deepening of theoretical knowledge on specific topics of the academic discipline;
- formation of skills to accept the acquired knowledge in practical activities;
- development of analytical, design and constructive skills;
- development of independence, responsibility and creative initiative.

Necessary structural elements of the laboratory lesson:

- instruction given by the teacher;
- independent activities of students;
- Discussion of the results of the laboratory work (task).

Before completing the laboratory task (work), the students' knowledge is tested, i.e. their theoretical readiness to perform the task.

A laboratory task (work) can be reproductive, partially exploratory and exploratory in nature.

Works of **a reproductive** nature are distinguished by the fact that when conducting them, students use detailed instructions, which indicate: the purpose of the work, explanations (theory, main characteristics), equipment, apparatus, materials and their characteristics, the procedure for performing the work, tables, conclusions (without formulations), control questions, educational and special literature.

The works, which are of a **partial-exploratory** nature, are distinguished by the fact that during the conduct of the works, students do not use detailed instructions, they are not given the order of performing the necessary actions, students are required to independently select equipment, choose ways to perform work, instructive and reference literature.

Exploratory works are distinguished by the fact that students have to solve a problem that is new to them, relying on their theoretical knowledge.

The forms of organization of students for conducting a laboratory lesson - frontal, group and individual - are determined by the teacher, based on the topic, goal, and order of work. In the frontal form of organizing classes, all students do the same work. In the group form of organizing classes, the same work is carried out in teams of 2-5 people. With an individual form of organizing classes, each student performs an individual task.

The results of the laboratory task (work) are drawn up by students in the form of a report, the grades for the performance of the laboratory task (work) are indicators of the current performance of students in the academic discipline.

Research skills and professional competencies are formed.

X. LOGISTICAL SUPPORT OF DISCIPLINE

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

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

Logistical and software of the discipline

Name of special rooms and rooms for independent work	Equipment special rooms and rooms for self-study	List of licensed software. Details of the supporting document
690922, Primorsky Krai, Vladivostok, Russky Island, Saperny Peninsula, Ajax village, 10, aud. M 605	Multimedia audience: Electric Screen 236*147cm Trim Screen Line; DLP Projector, 3000 ANSI Lm, WXGA 1280x800, 2000:1 EW330U Mitsubishi; CORSA-2007 Tuarex Specialized Equipment Fastening Subsystem; Video Switching Subsystem: Extron DXP 44 DVI Pro DVI Matrix Switcher; Extron DVI 201 Tx/Rx twisted-pair DVI extender Audio switching and sound amplification subsystem; Extron SI 3CT LP ceiling mount speaker system; Extron DMP 44 LC Digital Audio Processor; Extension for IPL T CR48 control controller;Wireless LAN for students is provided by a system based on 802.11a/b/g/n 2x 2 MIMO (2SS) access points. Моноблок HP ProOne 400 All-in-One 19.5 (1600x900), Core i3-4150T, 4GB DDR3-1600 (1x4GB), 1TB HDD 7200 SATA, DVD+/-RW, GigEth, Wi-Fi, BT, usb kbd/mse, Win7Pro (64-bit)+Win8.1Pro(64-bit), 1-1-1 Wty	-
690922, Primorsky Krai, Vladivostok, Russky Island,	Multimedia audience:	-

Saperny Peninsula, Ajax village, 10, aud. M 422	HP ProOne 400 G1 AiO 19.5" Intel Core i3-4130T 4GB DDR3-1600 SODIMM (1x4GB)500GB All-in-One PC; Projection screen Projecta Elpro Electrol, 300x173 cm; Multimedia projector, Mitsubishi FD630U, 4000 ANSI Lumen, 1920x1080; Mortise interface with TLS TAM 201 Stan automatic cable retraction; Avervision CP355AF visualizer; Sennheiser EW 122 G3 UHF lavalier microphone radio system consisting of a wireless microphone and receiver; LifeSizeExpress 220- Codeconly- Non-AES video conferencing codec; Multipix MP-HD718 Network Video Camera; Two 47" LCD panels, Full HD, LG M4716CCBA; Audio switching and sound amplification subsystem; Centralized, uninterrupted power supply	
690922, Primorsky Krai, Vladivostok, Russky Island, Saperny Peninsula, Ajax village, 10, aud. M 627	Light microscope Carl Zeiss GmbH Primo Star 3144014501 (13 pcs.); Light microscope with digital camera Altami BIO8 (2 pcs.).	-
Computer class of the School of Biomedicine aud. M723, 15 workplaces	Electric Screen 236*147cm Trim Screen Line; DLP projector, 3000 ANSI Lm, WXGA 1280x800, 2000:1 EW330U Mitsubishi; CORSA-2007 Tuarex Specialized Equipment Fastening Subsystem; Video Switching Subsystem: Extron DXP 44 DVI Pro DVI Matrix Switcher; Extron DVI 201 Tx/Rx twisted-pair DVI extender Audio switching and sound amplification subsystem; Extron SI 3CT LP Ceiling Mount Speaker System	-

	Extron DMP 44 LC Digital Audio Processor; extension for IPL T CR48 control controller; Wireless LAN for students is provided by a system based on 802.11a/b/g/n 2x2 MIMO(2SS) access points. Monoblock HP RgoOpe 400 All-in-One 19.5 (1600x900), Core and3-4150T, 4GB DDR3-1600 (1x4GB), 1TB HDD 7200 SATA, DVD+/-RW, GigEth, Wi- Fi, VT, usb kbd/mse, Win7Pro (64-bit)+Win8.1Pro(64-bit), 1-1-1 Wty	