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
Head of Educational Program
_____ V.V. Kumeiko
(Signed) (Surname)

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

WORK PROGRAM OF THE DISCIPLINE
Molecular Modeling of Biostructures
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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Abstract of the discipline

Molecular Modeling of Biostructures

The total labor intensity of the _ discipline is 4 credit units / 144 academic hours.The curriculum provides for lectures in the amount of 18 hours, laboratory work in the amount of *18* hours, practical *36* hours, and also allocated hours for independent work of the student - *72 hours.*

Language: Russian.

Purpose: to provide basic knowledge and ideas about the possibilities of practicing numerical methods of mathematical analysis, mathematical modeling, classification of mathematical models of biological objects.

Tasks:

1) to form ideas about the applicability of numerical methods of mathematical analysis in relation to mathematical modeling of biological systems;
2) introduce specific mathematical models that a research biologist can apply (adapt) to his or her research;
3) To expand knowledge on the use of software tools in modeling biological processes.

Students' Competencies, Indicators of Their Achievement and Learning Outcomes in the Discipline

Code and name of professional competence (result of mastering)	Code and name of the competency indicator
PC-4 Able to understand and analyze, and apply the principles of cellular and tissue organization of biological objects, biochemical and molecular-biological mechanisms of the development of pathological processes in cells and tissues of the human body to preserve the health of the population	PC-4.1 Analyzes biochemical and molecular-biological mechanisms of development of pathological processes in cells and tissues of the human body and applies the principles of cellular organization of biological objects
	PC-4.2 Understands the biochemical and molecular-biological mechanisms of the development of pathological processes in the cells and tissues of the human body
	PC-4.3 Understands and investigates the physical processes underlying the functioning of the body in normal and pathological conditions, understands the influence of physical factors on the functioning of biological systems, is able to study the physical structure of biologically important molecules in order to identify the relationship between the structure of substances and their biological activity
	PC-4.4 Able to develop and apply health-saving technologies

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-4.1 Analyzes biochemical and molecular-biological mechanisms of development of pathological processes in cells and tissues of the human body and applies the principles of cellular organization of biological objects	Knows biochemical and molecular-biological mechanisms of the development of pathological processes in the cells and tissues of the human body. Can apply the principles of cellular organization of biological objects. Owns skills of determining the biochemical and molecular-biological mechanisms of the development of pathological processes in the cells and tissues of the human body.
PC-4.2 Understands the biochemical and molecular-biological mechanisms of the development of pathological processes in the cells and tissues of the human body	Knows biochemical and molecular-biological mechanisms of the development of pathological processes in the cells and tissues of the human body. Can to apply biochemical and molecular-biological mechanisms of the development of pathological processes in the cells and tissues of the human body. Owns skills in the use of biochemical and molecular-biological mechanisms of the development of pathological processes in the cells and tissues of the human body
PC-4.3 Understands and investigates the physical processes underlying the functioning of the	Knows the physical structure of biologically important molecules and the physical processes underlying their functioning.

body in normal and pathological conditions, understands the influence of physical factors on the functioning of biological systems, is able to study the physical structure of biologically important molecules in order to identify the relationship between the structure of substances and their biological activity	Can determine the relationship between the physical structure and properties and the functions that perform them in the body. Owns skills in the study of the physical structuresof biologically important molecules and the physical processes underlying their functioning
PC-4.4 Able to develop and apply health-saving technologies	Knows technologies aimed at preserving the health of the population. Can apply health-saving technologies. Owns Ability to develop health-saving technologies
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	Knows Mathematical Models of Biological Processes. Can build mathematical models of biological processes, set

programming languages, including Python	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 "Molecular Modeling of Biostructures", the following educational technologies and methods of active/interactive learning are used: business game, work in small groups, round table.

I. Goals and objectives of mastering the discipline

Purpose: to provide basic knowledge and ideas about the possibilities of practicing numerical methods of mathematical analysis, mathematical modeling, classification of mathematical models of biological objects.

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PC-4.4 Able to develop and apply health-saving technologies	Knows technologies aimed at preserving the health of the population. Can apply health-saving technologies. Owns

	Ability to develop health-saving technologies
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	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 3 credits (108 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	Topic 1-2	6	3	3	6	-	6	6	Exam Questions
2	Topic 3-4		3	3	6	-	6	6	
3	Topic 4		3	3	6	-	6	6	
4	Topic 5-6		3	3	6	-	6	6	
5	Topic 7-8		3	3	6	-	6	6	
6	Topic 9		3	3	6	-	6	6	
	Total:	6	18	18	36	-	36	36	exam

IV. CONTENT OF THE THEORETICAL PART OF THE COURSE

Lectures (18 hours)

Topic 1. Introduction.

Cybernetic Concepts of the Biosystem. Control system. Adaptation of the system. Trigger systems. Parallelogram rule. Negentropic ideas about the biosystem. Negentropy. Approaches to evaluation. Nonlinear Thermodynamics of Biosystems. Macro parameter, micro parameter. Macro process and microprocess. Interaction of micro and macro processes in the process of evolution. Program/operating system kernel in cybernetic devices.

Topic 2. The concept of a model.

The concept of a model. Pattern. Patterns in Biology and Medicine. Objects, goals and methods of modeling. Classification of mathematical models. Models in different sciences. Computer and mathematical models. The history of the first models in biology. Modern Classification of Models of Biological Processes. Regression, simulation, qualitative models. Simulation principles and model examples. Specifics of Living Systems Modeling.

Topic 3. Differential and Integral Equations

The concept of the derivative and how to find it (rules of differentiation). Integral and Methods for Finding Integrals. Geometric representation of derivatives, differentials, and integrals. The Physical Meaning of Differential Equations. Multidimensional differential equations and their spaces. Differential and integral calculus software.

Topic 4. Stages of Mathematical Modeling

Organization of mathematical modeling. Mathematical modeling plan. Stages of mathematical modeling. Problem Statement: Define the purpose of the analysis and how to achieve it. Study of the theoretical foundations and collection of information about the original object. Formalization. Choice of solution method. Implement the model. Analysis of the information obtained. Checking the adequacy to the real object

Topic 5. Models described by systems of two autonomous differential equations.

Phase plane. Phase portrait. Phase space and phase trajectories. Isocline method. Main isoclines. Steady-state stability. Linear systems. Types of Singular Points: Node, Saddle, Focus, Center. Examples. Predator-prey model.

Topic 6. Examples of mathematical models in biology and medicine.

Theory of bifurcations of dynamical systems. Z-transform (Laurent transform). Cuvier's Catastrophism. Catastrophe theory. Seven elementary catastrophes according to Tom. A Fold-type disaster. An "Assemblage" type

disaster. A Butterfly-type disaster. Swallowtail Disaster (Polynomial Discriminator).

Topic 7. Examples of mathematical models in biology and medicine.

Analysis of some population growth patterns. Malthus's model. Verhulst's logistic model. Flow cultivator model.

Topic 8. Examples of mathematical models in biology and medicine.

Models of biochemical reactions are analytic reactions of enzymatic catalysis (Michaelis-Menten, Malthus, Higgins, Reich, Selkow). Oscillating systems. Local model of the Brussels

Topic 9. Examples of mathematical models in biology and medicine.

Models of morphogenesis. Growth of microbial colonies. Population range growth. Growth of a cancerous tumor. Neural impulse models. A model of the dynamics of the state of ion channels.

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

Practical exercises (36 hours)

Topic 1. Introduction.

Questions on the topic.

1. Cybernetic ideas about the biosystem.
2. Control system.
3. Adaptation of the system.
4. Trigger systems.
5. Parallelogram rule.
6. Negentropic ideas about the biosystem.
7. Negentropy. Approaches to evaluation.
8. Nonlinear thermodynamics of biosystems.
9. Macro parameter, micro parameter. Macro process and microprocess. Interaction of micro and macro processes in the process of evolution.
10. Program/Operating System Kernel in Cybernetic Devices.

Topic 2. The concept of a model.

1. The concept of the model.
2. Pattern. Patterns in Biology and Medicine.
3. Objects, goals and methods of modeling.
4. Classification of mathematical models.
5. Models in different sciences.
6. Computer and mathematical models.
7. History of the first models in biology.

8. Modern Classification of Models of Biological Processes. Regression, simulation, qualitative models.

9. Principles of simulation modeling and examples of models.

10. Specifics of modeling of living systems.

Topic 3. Differential and Integral Equations

11. The concept of the derivative and the ways of finding it (rules of differentiation).

12. Integral and methods of finding integrals.

13. Geometric representation of derivatives, differentials and integrals. The Physical Meaning of Differential Equations.

14. Multidimensional differential equations and their spaces. Differential and integral calculus software.

Topic 4. Stages of Mathematical Modeling

15. Organization of mathematical modeling.

16. Mathematical modeling plan.

17. Stages of mathematical modeling.

18. Problem Statement: Define the purpose of the analysis and how to achieve it. Study of the theoretical foundations and collection of information about the original object. Formalization.

19. Choice of solution method.

20. Implementation of the model.

21. Analysis of the information received.

22. Verification of adequacy to the real object

Topic 5. Models described by systems of two autonomous differential equations.

23. Phase plane.

24. Phase portrait.

25. Phase space and phase trajectories.

26. Isocline method. Main isoclines. Steady-state stability. Linear systems.

27.Types of special points: node, saddle, focus, center.

28. Examples. Predator-prey model.

29.Topic 6. Examples of mathematical models in biology and medicine.

30. Theory of bifurcations of dynamical systems.

31.Z-transform (Laurent transform).

32. Cuvier's catastrophism.

33. Catastrophe Theory.

34. The Seven Elementary Catastrophes According to Tom.

35. A Fold-type disaster.

36. Assemblage-type disaster.

37. Butterfly-type disaster.

38. Swallowtail Disaster (Polynomial Discriminator).

Topic 7. Examples of mathematical models in biology and medicine.

39.Analysis of some population growth patterns.

40. Malthus's model.

41. Verhulst's logistic model.

42. Flow cultivator model.

Topic 8. Examples of mathematical models in biology and medicine.

43. Models of biochemical reactions – analytically reactions of enzymatic catalysis (Michaelis-Menten, Malthus, Higgins, Reich, Selkow).

44. Oscillating systems.

45.Local model of Brussels

Topic 9. Examples of mathematical models in biology and medicine.

46. Models of morphogenesis.

47. Growth of microbial colonies.

48. Population range growth.

49. Growth of a cancerous tumor.

50. Neural impulse models.

51. Model of the dynamics of the state of ion channels.

Labs (18 hours)

Class 1. Fundamentals of Molecular Dynamics Modeling. Computational Experiment, Its Role and Place in Nanobiotechnology.

Class 2. Algorithms for Taking into Account the Thermodynamic Characteristics of the Medium

Class 3. Technologies for setting up and conducting computational experiments with various biomolecular systems.

Class 4. Software for molecular modeling of biostructures.

Self-study (54 hours)

Sample Essay Topics

1. Modeling based on neural networks.
2. Dynamic Models in Biology.
3. Simulation Procedure Software in Biology.
4. System Analysis and Modeling in Biology.
5. Cluster analysis of sputum cells and bronchoalveolar lavage.
6. Decision Support Systems (DSS) in Medicine.
7. Simulation of chemical migration processes in the food chain.

8. Classification of information sources for modeling biological processes.

VI. EDUCATIONAL AND METHODOLOGICAL SUPPORT OF STUDENTS' INDEPENDENT WORK

Independent work is defined as individual or collective learning activities carried out without the direct supervision of the teacher, but according to his tasks and under his supervision. Independent work is a cognitive learning activity, when the sequence of the student's thinking, his mental and practical operations and actions depends and is determined by the student himself.

Independent work of students contributes to the development of independence, responsibility and organization, a creative approach to solving problems at the educational and professional levels, which ultimately leads to the development of the skill of independent planning and implementation of activities.

The purpose of students' independent work is to acquire the necessary competencies in their field of training, experience in creative and research activities.

Forms of independent work of students:

- work with basic and additional literature, Internet resources;
- independent acquaintance with the lecture material presented on electronic media, in the library of an educational institution;
- preparation of abstract reviews of periodical press sources, reference notes, predetermined by the teacher;
- search for information on the topic with its subsequent presentation in the audience in the form of a report, presentations;
- preparation for classroom tests;
- Performing home tests;
- Performance of test tasks, problem solving;
- compilation of crosswords, schemes;
- preparation of reports for presentation at a seminar, conference;
- filling in the workbook;
- writing essays, term papers;
- preparation for business and role-playing games;
- Writing a resume;
- preparation for tests and exams;
- other types of activities organized and carried out by the educational institution and student self-government bodies.

Guidelines for writing and formatting an abstract

An essay is a creative activity of a student, which reproduces in its structure research activities to solve theoretical and applied problems in a certain branch of scientific knowledge. For this reason, coursework is the most important component of the educational process in higher education.

An essay, being a model of scientific research, is an independent work in which the student solves a problem of a theoretical or practical nature, applying scientific principles and methods of this branch of scientific knowledge. The result of this scientific research can have not only subjective, but also objective scientific novelty, and therefore can be presented for discussion by the scientific community in the form of a scientific report or a report at a scientific and practical conference, as well as in the form of a scientific article.

The abstract involves the acquisition of skills for building business cooperation based on ethical standards of scientific activity. Purposefulness, initiative, disinterested cognitive interest, responsibility for the results of one's actions, conscientiousness, competence are the personal qualities that characterize the subject of research activities that correspond to the ideals and norms of modern science.

An essay is an independent educational and research activity of a student. The instructor provides advice and evaluates the process and results. He provides an approximate topic of abstracts, clarifies the problem and topic of research together with students, helps to plan and organize research activities, appoints a time and a minimum number of consultations.

The teacher accepts the text of the essay for review at least ten days before the defense.

Traditionally, there is a certain structure of the abstract, the main elements of which, in the order of their arrangement, are the following:

1. Title page.
2. Task.
3. Table of Contents.
4. List of symbols, symbols and terms (if necessary).
5. Introduction.
6. Main part.
7. Conclusion.
8. References.
9. Applications.

The title page indicates: educational institution, graduating department, author, teacher, research topic, place and year of the abstract.

The title of the abstract should be as brief as possible and fully correspond to its content.

The table of contents (contents) reflects the names of the structural parts of the abstract and the pages on which they are located. It is advisable to place the table of contents at the beginning of the work on one page.

The presence of a detailed introduction is a mandatory requirement for the abstract. Despite the small volume of this structural part, its writing causes significant difficulties. However, it is the high-quality introduction that is the key to understanding the entire work, testifying to the professionalism of the author.

Thus, the introduction is a very important part of the abstract. The introduction should begin with a justification of the relevance of the chosen topic. When applied to an abstract, the concept of "relevance" has one peculiarity. How the author of the essay is able to choose a topic and how correctly he understands and evaluates this topic from the point of view of modernity and social significance, characterizes his scientific maturity and professional training.

In addition, in the introduction, it is necessary to identify the methodological base of the abstract, to name the authors whose works formed the theoretical basis of the study. A review of the literature on the topic should show the author's thorough familiarity with specialized literature, his ability to systematize sources, critically consider them, highlight the essential, and determine the main thing in the current state of study of the topic.

The introduction reflects the significance and relevance of the chosen topic, defines the object and subject, the purpose and objectives, and the chronological framework of the study.

The introduction concludes with a statement of general conclusions about the scientific and practical significance of the topic, the degree of its study and provision with sources, and the formulation of a hypothesis.

In the main part, the essence of the problem is stated, the topic is revealed, the author's position is determined, factual material is provided as an argument and to illustrate the proposed provisions. The author needs to demonstrate the ability to consistently present the material while simultaneously analyzing it. Preference is given to the main facts rather than small details.

The abstract ends with the final part, which is called the "conclusion". Like any conclusion, this part of the abstract plays the role of a conclusion conditioned by the logic of the research, which is in the form of a synthesis of the scientific information accumulated in the main part. This synthesis is a consistent, logically harmonious presentation of the results obtained and their correlation with the general goal and specific tasks set and formulated in the introduction. It is here that the so-called "inferential" knowledge is contained, which is new in relation to the original knowledge. The conclusion may include suggestions of a practical nature, thereby increasing the value of the theoretical materials.

So, the conclusion of the abstract should include: a) the conclusions of the study; b) theoretical and practical significance, novelty of the abstract; c) the possibility of applying the results of the study is indicated.

After the conclusion, it is customary to place a bibliographic list of the references. This list is one of the essential parts of the abstract and reflects the independent creative work of the author of the abstract.

A list of the sources used is placed at the end of the work. It is drawn up either in alphabetical order (by the author's surname or the title of the book), or in the order in which references appear in the text of the written work. In all cases, the full title of the work, the names of the authors or the editor of the publication, if a team of authors participated in the writing of the book, data on the number of volumes, the name of the city and publishing house in which the work was published, the year of publication, the number of pages are indicated.

Guidelines for Preparing Presentations

To prepare a presentation, it is recommended to use: PowerPoint, MS Word, Acrobat Reader, LaTeX beamer package. The easiest program to create presentations is Microsoft PowerPoint. To prepare a presentation, it is necessary to process the information collected when writing the abstract.

Sequence of presentation preparation:

1. Clearly state the purpose of the presentation.

2. Determine what the format of the presentation will be: live performance (how long it will be) or e-mailing (what will be the context of the presentation).

3. Select all the content for the presentation and build a logical chain of presentation.

4. Identify the key points in the content of the text and highlight them.

5. Determine the types of visualization (pictures) to be displayed on slides in accordance with the logic, purpose and specifics of the material.

6. Choose the design and format the slides (the number of pictures and text, their location, color and size).

7. Check the visual perception of the presentation.

Types of visualization include illustrations, images, diagrams, tables. An illustration is a representation of a real-life visual series. Images, as opposed to illustrations, are metaphors. Their purpose is to evoke an emotion and create an attitude towards it, to influence the audience. With the help of well-thought-out and presented images, information can stay in a person's memory for a long time. Diagram – visualization of quantitative and qualitative relationships. They are used for convincing demonstration of data, for spatial thinking in addition to logical thinking. A table is a concrete, visual and accurate display of data. Its main purpose

is to structure information, which sometimes makes it easier for the audience to perceive the data.

Practical tips for preparing a presentation

– printed text + slides + handouts are prepared separately;

– Slides – visual presentation of information, which should contain a minimum of text, a maximum of images that carry a semantic load, look clear and simple;

– Textual content of the presentation – oral speech or reading, which should include arguments, facts, evidence and emotions;

– Recommended number of slides 17-22

– mandatory information for the presentation: topic, surname and initials of the speaker; Communication plan brief conclusions from all that has been said; list of references;

– Handouts – should provide the same depth and reach as a live performance: people trust what they can take with them more than disappearing images, words and slides are forgotten, and the handout remains a constant tangible reminder; Handouts should be given out at the end of the presentation, handouts should be different from slides, should be more informative.

Criteria for evaluating the abstract.

The stated understanding of the abstract as an integral author's text determines the criteria for its evaluation: novelty of the text; the reasonableness of the choice of source; the degree of disclosure of the essence of the issue; compliance with the design requirements.

Novelty of the text: a) relevance of the research topic; b) novelty and independence in the formulation of the problem, formulation of a new aspect of the known problem in the establishment of new connections (interdisciplinary, intra-subject, integration); c) ability to work with research, critical literature, systematize and structure material; d) the manifestation of the author's position, the independence of assessments and judgments; e) stylistic unity of the text, unity of genre features.

Degree of disclosure of the essence of the issue: a) correspondence of the plan to the topic of the abstract; b) correspondence of the content to the topic and outline of the abstract; c) completeness and depth of knowledge on the topic; d) the validity of the ways and methods of working with the material; f) the ability to generalize, draw conclusions, compare different points of view on one issue (problem).

Reasonableness of the choice of sources: a) assessment of the literature used: whether the most well-known works on the topic of research are involved

(including journal publications of recent years, the latest statistical data, summaries, references, etc.).

Compliance with formatting requirements: a) how correctly the references to the literature used, the list of references; b) assessment of literacy and culture of presentation (including spelling, punctuation, stylistic culture), knowledge of terminology; c) compliance with the requirements for the length of the abstract.

The reviewer should clearly formulate a comment and questions, preferably with references to the work (it is possible to specific pages of the work), to research and factual data that the author did not take into account.

The reviewer can also indicate: whether the student has addressed the topic before (essays, written works, creative works, Olympiad works, etc.) and whether there are any preliminary results; how the graduate conducted the work (plan, intermediate stages, consultation, revision and revision of the written or lack of a clear plan, rejection of the recommendations of the supervisor).

The student submits an abstract for review no later than a week before the defense. The reviewer is the teacher. Experience shows that it is advisable to familiarize the student with the review a few days before the defense. Opponents are appointed by a teacher from among the students. 10-20 minutes is enough for a student to make an oral presentation (this is about the time it takes to answer the exam tickets).

Grade 5 is given if all the requirements for writing and defending an abstract are met: the problem is identified and its relevance is justified, a brief analysis of various points of view on the problem under consideration is made and one's own position is logically stated, conclusions are formulated, the topic is fully disclosed, the volume is maintained, the requirements for external design are met, correct answers to additional questions are given.

Grade 4 – the main requirements for the abstract and its defense have been met, but at the same time there are shortcomings. In particular, there are inaccuracies in the presentation of the material; there is no logical consistency in judgments; the volume of the abstract is not maintained; there are omissions in the design; Incomplete answers were given to additional questions during the defense.

Grade 3 – there are significant deviations from the abstract requirements. In particular, the topic is covered only partially; factual errors were made in the content of the abstract or in answering additional questions; There is no conclusion during the defense.

Grade 2 – the topic of the abstract is not disclosed, a significant misunderstanding of the problem is revealed.

Grade 1 – the abstract is not submitted by the student.

VII. MONITORING THE ACHIEVEMENT OF THE COURSE OBJECTIVES

Item No.	Supervised modules/sections/topics of the discipline	Codes and Stages of Competency Formation		Valuation Tools – Name	
				Current control	Intermediate Attestation
1	Topic 1-2	PC-4.1 Analyzes biochemical and molecular-biological mechanisms of development of pathological processes in cells and tissues of the human body and applies the principles of cellular organization of biological objects	Knows biochemical and molecular-biological mechanisms of the development of pathological processes in the cells and tissues of the human body. Can apply the principles of cellular organization of biological objects. Owns skills of determining biochemical and molecular-biological mechanisms of development of pathological processes in cells and tissues of the human body.	Poll	Exam Questions
		PC-4.2 Understands the biochemical and molecular-biological mechanisms of the development of pathological processes in the cells and tissues of the human body	Knows biochemical and molecular-biological mechanisms of the development of pathological processes in the cells and tissues of the human body. Can to apply biochemical and molecular-biological mechanisms of the development of pathological processes in the cells and tissues of the human body. Owns skills in the use of biochemical and molecular-biological mechanisms of the development of pathological processes in the cells and tissues of the human body	Test	

		PC-4.3 Understands and investigates the physical processes underlying the functioning of the body in normal and pathological conditions, understands the influence of physical factors on the functioning of biological systems, is able to study the physical structure of biologically important molecules in order to identify the relationship between the structure of substances and their biological activity	Knows the physical structure of biologically important molecules and the physical processes underlying their functioning. Can determine the relationship between the physical structure and properties and the functions that perform them in the body. Owns skills to study the physical structure of biologically important molecules and the physical processes underlying their functioning	Test	
2	Topic 3	PC-4.4 Able to develop and apply health-saving technologies	Knows technologies aimed at preserving the health of the population. Can apply health-saving technologies. Owns ability to develop health-saving technologies	Poll	
		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	Test	Exam Questions

		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.	Poll	Exam Questions
3	Topic 4-5	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 tasks in common programming languages, including Python.	Test	Exam Questions

4	Topic 6-8	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	
5	Topic 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, 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.	Test	Exam Questions

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

Reference citations

1. Mathematical Modeling, Numerical Methods and Complexes of Programs: Collection of Scientific Works / Kazaryan M.L., Muzaev I.D., Gioeva E.G. - Moscow: NITS INFRA-M, 2018. - 150 p.ISBN 978-5-16-106772-7 (online). - Text : electronic. - URL: https://znanium.com/catalog/product/972756

2. Mathematical Modeling and Design. Textbook / A.S. Kolomeichenko, I.N. Kravchenko, A.N. Stavtsev, A.A. Polukhin; edited by A.S. Kolomeichenko. Moscow: INFRA-M, 2018. — 181 p. — (Higher education: Master's degree). — www.dx.doi.org/10.12737/textbook_59688803c3cb35.15568286. - ISBN 978-5-16-012890-0. - Text : electronic. - URL: https://znanium.com/catalog/product/884599

3. Golitsyna O.L., Maksimov N.V., Popov I.I. Informatsionnye sistemy i tekhnologii: uchebnoe posobie [Information systems and technologies: textbook]. — Moscow : FORUM : INFRA-M, 2021. — 400 p. — (Secondary vocational education). - ISBN 978-5-00091-592-9. - Text : electronic. - URL: https://znanium.com/catalog/product/1138895

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6. Dubrovskiy S. A., Dudina V. A., Sadyeva Y. V. Metody obrabotki i analiza eksperimental'nykh dannykh [Methods of processing and analysis of experimental data: textbook]. - Lipetsk: Lipetsk State Technical University, EBS ASV, 2015. — 62 c. — ISBN 978-5-88247-719-5. — Text : electronic // Digital educational resource IPR SMART : [site]. — URL: https://www.iprbookshop.ru/55640.html

7. Selivanova I. A., Blinov V. A. Stroitel'nie i analiz algoritm obrabotki dannykh [Construction and analysis of algorithms for data processing: educational and methodological manual]. - Ekaterinburg: Ural Federal University, EBS ASV, 2015. — 108 c. — ISBN 978-5-7996-1489-8. — Text : electronic // Digital

educational resource IPR SMART : [site]. — URL: https://www.iprbookshop.ru/68277.html

Further reading

1. Boev V.D., Sypchenko R.P. Komp'yuternoe modelirovanie [Computer modeling]. - Moscow: Internet University of Information Technologies, 2010. - 455 p. : illus., table, diagram.; http://biblioclub.ru/index.php?page=book&id=233705

2. Galliamova S.E. Metodicheskie rekomendatsii dlya ispolnenie kontrol'nykh raboty po kursu «Komp'yuternoe modelirovaniya» [Methodical recommendations for the implementation of control work on the course "Computer modeling"]. S.E. Gallyamova. - Kristina & K LLC, Borisoglebsk, BGPI, 2007 – 67 p.

3. Kolesov, Y.B. Modelirovanie sistem: praktikum po komp'yuternomu modelirovaniya [Modeling of systems: practical training on computer modeling]. pos. + CD for Higher Educational Institutions / Yu.B. Kolesov, Yu.B. Senichenkov. - St. Petersburg: BHV-Petersburg, 2007

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12. Burtseva A.D., Voronov M.P. Theory of Catastrophes: Approaches to Research and Application. – 2016. – No 8. – pp. 43-52;

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 DJV and DjVu formats of the same name; 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 the lecture course on the discipline "Modeling of Biosystems and Big Data Analysis", the following are used as forms of active learning: 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 presentation of the lecture material, problematic questions or questions with elements are posed Discussion.

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.

Colloquia

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

As methods of interactive learning at colloquiums, the following are used: an extended conversation, a dispute, a press conference.

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

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

Press conference. The teacher assigns several students to prepare short (thesis) reports. After the presentations, students ask questions, which are answered

by the speakers and other members of the expert group. Based on the questions and answers, a creative discussion unfolds together with the teacher.

Case study method**.**The case-study method is a method of active problem-situational analysis based on learning by solving specific problems (case solving). The method of specific situations (case-study method) refers to non-game imitation active teaching methods and is considered as a tool that allows you to apply theoretical knowledge to solving practical problems. At the end of the lesson, the teacher tells a series of situations and offers to find solutions for those problems that are voiced in them. At the same time, the problem itself does not have unambiguous solutions. Students must analyze the situation, understand the essence of the problems, propose possible solutions and choose the best one. Thanks to the knowledge gained at the lecture, it is easy for the student to correlate the theoretical knowledge received with a real practical situation. As an interactive teaching method, it gains a positive attitude from students, who see it as an opportunity to take the initiative, feel independent in mastering theoretical provisions and mastering practical skills. No less important is the fact that the analysis of situations has a strong impact on the professionalization of students, contributes to their maturation, forms interest and positive motivation for learning. The method is aimed not so much at mastering specific knowledge or skills, as at developing the general intellectual and communicative potential of the student and the teacher.

It is a learning method designed to improve skills and gain experience in the following areas:

- identifying, selecting and solving problems;
- working with information – comprehending the meaning of the details described in the situation;
- analysis and synthesis of information and arguments;
- working with assumptions and conclusions;
- evaluation of alternatives;
- decision-making;
- Listening to and understanding other people is a group work skill. The main function of the case method is to teach students to solve complex unstructured problems that cannot be solved in an analytical way. The case activates students, develops analytical and communicative skills, leaving students face to face with real situations.

The case study is designed to increase the effectiveness of educational activities: as an illustration for solving a certain problem, explaining a particular phenomenon, studying the features of its manifestations in real life, developing competence aimed at solving various life and work situations (the use of the case involves individual and group work of students).

Brainstorming is a widely used way of generating new ideas to solve scientific and practical problems. Its goal is to organize collective thinking to find non-traditional ways to solve problems.

The use of the brainstorming method in the educational process allows you to solve the following tasks:

- creative assimilation of educational material by students;
- connection of theoretical knowledge with practice;
- • activation of educational and cognitive activities of students;
- formation of the ability to concentrate attention and mental efforts on the solution of an urgent task;
- formation of the experience of collective thinking activity.

The problem formulated in the brainstorming class should have theoretical or practical relevance and arouse the active interest of students. A common requirement that must be taken into account when choosing a problem for brainstorming is the possibility of many ambiguous solutions to the problem, which is put forward to students as a learning task.

Quizzes & Testing

Current control of material assimilation is assessed by oral answers, tests, as well as paper testing.

Assessments of laboratories, colloquiums, tests and testing mainly form the grade for this discipline.

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, Saperny Peninsula, Ajax village, 10, aud. M 422	Multimedia audience: 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	-