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

DISCIPLINE WORK PROGRAM (RAP)
"Bioengineering"
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 Russia dated 07.08.2020 No. 920

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
Authors: Candidate of Biological Sciences, Associate Professor Kumeiko V.V.

Vladivostok
2022

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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

Bioengineering

The total labor intensity of the discipline is 4 credits / 144 academic hours. It is a discipline of the elective part of the EP, studied in the 3rd year and ends *with a test.* The curriculum provides for 18 hours of lectures, *18* hours of laboratory work, *36* hours of practical work, and *72 hours* of independent work for the student.

Language: Russian.

The purpose of mastering the discipline "Bioengineering" is to familiarize the student with the main achievements in the field of bioengineering, to outline the range of modern technologies used and to indicate the prospects for the development of this field of knowledge and practical skills.

Objectives: formation of modern ideas about the latest trends in the development of biotechnology; The course covers the whole range of issues related to technological processes based on the use of living systems (modified microorganisms, cell cultures of plant and animal tissues, etc.).

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

- uses the principles of modern biotechnology, genetic engineering techniques, the basics of nanobiotechnology, molecular modeling in professional activities; - applies methods of virological, microbiological and epidemiological analysis;

- applies modern ideas about the basics of biotechnological and biomedical production, genetic engineering, nanobiotechnology, molecular modeling in professional activities.

Competencies are obtained as a result of studying the disciplines of *biomedical cell technologies*, molecular and cellular biology, *methods of molecular and cellular biology*, the student should be ready to study such disciplines as *bioengineering, genetic engineering, medical biotechnology,* forming competencies:

- conducts fundamental and relevant research in molecular genetics, genetic and bioengineering, and molecular and biomedical technologies;

- applies basic concepts of the basic laws and modern achievements of genetics, breeding, genomics, proteomics, in technologies for the production of pharmaceutical substances, medicines and nanotechnologies;

- applies the principles of obtaining and using enzymes, viruses, microorganisms, cell cultures of animals and plants, products of their biosynthesis.

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-2 Applies biotechnology and bioengineering methods to the development and production of medicines, medical devices, biomedical cell products and medical diagnostic systems	PC-2.1 Uses fundamental knowledge of molecular and cellular biology to put genetic and cellular engineering technologies into practice
	PC-2.2 Able to apply genetic and cellular engineering methods to the development and production of medicines, medical devices, biomedical cell products and medical diagnostic systems
	PC-2.3 Able to analyze the results of an experiment in the field of biotechnology and bioengineering and carry out the development of medicines, medical devices, biomedical cell products and medical diagnostic systems
	PC-2.4 Able to transfer the results of research work in the field of biotechnology and bioengineering for the development and production of medicines, medical devices, biomedical cell products and medical diagnostic systems

Code and name of the competency indicator	Name of the assessment indicator (the result of learning in the discipline)
PC-2.1 Uses fundamental knowledge of molecular and cellular biology to put genetic and cellular engineering technologies into practice	Knows methods of biotechnology and bioengineering. Can apply biotechnology and bioengineering techniques. Owns skills in obtaining medicines, medical devices, biomedical cell products and medical diagnostic systems.
PC-2.2 Able to apply genetic and cellular engineering methods to the development and production of medicines, medical devices, biomedical cell products and medical diagnostic systems	Knows methods of genetic and cellular engineering. Can apply genetic and cellular engineering methods. Owns the ability to obtain medicines, medical devices, biomedical cell products and medical diagnostic systems.

PC-2.3 Able to analyze the results of an experiment in the field of biotechnology and bioengineering and carry out the development of medicines, medical devices, biomedical cell products and medical diagnostic systems	Knows Features of the development of medicines, medical devices, biomedical cell products and medical diagnostic systems. Can analyze the results of an experiment in the field of biotechnology and bioengineering Owns skills in the development of medicines, medical devices, biomedical cell products and medical diagnostic systems.
PC-2.4 Able to transfer the results of research work in the field of biotechnology and bioengineering for the development and production of medicines, medical devices, biomedical cell products and medical diagnostic systems	Knows Features of the development of medicines, medical devices, biomedical cell products and medical diagnostic systems. Can to transfer the results of research work in the field of biotechnology and bioengineering. Owns skills in the development of medicines, medical devices, biomedical cell products and medical diagnostic systems.

To form the above competencies within the framework of the discipline "Bioengineering", 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

The purpose of mastering the discipline "Bioengineering" is to familiarize the student with the main achievements in the field of bioengineering, to outline the range of modern technologies used and to indicate the prospects for the development of this field of knowledge and practical skills.

Objectives: formation of modern ideas about the latest trends in the development of biotechnology; The course covers the whole range of issues related to technological processes based on the use of living systems (modified microorganisms, cell cultures of plant and animal tissues, etc.).

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-2 Applies biotechnology	PC-2.1 Uses fundamental knowledge of molecular and cellular

and bioengineering methods to the development and production of medicines, medical devices, biomedical cell products and medical diagnostic systems	biology to put genetic and cellular engineering technologies into practice
	PC-2.2 Able to apply genetic and cellular engineering methods to the development and production of medicines, medical devices, biomedical cell products and medical diagnostic systems
	PC-2.3 Able to analyze the results of an experiment in the field of biotechnology and bioengineering and carry out the development of medicines, medical devices, biomedical cell products and medical diagnostic systems
	PC-2.4 Able to transfer the results of research work in the field of biotechnology and bioengineering for the development and production of medicines, medical devices, biomedical cell products and medical diagnostic systems

Code and name of the competency indicator	Name of the assessment indicator (the result of learning in the discipline)
PC-2.1 Uses fundamental knowledge of molecular and cellular biology to put genetic and cellular engineering technologies into practice	Knows methods of biotechnology and bioengineering. Can apply biotechnology and bioengineering techniques. Owns skills in obtaining medicines, medical devices, biomedical cell products and medical diagnostic systems.
PC-2.2 Able to apply genetic and cellular engineering methods to the development and production of medicines, medical devices, biomedical cell products and medical diagnostic systems	Knows methods of genetic and cellular engineering. Can apply genetic and cellular engineering methods. Owns the ability to obtain medicines, medical devices, biomedical cell products and medical diagnostic systems.
PC-2.3 Able to analyze the results of an experiment in the field of biotechnology and bioengineering and carry out the development of medicines, medical devices, biomedical cell products and medical diagnostic systems	Knows Features of the development of medicines, medical devices, biomedical cell products and medical diagnostic systems. Can analyze the results of an experiment in the field of biotechnology and bioengineering Owns skills in the development of medicines, medical devices, biomedical cell products and medical diagnostic systems.

PC-2.4 Able to transfer the results of research work in the field of biotechnology and bioengineering for the development and production of medicines, medical devices, biomedical cell products and medical diagnostic systems	Knows Features of the development of medicines, medical devices, biomedical cell products and medical diagnostic systems. Can to transfer the results of research work in the field of biotechnology and bioengineering. Owns skills in the development of medicines, medical devices, biomedical cell products and medical diagnostic systems.

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

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

The types of training and work of the student in the discipline are:

Designation	Types of Study Sessions and Student Work
Mild	Lecture
Lex electric.	
Ave	Practical exercises
Pp electric.	
Lab	Labs
WED:	Student's independent work during the period of theoretical training
	And other types of work

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	Biomedical Engineering. Biomimetics. Genetic engineering. Recombinant DNA Technology	7	6	6	12	-	72	-	Questions for the test
2	Tissue Engineering and Transplantology. Bioinformatics.		6	6	12				Questions for the test

3	Process Bioengineering and Biochemical Engineering. Development of scientific and industrial equipment in biomedicine.		6	6	12				Questions for the test
	Total:	7	18	18	36	-	72	-	Credit

IV. CONTENT OF THE THEORETICAL PART OF THE COURSE

Lectures

Lecture 1. Biomedical Engineering.

The history of the formation and development of engineering areas in biology and medicine. Aims and objectives of bioengineering. Biomimetics as a key approach in bioengineering. Current trends and prospects for the development of bioengineering.

Problematic issues of the lecture: Unsolved topical problems of modern medicine and possible ways to solve them by bioengineering methods

Lecture 2. Biomimetics.

Bionics is an applied field of application of the principles of organization of living systems in technical devices and systems. Cybernetics. Modeling of living organisms. Application of bionics in medicine and engineering.

Biomechanics. Prosthetics. Endoprosthetics and prosthetics of limbs and other parts of the body. Materials used in prosthetics. Osseointegration. Neuroprosthetics.

Biodesign is an industrial and artistic design inspired by bionics. "Bio-tech" vs. "high-tech".

Problematic questions of the lecture: What is the relationship between the concepts of biomimetics, bionics and bioengineering – different fields or different names for the same field of activity?

Lecture 3-4. Genetic engineering. Recombinant DNA Technology

The prerequisites for the formation of genetic engineering are the establishment of the Central Dogma of molecular biology as one of the key postulates of modern natural sciences. The history of the emergence and development of genetic engineering. Emergence and development of recombinant DNA technologies. Vectors. Molecular cloning. Human Gene Therapy. Development of CRISPR-Cas technology 9.

Problematic issues of the lecture: Irreversibility of the transition of industry, agriculture, medicine and society to the era of biotechnology

Lecture 5-6. Tissue Engineering and Transplantology.

Principles of Differential Gene Expression. Stem cells. The concept of the intercellular matrix and the cellular microenvironment. Stem cell and cancer cell niches. Cell signaling. Induced stem cells. Cell and Tissue Technologies. Understanding biopolymers. Biocompatible materials. Organ growing, 3D bioprinting.

Fundamentals of Transplantology. Overcoming the immune response and organ rejection.

Problematic questions of the lecture: Historical misconceptions and miscalculations: "elixir of youth from stem cells" – truth, fraud or a time bomb?

Lecture 7. Bioinformatics

Bioinformatics as the Most Important Approach to the Processing of Medical and Biological Data in Modern Science. "Dry Biology" vs. "Wet Biology". A brief history of the development and formation of bioinformatics. Principles of data collection, storage and retrieval in information networks. Sequence bioinformatics. Structural Bioinformatics. Drug-design, targeted drug development.

Problematic questions of the lecture: Who will cope better with the tasks of bioinformatics – a doctor or a programmer?

Lecture 8. Process Bioengineering and Biochemical Engineering.

Enzymatic processes, kinetics of chemical reactions. Biocatalysis, bioenergetics (energy processes in living systems). Perfect and better-than-perfect enzymes. Design of biochemical processes, development of biochemical reactors. Biotechnology in the food industry. Genetically modified microorganisms in chemical, pharmaceutical and food production. Biodegradation of pollutants.

Lecture 9. Development of scientific and industrial equipment in biomedicine.

Sustainability and efficiency as key principles of biomedical device design. The concepts of "lab-on-a-chip", "multiplex", "high-throughput screening" are multi-threaded and high-performance technologies. Microarray technology. Process automation. Development of standards and requirements for the presentation of the results of scientific experiments. Integration of the principles and methods of bioinformatics into the principles of data acquisition and processing state-of-the-art biomedical equipment

Problematic issues of the lecture: The struggle between the principles of unification and standardization against know-how on the example of heterogeneity of next-generation sequencing (NGS) technologies.

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

Practical exercises

Practical lesson (seminar) 1. Biomedical Engineering.

The main unsolved problems and challenges of biotechnology and medicine. Proposed solutions, perspectives and current difficulties.

1. Unsolved Problems of Modern Biology: The Problem of Aging
2. Unsolved Problems of Modern Medicine: Incurable Diseases
3. Actual Tasks of Modern Medicine: The Problem of Allergy
4. Application of Genetically Modified Microorganisms in Medicine and Pharmaceutics (Biopharmaceuticals)
5. Bionics (biomimetics)
6. Application of biotechnologies in food production (fermented milk products, alcoholic beverages, etc.)
7. Applications of Biotechnology in Agriculture: Genetically Modified Organisms
8. Biotechnology Perspective: Biodegradation of Pollutants by Microorganisms
9. Biotechnology Perspective: Biofuels and Biogas Production
10. Gene Therapy: Technology and Prospects for Its Application.

Practical lesson (seminar) 2-3. Bionics and Prosthetics (4 hours) (using the active learning method: seminar-press conference)

Biomechanics. Mechanics of Body Movement, Man as a Kinetic System. Computer simulation of human and animal movements. Limb prosthetics. Modern materials in prosthetics. Biocompatibility, osseointegration.

Neurointegration. Basic principles of nervous system functioning. Neuroprosthetics – motor and sensory. Sensory prosthetics.

Human-Computer Integration: Cyborgs – Science Fiction or Reality? ("Cyberpunk" we need).

Practical Exercise 4. Recombinant DNA Technology (Part 1) (2 hours) (using the active learning method: workshop)

Molecular cloning methods. Plasmid DNA technology. Restriction reactions, restriction enzyme technology. Restriction cards. Work with plasmid maps and plasmid viewing software. Linearization and ligation of plasmids. Sticky and blunt ends. Terminal nukeotide transferases.

Practical Exercise 5. Recombinant DNA Technology (Part 2) (2 hours) (using the active learning method: workshop)

Creation of genetically modified microorganisms. Transformation. Culturing bacteria. Selection of modified microorganisms: antibiotic resistance selection, blue-white screening.

Practical Exercise 6. Recombinant DNA Technology (Part 3) (2 hours) (using the active learning method: workshop)

Polymerase chain reaction. Theory and technology of PCR. Types of PCR. Polymerases – Variety and Principles of Action. Development of new types of polymerases.

Workshop 7-8. Recombinant DNA Technology (Part 4) (4 hours) (using active learning methods: workshop, extended conversation)

Transfection of eukaryotic cells. Different ways of delivering vectors into the cell are electroporation, heat shock, lipid reagents, and liposomes. Viral vectors. Cosmids. Artificial chromosomes of bacteria, yeast and humans. Gene therapy. CRISPR-Cas Technology 9. Use of *Agrobacterium* for plant modification.

Practical Exercise 9-10. Bioinformatics. Access to archives of scientific information (4 hours) (using the active learning method: workshop)

Access to archives of scientific information. Nucleic acid sequence databases. Genomic databases. Proteomic databases. Protein sequence databases. Structure databases. Expression and proteomics databases. Metabolic pathway databanks. Signal transduction databases. Main databases on scientific literature and access systems. Databases for citation of academic literature.

Practical Exercise 11-12. Bioinformatics. Working with Sequences of Biological Molecules (4 hours) (using the active learning method: workshop)

Dynamic programming. Build and use point similarity matrices. Sequence alignment algorithms. Programs for building point similarity matrices. Programs for multiple alignment of amino acid and nucleotide sequences across databases.

BLAST (Basic Local Alignment Search Tool). Work in GeneBank and integrated databases.

DNA sequencing. Sanger sequencing and high-throughput sequencing. Whole genome sequencing. Assembling sequences.

Practical Exercise 13-14. Structural Bioinformatics and Proteomics (4 hours) (using the active learning method: workshop)

Formation of three-dimensional structure by proteins, folding (folding of proteins). The primary structure of proteins and the secondary structure of proteins. Tertiary and Quaternary structure of proteins. Stabilization of the tertiary structure of proteins: hydrophobicity and hydrophilicity. Stability of the structure of proteins. Isoforms of proteins. Graphical representations to describe the permitted conformations of the main chain. Structural alignments. Prediction and modeling of the three-dimensional structure of proteins. Homology modeling. Recognition of folding patterns. Conformational Energy Calculation and Molecular Dynamics. Prediction of protein functions.

Drug design. Drug discovery and drug development. Practical and legal aspects of drug development and introduction.

Practical Exercise 15-16. Cell and Tissue Technologies. (4 hours) (using the active learning method: workshop)

Stem cells. Cell Culture Technology. Work with stem cells and cancer cells. Types of cell media, application of extracellular matrix. Biocompatible, biodegradable materials. 3 D-bioprinting. Development of the extracellular matrix for the needs of transplantology and therapy of cancerous tumors.

Practical Exercise 17-18 (Seminar). Principles of development of scientific and industrial equipment in biomedicine. (4 hours) (seminar, press conference)

Sustainability and efficiency as key principles of biomedical device design. The concepts of "lab-on-a-chip", "multiplex", "high-throughput screening" are multi-threaded and high-performance technologies. Microarray technology. Process automation. Development of standards and requirements for the presentation of the results of scientific experiments. Integration of the principles and methods of bioinformatics into the principles of data acquisition and processing modern biomedical equipment.

Labs

Lab 1. Biomedical Engineering.

Lab 2. Biomimetics.

Lab 3. Genetic engineering. Recombinant DNA technology.

Lab 4. Tissue Engineering and Transplantology.

Lab 5. Bioinformatics.

Lab 6. Process Bioengineering and Biochemical Engineering.

Lab 7. Development of scientific and industrial equipment in biomedicine.

Self-paced work

Students' independent work consists of preparing for practical classes, working on recommended literature, writing reports on the topic of the seminar, and preparing presentations.

The teacher offers each student individual and differentiated assignments. Some of them can be carried out in a group (for example, the preparation of a report and a presentation on the same topic can be done by several students with a division of their responsibilities - one prepares the scientific and theoretical part, and the second analyzes the practice).

Independent work can be carried out individually or by groups of students, depending on the purpose, volume, specific topic of independent work, level of complexity and level of skills of students.

Control of the results of students' independent work should be carried out within the time allotted for compulsory classes and extracurricular independent work of students in the discipline, can take place in written, oral or mixed form.

Self-paced tasks

1. Writing an essay on a topic proposed by the teacher or independently chosen by the student and agreed with the teacher.

2. Preparation of presentations using multimedia equipment.

Sample essay topics:

1. Prospects and significance of purposeful change of biological objects.
2. Cell engineering as a branch of modern biotechnology.
3. Application of engineering principles in working with biological systems.
4. Possibilities of Cell Engineering in Crop Production.
5. Methods of isolation and cultivation of plant cells.
6. Ways of changing the properties of cells.
7. Cell reconstruction by fusion of cell fragments.
8. Methods of cell hybridization.
9. The importance of reconstructed cells for studying the influence of cytoplasm in the regulation of nuclear activity.
10. Biotechnologies based on isolated protoplasts.
11. Transplantation of nuclei and other organelles in plant cells.

12. Possibilities of genetic engineering in crop production.

13. Assessment of the potential risk of genetic transformation of plants.

14. Ways to accelerate the selection process in crop production.

15. Methods of isolation and cultivation of animal cells.

16. Creation of animal cell cultures.

17. Somatic hybridization of animal cells.

18. Cell Engineering in Animal Husbandry

19. Ways of preservation, improvement and improvement of the gene pool of existing and creation of new breeds of animals.

20. Principles and Methods of Animal Cloning.

21. Principles and methods of obtaining transgenic animals.

22. Cell engineering in humans and animals.

23. Principles and methods of controlling animal gene expression.

24. Methods of regulation of productivity of farm animals.

25. Safety issues of work with transgenic animals.

26. Scientific, Ethical, and Economic Problems of Animal Embryo Engineering.

27. Main achievements of domestic bioengineering.

28. History of the creation of artificial organs.

29. Artificial blood. Characteristics, purpose, creation technologies.

30. Nanotechnologies in plant breeding.

31. Nanotechnologies in animal breeding.

32. Construction of tissues and organs from human epithelial cells.

33. Bioengineering methods of natural resource conservation.

VI. 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	Biomedical Engineering. Biomimetics. Genetic engineering. Recombinant DNA Technology Tissue Engineering and Transplantology. Bioinformatics.	PC-2.1 Uses fundamental knowledge of molecular and cellular biology to put genetic and cellular engineering technologies into practice	Knows methods of biotechnology and bioengineering. Can apply biotechnology and bioengineering techniques. Owns skills in obtaining medicines, medical devices, biomedical cell products and medical diagnostic systems.	Test	Questions for the test
				Test	Questions for the test
2	Process Bioengineering and Biochemical Engineering. Development of scientific and industrial equipment in biomedicine.	PC-2.2 Able to apply genetic and cellular engineering methods to the development and production of medicines, medical devices, biomedical cell products and medical diagnostic systems	Knows methods of genetic and cellular engineering. Can apply genetic and cellular engineering methods. Owns the ability to obtain medicines, medical devices, biomedical cell products and medical diagnostic systems.	Test	Questions for the test

	Biomedical Engineering. Biomimetics. Genetic engineering. Recombinant DNA Technology	PC-2.3 Able to analyze the results of an experiment in the field of biotechnology and bioengineering and carry out the development of medicines, medical devices, biomedical cell products and medical diagnostic systems	Knows Features of the development of medicines, medical devices, biomedical cell products and medical diagnostic systems. Can analyze the results of an experiment in the field of biotechnology and bioengineering Owns skills in the development of medicines, medical devices, biomedical cell products and medical diagnostic systems.	Oral Questioning	Questions for the test
3	Tissue Engineering and Transplantology. Bioinformatics.	PC-2.4 Able to transfer the results of research work in the field of biotechnology and bioengineering for the development and production of medicines, medical devices, biomedical cell products and medical diagnostic systems	Knows Features of the development of medicines, medical devices, biomedical cell products and medical diagnostic systems. Can to transfer the results of research work in the field of biotechnology and bioengineering. Owns skills in the development of medicines, medical devices, biomedical cell products and medical diagnostic systems.	Oral Questioning	Questions for the test
				Test	Questions for the test

VII. EDUCATIONAL AND METHODOLOGICAL SUPPORT OF STUDENTS' INDEPENDENT WORK

Guidelines for writing and formatting an abstract

Abstracting of educational and scientific literature involves an in-depth study of individual scientific works, which should ensure the development of the necessary skills for working on the book. All this will contribute to the expansion of scientific horizons, the improvement of their theoretical training, and the formation of scientific competence.

Textbooks, individual monographic studies and articles on issues provided for by the program of the academic discipline are offered for abstracting. When selecting literature on the chosen issue, it is necessary to cover the most important areas of development of this science at the present stage. Particular attention should be paid to those literary sources that (directly or indirectly) can help the specialist in his practical activities. However, this section also includes works and individual studies on issues that go beyond the discipline being studied. It is recommended to use this literature if you want to expand your knowledge in any branch of science.

Along with literature on general issues, students are supposed to read literature taking into account the profile of their professional activity, obtained independently. Not all the proposed literature is equal in content and volume, so different approaches to its study are possible. In one case, it can be a general abstract of several literary sources of different authors devoted to the consideration of the same issue, in the other case, it can be a detailed study and abstract of one of the recommended works or even its individual sections, depending on the degree of complexity of the issue (problematic). In order to decide what to do in each case, you should consult with the teacher.

The choice of a specific work for the abstract should be preceded by a detailed acquaintance with the list of all literature given in the curriculum of the discipline. It is recommended to first familiarize yourself with the selected work by looking at the subheadings, highlighted texts, diagrams, tables, and general conclusions. Then it is necessary to read it carefully and thoughtfully (delving into the ideas and methods of the author), making notes on a separate sheet of paper about the main provisions and key issues. After reading, you should think over the content of the article or a separate chapter, paragraph (if we are talking about a monograph) and briefly write it down. Only strict definitions and formulations of laws should be written out verbatim. Sometimes it's helpful to include one or two examples to illustrate. In the event that there are unclear passages, it is recommended to read the following exposition, as it can help to understand the previous material, and then return to the comprehension of the previous exposition.

The result of the work on literary sources is an abstract.

When preparing an abstract, it is necessary to highlight the most important theoretical provisions and substantiate them independently, paying attention not only to the result, but also to the methodology used in the study of the problem. Reading scientific literature should be critical. Therefore, it is necessary to strive not only to assimilate the main content, but also the method of proof, to reveal the features of different points of view on the same issue, to assess the practical and theoretical significance of the results of the reviewed work. A very desirable element of the abstract is the expression by the listener of his own attitude to the ideas and conclusions of the author, supported by certain arguments (personal experience, statements of other researchers, etc.).

As mentioned above, abstracts of monographs and journal articles of a research nature must contain a definition of the problem and specific objectives of the research, a description of the methods used by the author, as well as the conclusions that he came to as a result of the research. The proposed literature for abstracting is constantly updated.

Instructions for writing essays:

General requirements for the abstract:

The abstract should be written according to the standard scheme, including:

- Title page
-contents
-introduction
- Main part
-conclusion
- List of references.

It is desirable to include tables and (or) figures in the text of the abstract: diagrams, graphs.The volume of the abstract: 10-20 pages of A4 format computer layout in the Times New Roman editor, with 1.5 intervals, in 14 fonts. The title of the topic of the essay should fully correspond to the chosen option.

The structure of the abstract should meet the standard requirements for writing essays: introduction, justification for the choice of topic, presentation of the topic, conclusion. More detailed requirements for the written design of the abstract are presented in the Procedure "Requirements for the design of written works performed by FEFU students and listeners" http://law.wl.dvgu.ru/docs/treb_2012.pdf

Approximate list of abstract topics:

1. Mechanisms of energy production in mitochondria.
2. The liver is its role in the human body.
3. Alcoholism and drug addiction are metabolic disorders.
4. Influence of trace elements on enzyme activity.

5. Metabolic connections of the Krebs cycle.
6. Types of jaundice.
7. Biotransformation of xenobiotics in the body.
8. Cholesterol fund in the human body and ways of its consumption.
9. Biological role of iron, molybdenum and zinc.

Criteria and Indicators Used in the Evaluation of the Educational Essay

Criteria	Indicators
1. Novelty of the abstracted text Max. – 5 points	- relevance of the problem and topic;- novelty and independence in the formulation of the problem, in the formulation of a new aspect of the problem selected for analysis;- the presence of the author's position, independence of judgments.
2. Degree of disclosure of the essence of the problemMax. – 5 points	- correspondence of the plan to the topic of the abstract;- correspondence of the content to the topic and plan of the abstract;- completeness and depth of disclosure of the main concepts of the problem;- validity of ways and methods of working with the material;- ability to work with literature, systematize and structure the material;- ability to generalize, compare different points of view on the issue under consideration, argue the main provisions and conclusions.
3. Reasonableness of the choice of sourcesMax. – 5 points	- the range and completeness of the use of literary sources on the problem;- attraction of the latest works on the problem (journal publications, materials of collections of scientific papers, etc.).
4. Compliance with Registration Requirements Max. – 5 points	- correct formatting of references to the literature used;- literacy and culture of presentation;- knowledge of terminology and conceptual apparatus of the problem;- compliance with the requirements for the volume of the abstract;- culture of design: highlighting paragraphs.
5. Literacy Max. - 5 points	- absence of spelling and syntax errors, stylistic errors;- absence of typos, abbreviations of words, except for generally accepted ones;- literary style.

Guidelines for Maintenance, Submission Requirements and Criteria for Evaluating the Outline

A synopsis (from the Latin conspectus – review) is a written text in which the content of the main source of information is briefly and consistently stated. To take notes is to bring to some order the information gleaned from the original. The process is based on the systematization of what has been read or heard. Notes can be made both in the form of precise excerpts, quotations, and in the form of a free presentation of meaning. The manner of writing the synopsis, as a rule, is close to the style of the original source. If the synopsis is written correctly, it should reflect the logic and semantic connection of the information being recorded.

In well-made notes, it is easy to find specialized terminology that is clearly explained and clearly highlighted for memorizing the meanings of various words.

Using the outline information, it is easier to create meaningful creative or scientific works, various essays and articles.

Note-taking rules

1. Read the text carefully. Along the way, mark incomprehensible places, new words, names, dates.

2. Make inquiries about the persons and events mentioned in the text. When recording, do not forget to put reference data in the fields.

3. When reading the text for the first time, make a simple outline. When re-reading, try to summarize the main points of the text, noting the author's arguments.

4. The final stage of note-taking consists of re-reading the previously marked passages and writing them down consecutively.

5. When taking notes, you should try to express the author's thought in your own words.

6. Strive to ensure that one paragraph of the author's text is conveyed in one, maximum two sentences.

When taking notes of lectures, it is recommended to adhere to the following basic rules.

1. Do not start writing down the material from the first words of the teacher, first listen to his thought to the end and try to understand it.

2. Start writing at the moment when the teacher, having finished the presentation of one idea, begins to comment on it.

3. In the synopsis, it is necessary to highlight individual parts. It is necessary to distinguish between headings, subheadings, conclusions, to separate one topic from another. Selection can be done with an underline or a different color (just don't turn the text into colorful pictures). It is recommended to indent paragraphs and points of the plan, white lines to separate one thought from another, and numbering. If definitions, formulas, rules, and laws can be made more visible in the text, they are framed. Over time, you'll have your own selection system.

4.Create your entries using accepted conventions. When taking notes, be sure to use a variety of signs (they are called signal signs). These can be pointers and directional arrows, exclamation and question marks, combinations PS (afterword) and NB (pay attention). For example, you can denote the word "therefore" with a mathematical arrow =>. Once you've developed your own character set, it's easier and faster to create an outline and then study it.

5. Don't forget about abbreviations (abbreviated words), equal and inequality signs, more and less.

6. Abbreviations are very useful for creating a correct outline. Be careful, though. Connoisseurs believe that abbreviations such as "d-t" (to think) and similar

ones should not be used, since later a large amount of time is spent on deciphering, and after all, the reading of the synopsis should not be interrupted by extraneous actions and reflections. The best thing to do is to develop your own system of abbreviations and use them to denote the same words (and nothing else) in all entries. For example, the abbreviation "g-t" will always and everywhere be the word "to speak," and the capital "P" will be the word "work."

7. Undoubtedly, foreign words will help to organize a good synopsis. The most common among them are English. For example, the abbreviated "ok" successfully denotes the words "excellent", "wonderful", "good".

8. Complex and lengthy reasoning should be avoided.

9. When taking notes, it is better to use declarative sentences, avoid independent questions. Questions are appropriate in the margins of the outline.

10. Do not try to record the material verbatim, in this case the main idea is often lost, and it is difficult to keep such a record. Discard secondary words, without which the main idea is not lost.

11. If there are terms in the lecture that you do not understand, leave a place, clarify their meaning with the teacher after the lesson.

Evaluation criteria:

86-100 points are given to the student if the abstract is presented in the most understandable form, has a plan, schemes and drawings in the structure, reveals all the basic concepts and questions given above;

76-85 points are given to the student if the abstract is presented in a sufficiently understandable form, has schemes and/or drawings in the structure, reveals more than half of the main concepts and questions;

75-61 points are given to the student if the abstract is presented in a relatively understandable form and reveals half of the main concepts and questions;

60-50 points are given to the student if the outline is presented in an incomprehensible form and reveals less than half of the main concepts and questions.

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

Reference citations

(electronic and print media)

1. Prikhodko N.A., Esimova A.M., Nadirova Zh.K. – Elektronnyi [Fundamentals of Bioengineering]. Text data. Almaty: Nur-Print, 2014. – 146 p. – Mode of access: http://www.iprbookshop.ru/69157.html. – EBS "IPRbooks"

2. Andrianov A.M. Konformational'nyy analiz belkov [Elektronnyi resurs]: teoriya i primeneniya [Elektronnyi resurs]: teoriya i primeneniya [Conformational

analysis of proteins]. –Electron. Text data. Minsk: Belorusskaya nauka, 2013. – 531 p. – Mode of access: http://www.iprbookshop.ru/29465.html

3. Genetic Foundations of Plant Breeding. Volume 3. Biotechnology in Plant Breeding. Cellular Engineering [Elektronnyi resurs]/ V.S. Anokhina [i dr.]. – Electron. Text data. Minsk: Belorusskaya nauka, 2012. – 490 p. – Mode of access: http://www.iprbookshop.ru/29441.html. – EBS "IPRbooks"

4. Dolgikh S.G. Uchebnoe posobie po gennoy inzheneriya v biotekhnologii rastenii [Textbook on genetic engineering in plant biotechnology]. –Electron. Text data. Almaty: Nur-Print, 2014. – 141 c. http://www.iprbookshop.ru/67169.html

5. A.M. Abaturova, D.V. Bagrov, A.A. Baizumanov [i dr.] [Nanobiotechnology: Practicum] / A.M. Abaturova, D.V. Bagrov, A.A. Baizumanov [i dr.] – M.: BINOM. Knowledge Lab, 2012. 384 p. (In Russian). Mode of access: http://lib.dvfu.ru:8080/lib/item?id=chamo:668224&theme=FEFU

6. Schelkunov S.N. Geneticheskaya inzheneriya [Elektronnyi resurs]: uchebno-spravochnoe posobie [Genetic engineering]. –Electron. Text data. Novosibirsk: Siberian University Publishing House, 2017. – 514 c. http://www.iprbookshop.ru/65273.html

Further reading

(print and electronic publications)

1. Online Resources Centre: Lesk: Introduction to Bioinformat http://global.oup.com/uk/orc/biosciences/bioinf/leskbioinf3e/ ics

2. Bionics. Biocybernetics. Bioengineering. T.2. Osnovy teorii excitable sredy [Fundamentals of the theory of excitable media] / Ed. by A.A.Nichiporovich. Moscow, VINITI Publ., 1977. – 106 c. http://lib.dvfu.ru:8080/lib/item?id=chamo:118494&theme=FEFU

3. Ignasimutu S. Osnovy bioinformatiki [Fundamentals of bioinformatics] / Ignasimutu S. – Elektron. Text data. Moscow, Izhevsk: Regular and Chaotic Dynamics, Izhevsk Institute for Computer Research, 2007. – 324 p. – Mode of access: http://www.iprbookshop.ru/16582.html. – EBS "IPRbooks"

4. Karetin, Y.A. Synergetics. Course of lectures for biologists / Y.A. Karetin. –Vladivostok. Far Eastern University Publ., 2008. 259 p. (in Russian). Available at: http://lib.dvfu.ru:8080/lib/item?id=chamo:262992&theme=FEFU

5. Kartavtsev, Y.F. Molecular Evolution and Population Genetics: Textbook for Higher Educational Institutions. Vladivostok: Far Eastern University Publ., 2009. 277 p. (in Russian). Mode of access: http://ini-fb.dvgu.ru/scripts/refget.php?ref=/ukazatel/kartavtsev/kartavtsev54.pdf

6. Lesk, A. Introduction to Bioinformatics, 2nd edition. Moscow: BINOM. Laboratory of Knowledge. 2015. – 318 p. Mode of access: http://lib.dvfu.ru:8080/lib/item?id=chamo:797691&theme=FEFU

7. Lukashov, V.V. Molecular Evolution and Phylogenetic Analysis. Tutorial. Moscow, Binom Publ., 2009. 256 p. (In Russian). Mode of access: http://lib.dvfu.ru:8080/lib/item?id=chamo:299205&theme=FEFU

8. A.M. Abaturova, D.V. Bagrov, A.A. Baizhumanov [et al.] ; edited by A.B. Rubin. Moscow: BINOM. Knowledge Lab, 2012. – 384 p. http://lib.dvfu.ru:8080/lib/item?id=chamo:668224&theme=FEFU

9. Fundamentals of Biochemical Engineering in 2 Hours: Part 1 / J. Bailey, D. Ollis; transl. by A. A. Kiryushkin. Moscow: Mir, 1989. – 692 c. http://lib.dvfu.ru:8080/lib/item?id=chamo:26812&theme=FEFU

10. Fundamentals of Biochemical Engineering in 2 Hours: Part 2 / D. Ollis, transl. by A.A. Kiryushkin. Moscow: Mir, 1989. – 590 c. http://lib.dvfu.ru:8080/lib/item?id=chamo:26813&theme=FEFU

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

12. Wilson, K. Principles and Methods of Biochemistry and Molecular Biology / K. Wilson, J Walker; transl. by T.P. Mosolova, E.Y. Bozelek-Reshetnyak. Moscow, Binom Publ., 2012. 848 p. (in Russian). Mode of access: http://lib.dvfu.ru:8080/lib/item?id=chamo:705602&theme=FEFU

13. Fedorenko, B.N. Promyshlennaya bioengineering [Industrial bioengineering]. Engineering Support of Biotechnological Production: Textbook for Universities // St. Petersburg: Profession, 2016. 616 p. (in Russian). Mode of access: http://lib.dvfu.ru:8080/lib/item?id=chamo:834295&theme=FEFU

14. Haubold B., Vie T. Introduction to Computational Biology: An Evolutionary Approach; transl. by S.V. Chudov. Moscow: Institute of Computer Research "Regular and Chaotic Dynamics" Publ., 2011. 455 p. (in Russian). Available at: http://lib.dvfu.ru:8080/lib/item?id=chamo:673149&theme=FEFU

15. Tsarik G.N., Polyanskaya I.A. Informatika i meditsinskaya statistiki [Informatics and medical statistics]. Moscow: GEOTAR-Media, 2017. 302 p. (in Russian). Mode of access: http://lib.dvfu.ru:8080/lib/item?id=chamo:842407&theme=FEFU

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 is a free file archiver with a high compression ratio;

3. Adobe Acrobat XI Pro – 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 – comprehensive protection for Windows-based workstations. Virtualization support + new technologies;

6. WinDjView 2.0.2 – 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

A lecture is the main active form of classroom classes, an 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 "Bioengineering" as forms of active learning, the following are used: lecture-conversation, lecture-visualization,

which are built on the basis of knowledge received by students in the framework of the 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.

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.

LOGISTICAL SUPPORT FOR 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: Motorized Screen 236*147 cm Trim Screen Line; DLP Projector, 3000 ANSI Lm, WXGA 1280x 800, 2000:1 EW330U Mitsubishi; CORSA-2007 Tuarex Specialized Equipment Mounting Subsystem; Video Switching Subsystem: Extron DVI DXP 44 DVI Pro Matrix Switcher Extron DVI 201	-

	Tx/Rx twisted-pair DVI extender Audio switching and sound reinforcement subsystem; SI 3CT LP Extron ceiling-mounted speaker system; Extron DMP 44 LC Digital Audio Processor; IPL T CR Control Controller Extension48; 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" All-in-One PC Intel Core i3-4130T 4GB DDR3-1600 SODIMM (1x4GB)500GB; 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. 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	