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

School of Biomedicine

Department of Medical Biology and Biotechnology

APPROVED
Head teacher
Yu.S. Khotimchenko
"_____" _____ 2021

PROGRAM
State final certification

DIRECTION OF TRAINING
19.03.01 Biotechnology
Academic Baccalaureate Program
Profile Molecular Biotechnology

Graduate Qualification - Academic Bachelor

Full-time form of education
The standard term for the development of the program
(full-time education) 4 years

Vladivostok
2021

APPROVAL SHEET
State final certification programs

In the field of training 03.19.01 Biotechnology
Educational program in the profile "Molecular Biotechnology"

The program of state final certification in the profile of "Molecular Biotechnology" has been drawn up in accordance with the requirements of the educational standard independently established by the federal state autonomous educational institution of higher education "Far Eastern Federal University" for the basic professional educational programs in the field of training 03.19.01 Biotechnology, higher education level bachelor degree , approved by the order of the rector of March 22, 2017 No. 12-13-485.

Reviewed and approved at a meeting of the Academic Council of the School of Biomedicine December 5, 2019 (Minutes No. 4)

Leader
abouteducational program — Department Director medical biology biotechnology, Ph.D. biol. Sciences, Associate Professor V.V. Kumeiko

Deputy Director
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for educational and educational work — Cand. biol. sciences, associate professor E.V. Khozhaenko

Content

Explanatory note

The program was developed in accordance with the educational standard independently established by the federal state autonomous educational institution of higher professional education "Far Eastern Federal University" for the implemented basic professional educational programs of higher education - undergraduate programs (hereinafter - the educational standard of FEFU) in the direction of training 03.19.01 Biotechnology (adopted by the decision Of the FEFU Academic Council, minutes No. 02-17 of 03/10/2017, put into effect by order of the FEFU rector of 03/22/2017 No. 12-13-485).

For students from among the disabled, the state final certification is carried out by the organization, taking into account the peculiarities of their psychophysical development, their individual capabilities and state of health. The specifics of conducting state attestation tests for persons with disabilities are enshrined in the Regulations on the state final attestation of graduates of the federal state autonomous educational institution of higher professional education "Far Eastern Federal University" (approved by order No. 12-13-2285 of November 27, 2015 (p. last change).

During the state final certification, the following general requirements are met:

– conducting state final certification for disabled people in one classroom together with students who do not have disabilities, if this does not create difficulties for students when passing the state final certification;

– the presence in the classroom of an assistant (assistants) who provides students with disabilities with the necessary technical assistance, taking into account their individual characteristics (take a workplace, move around, read and complete the task, communicate with members of the state examination commission);

– using the technical means necessary for students with disabilities when passing the state final certification, taking into account their individual characteristics;

– ensuring the possibility of unimpeded access for students with disabilities in the classroom, toilets and other premises, as well as their stay in the specified premises (the presence of ramps, handrails, widened doorways, elevators, in the

absence of elevators, the audience should be located on the first floor, the presence of special chairs and other devices) ...

1. Characteristics of the professional activity of graduates - the qualification characteristics of the graduate

1.1 Field and objects of professional activity:

The area of professional activity of graduates who have mastered the bachelor's program includes:

– obtaining, research and use of enzymes, viruses, microorganisms, cell cultures of animals and plants, products of their biosynthesis and biotransformation;

– technologies for obtaining products using microbiological synthesis, biocatalysis, genetic engineering and nanobiotechnology;

– operation and quality management of biotechnological industries in compliance with the requirements of national and international regulations;

– organization and implementation of quality control of raw materials, intermediate products and finished products.

1.2 Types of professional activities, for which graduates who have mastered the bachelor's program are preparing:

main types of professional activity:

– production and technological;

– research;

additional types of professional activities:

– organizational and managerial;

– design.

A graduate who has mastered the bachelor's program in the direction of training 03/19/01 Biotechnology must be ready to solve the following professional tasks in production and technological activities:

– management of individual stages of existing biotechnological industries;

– organization of workplaces, their technical equipment, placement of technological equipment;

– control over the observance of technological discipline;

– organization and conduct of incoming control of raw materials and materials;

– use of standard methods of quality control of manufactured products;

– identification of the causes of defects in production and the development of measures for its prevention and elimination;

– participation in fine-tuning and mastering of technological processes in the

course of preparationproduction of new products;

– participation in commissioning, tuning and experimental testing of equipment and software;

– checking the technical condition and residual life of equipment, organizing preventive examinations and maintenance, drawing up applications for equipment and spare parts, preparing technical documentation for repair work;

A graduate who has mastered the bachelor's program in the direction of training 03.19.01 Biotechnology must be ready to solve the following professional tasks in research activities:

– studying scientific and technical information, performing literary and patent searches on the research topic;

– participation in the organization and conduct of scientific research on a topical topic;

– experimental research and testing according to a given method, mathematical processing of experimental data;

– participation in the implementation of research and development results;

– preparation of data for the preparation of reports, reviews, scientific publications;

– participation in activities for the protection of intellectual property objects;

– participation in selected research and applied events in the implementation of the Biotechnology Development Program in the Russian Federation

– creation of research potential for the production of competitive products;

A graduate who has mastered the bachelor's program in the direction of training 03.19.01 Biotechnology must be ready to solve the following professional tasks in organizational and managerial activities:

– development of operational plans for the work of primary production units;

– organization of the work of teams of performers;

– participation in the preparation of technical documentation (work schedules, technological instructions, safety instructions, applications for materials and equipment, business correspondence documents);

– collection and preparation of initial data for the selection and justification of scientific, technical and organizational decisions based on economic analysis;

– preparation of documentation and participation in the implementation of the quality management system of the enterprise;

– execution of works on preparation for certification of technical means, systems, processes, equipment and materials;

– organization and implementation of measures to prevent industrial injuries, occupational diseases and environmental violations;

A graduate who has mastered the bachelor's program in the direction of training 03/19/01 Biotechnology must be ready to solve the following professional tasks in project activities:

– collection of initial data for the design of technological processes and installations;

– mathematical modeling of processes and objects based on standard computer-aided design packages;

– calculation and design of individual stages of the technological process using standard design automation tools;

– negotiating with design organizations and suppliers of technological equipment, evaluating the design results of biotechnological enterprises at the project stage;

– participation in the development of the main stages of the technological scheme, the study of the technological process at pilot and pilot-industrial installations and in the development of regulatory, technical and design documentation.

2. Requirements for the results of mastering the main professional educational program of an academic bachelor's degree in the direction of training 03.19.01 Biotechnology

A graduate who has mastered the bachelor's program "Molecular Biotechnology" must have the following general cultural competencies:

– the ability for self-improvement and self-development in the professional sphere, for raising the general cultural level (OK-1);

– readiness to integrate into the scientific, educational, economic, political and cultural space of Russia and the APR (OK-2);

– the ability to show initiative and make responsible decisions, realizing responsibility for the results of their professional activities (OK-3);

– the ability to creatively perceive and use the achievements of science and technology in the professional sphere in accordance with the needs of the regional and world labor market (OK-4);

– the ability to use modern methods and technologies (including information) in professional activities (OK-5);

– the ability to understand, use, generate and competently present innovative ideas in Russian in reasoning, publications, public discussions (OK-6);

– knowledge of a foreign language in oral and written form for the implementation of intercultural and foreign language communication (OK-7);

– the ability to use the foundations of philosophical knowledge to form an ideological position (OK-8);

– the readiness to use the basic methods of protecting production personnel and the population from the possible consequences of accidents, catastrophes, natural disasters (OK-9);

– the ability to analyze the main stages and patterns of the historical development of society for the formation of a civic position (OK-10);

– the ability to use the basics of economic knowledge in various fields of activity (OK-11);

– the ability to use the basics of legal knowledge in various fields of activity (OK-12);

– the ability to work in a team, tolerantly perceiving social and cultural differences (OK-13);

– the ability for self-organization and self-education (OK-14);

– the ability to use methods and means of physical culture to ensure full-fledged social and professional activity (OK-15).

A graduate who has mastered the bachelor's program "Molecular Biotechnology" must have the following general professional competencies:

– the ability to search, store, process and analyze information from various sources and databases, to present it in the required format using information, computer and network technologies (OPK-1);

– the ability and willingness to use the basic laws of natural science disciplines in professional activities, to apply the methods of mathematical analysis and modeling, theoretical and experimental research (OPK-2);

– the ability to use knowledge about the modern physical picture of the world, spatio-temporal laws, the structure of matter to understand the world around and natural phenomena (OPK-3);

– the ability to understand the importance of information in the development of a modern information society, awareness of the danger and threat arising in this process, the ability to comply with the basic requirements of information security, including the protection of state secrets (GPC-4);

– possession of basic methods, methods and means of obtaining, storing, processing information, skills of working with a computer as a means of information management (OPK-5);

– possession of the basic methods of protecting production personnel and the population from the possible consequences of accidents, catastrophes, natural disasters (OPK-6);

– the ability to find and evaluate new technological solutions, implement the results of biotechnological research and development (OPK-7).

A graduate who has mastered the bachelor's program "Molecular Biotechnology" must have the following professional competencies in accordance with the type of activity:

production and technological activities:

– the ability to carry out the technological process in accordance with the regulations and use technical means to measure the main parameters of biotechnological processes, properties of raw materials and products (PC-1);

– the ability to implement and manage biotechnological processes (PC-2);

– readiness to evaluate technical means and technologies, taking into account the environmental consequences of their use (PC-3);

– the ability to ensure compliance with safety regulations, industrial sanitation, fire safety and labor protection (PC-4);

organizational and management activities:

– the ability to organize the work of performers, find and make managerial decisions in the field of organization and work rate setting (PC-5);

– readiness to implement a quality management system for biotechnological products in accordance with the requirements of Russian and international quality standards (PC-6);

– the ability to systematize and generalize information on the formation and use of enterprise resources (PC-7);

research activities:

– the ability to work with scientific and technical information, use Russian and international experience in professional activities (PC-8);

– possession of the basic methods and techniques of experimental research in their professional field (PC-9);

– the ability to conduct standard and certification tests of raw materials, finished products and technological processes (PC-10);

– possession of methods for planning an experiment, processing and presenting the results obtained (PC-11);

– willingness to use modern information technologies in their professional field, including databases and application packages (PC-12);

project activity:

– the ability to participate in the development of technological projects as part of the team of authors (PC-13);

– readiness to use modern computer-aided design systems (PC-14);

– the ability to design technological processes using automated systems for technological preparation of production as part of the team of authors (PC-15);

– willingness to negotiate with design organizations and suppliers of technological equipment, evaluate the design results of biotechnological enterprises at the project stage (PC-16);

– the ability to develop the main stages of the biotechnological process (PC-17);

– willingness to participate in research on the biotechnological process at pilot and pilot industrial installations (PC-18);

– willingness to participate in the development of design and working technical documentation (PC -19)

3. Indicators, criteria for assessing competencies and scale assessing the level of competence formation

Competency code and wording	Stages of competence formation		criteria	indicators
General cultural competences				
OK-1 the ability for self-improvement and self-development in the professional sphere, for raising the general cultural level	knows (threshold level)	–the history of the development of the main directions of human thought; –ways of self-improvement and self-development in the professional sphere, raising the general cultural level	**knowledge (basic material only)** the history of the development of the main directions of human thought; ways of self-improvement and self-development in the professional sphere, raising the general cultural level	**demonstrates knowledge** the history of the development of the main directions of human thought; ways of self-improvement and self-development in the professional sphere, raising the general cultural level
	can (advanced)	–improve and develop in the professional sphere, raise the general cultural level	**the ability to use knowledge of the basic material in solving practical issues and problems and** improve and develop in the professional sphere, raise the general cultural level	**demonstrates (based on knowledge) the solution of practical issues and problems** in the professional sphere, taking into account the development and improvement of the professional and general cultural level
	owns (high)	–skills of participation in scientific discussions, speaking with messages and reports, oral, written and	**deep and solid possession of knowledge, skills and abilities** participation in scientific discussions, speeches with	**demonstrates skills** participation in scientific discussions, presentations with messages and reports,
		virtual (placement in information networks) presentation of materials;	messages and reports, oral, written and virtual (placement in information networks)	oral, written and virtual (posting in information networks) presentation of

		–culture of thinking; the ability to perceive, analyze, generalize information, set goals and choose ways to achieve them; –the skills of improving their professional qualifications, self-development, self-education, raising the cultural level; –ways of self-improvement and self-development in the professional sphere, raising the general cultural level	presentation of materials; culture of thinking; the ability to perceive, analyze, generalize information, set goals and choose ways to achieve them; skills of improving one's professional qualifications, self-development, self-education, raising the cultural level, ways of self-improvement and self-development in the professional sphere, raising the general cultural level	materials; culture of thinking; the ability to perceive, analyze, generalize information, set goals and choose ways to achieve them; skills of improving one's professional qualifications, self-development, self-education, raising the cultural level, ways of self-improvement and self-development in the professional sphere, raising the general cultural level
OK-2 readiness to integrate into the scientific, educational, economic, political and cultural space of Russia and the APR	knows (threshold level)	–stages of the historical and geopolitical process (world and domestic), their objectivity and regularity, the latest achievements of domestic and	**knowledge (basic material only)** stages of the historical and geopolitical process (world and domestic), their objectivity and	**demonstrates knowledge** stages of the historical and geopolitical process (world and domestic), their objectivity and
		foreign science, controversial problemseducational, economic, political and cultural space of Russia and the APR	regularity, the latest achievements of domestic and foreign science, controversial problems educational, economic, political and cultural space of Russia and the APR	regularity, the latest achievements of domestic and foreign science, controversial problems educational, economic, political and cultural space of Russia and the APR
	can (advanced)	–work with scientific sources; critically comprehend facts and events, overcome subjectivity and	**the ability to use knowledge of the basic material in solving practical issues and problems**	**demonstrates (based on knowledge) when solving practical issues and**

		tendentiousness in their presentation, draw conclusions and argue their own position based on the analysis of available information	**and** work with scientific sources; critically comprehend facts and events, overcome subjectivity and tendentiousness in their presentation, draw conclusions and argue their own position based on the analysis of available information	**problems**work with scientific sources; critically comprehend facts and events, overcome subjectivity and tendentiousness in their presentation, draw conclusions and argue their own position based on the analysis of available information
	owns (high)	– culture of thinking, the ability to generalize, analyze, perceive information; – general scientific methods in science, special historical methods, methods borrowed from other sciences;	**deep and solid possession of knowledge, skills and abilities** general scientific methods in science, special	**demonstrates skills** general scientific methods in science, special historical methods, methods borrowed from
		– methods of conducting discussion and polemics; – readiness to integrate into the scientific, educational, economic, political and cultural space of Russia and the APR	historical methods, methods borrowed from other sciences; conducting discussion and polemics;integration into the scientific, educational, economic, political and cultural space of Russia and the APR	other sciences; conducting discussion and polemics;integration into the scientific, educational, economic, political and cultural space of Russia and the APR

OK-3 ability to exercise initiative and make responsible decisions, realizing responsibility for the results of their professional activities	knows (threshold level)	–ways of making the right decisions in difficult situations, the consequences of making a decision, a measure of responsibility for the results of their professional activities	**knowledge (basic material only)** ways making the right decisions in difficult situations, the consequences of decision-making, a measure of responsibility for the results of their professional activities	**demonstrates knowledge** ways of accepting the right decisions in difficult situations, the consequences of decision-making, the degree of responsibility for the results of their professional activities
	can (advanced)	–show initiative, make responsible decisions, be responsible for them	**the ability to use knowledge of the basic material in solving practical issues and problems and** show initiative, make responsible decisions, be responsible for them	**demonstrates (on the basis of knowledge) the solution of practical issues and problems in** showing initiative, making responsible decisions, taking responsibility for them
	owns (high)	–the skills of making responsible decisions, manifestation of initiative, responsibility for the results of their professional activities	**deep and lasting possession of knowledge, skills and** **skills** making responsible decisions, showing initiative, responsibility for the results of their professional activities	**demonstrates skills** taking responsible decisions, initiative, responsibility for the results of their professional activities

OK-4 the ability to creatively perceive and use the achievements of science, technology in professional sphere in accordance with the needs of the regional and global labor market	knows (threshold level)	advances in science, technology in the professional field in accordance with the needs of the regional and global labor market	**knowledge (basic material only)** achievements of science, technology in the professional field in in accordance with the needs of the regional and global labor market	**demonstrates knowledge** achievements of science, technology in the professional field in accordance with the needs of the regional and global labor market
	can (advanced)	creatively perceive and use the achievements of science and technology in the professional sphere in accordance with the needs of the regional and world labor market	**the ability to use knowledge of the basic material in solving practical issues and problems and** creatively perceive and use the achievements of science and technology in the professional sphere in accordance with the needs of the regional and world labor market	**demonstrates (based on knowledge) the solution of practical issues and problems** using the achievements of science and technology in the professional sphere in accordance with the needs of the regional and world labor market
	owns (high)	ability to creatively perceive and use achievements of science, technology in the professional sphere in accordance with the needs of the regional and world labor market	**deep and lasting possession of knowledge, skills and** **skills in** using the achievements of science and technology in the professional sphere in accordance with the needs of the regional and world labor market	**demonstrates skills** use of achievements science, technology in the professional sphere in accordance with the needs of the regional and world labor market

OK-5 the ability to use modern methods and technologies (including information) in professional activities	knows (threshold level)	– modern methods and technologies (including information) for the development of new directions in industrial biotechnology; – the importance and role of information and information technologies in the development of modern society and economic knowledge, ways of using information and communication technologies in industrial biotechnology; – the procedure for entering and editing information in the automation system	**knowledge (basic material only)** modern methods and technologies (including information) for the development of new directions in industrial biotechnology; the significance and role of information and information technologies in the development of modern society and economic knowledge, ways of using information and communication technologies in industrial biotechnology; the procedure for entering and editing information in the automation system	**demonstrates knowledge** modern methods and technologies (including information) for the development of new directions in industrial biotechnology; the significance and role of information and information technologies in the development of modern society and economic knowledge, ways of using information and communication technologies in industrial biotechnology; the procedure for entering and editing information in the automation system

	can (advanced)	– use modern methods and technologies (including information) in molecular biotechnology; – use software to solve professional problems; – use services and information resources of the Internet in molecular biotechnology	**the ability to use knowledge of the basic material in solving practical issues and problems and** use modern methods and technologies (including information) in molecular biotechnology; use software to solve professional problems; use services and information resources of the Internet in molecular biotechnology	**demonstrates (based on knowledge) the solution of practical issues and problems** the use of modern methods and technologies (including information) in molecular biotechnology; use of software for solving professional problems; use of services and information resources of the Internet in molecular biotechnology
	owns (high)	– modern methods and technologies (including information) in molecular biotechnology; – the main methods, methods and means of obtaining, storing, processing information; computer skills as a means of information management	**deep and solid possession of knowledge, skills and abilities** modern methods and technologies (including information) in molecular biotechnology; basic methods, methods and means of obtaining, storing, processing information; computer skills as a tool	**demonstrates skills** modern methods and technologies (including information) in molecular biotechnology; the main methods, methods and means of obtaining, storing, processing information; skills to work with
			information management	computer as a means of information management

ОК-6 the ability to understand, use, generate and competently present innovative ideas in Russian in reasoning, publications, public discussions	knows (threshold level)	– basic norms of the modern Russian language and the system of functional styles of the Russian language – features of functional-style and genre differentiation of the Russian literary language	**knowledge (basic material only)** the basic norms of the modern Russian language and the system of functional styles of the Russian language, features of the functional-style and genre differentiation of the Russian literary language	**demonstrates knowledge** the basic norms of the modern Russian language and the system of functional styles of the Russian language, features of functional-style and genre differentiation Russian literary language
	can (advanced)	– use the main reference literature, explanatory and normative dictionaries of the Russian language – use different linguistic means in different situations of communication in oral and written form, demonstrating knowledge of linguistic norms	**the ability to use knowledge of the basic material in solving practical issues and problems and** use the main reference literature, explanatory and normative dictionaries of the Russian language, use various linguistic means in various situations of communication in oral and written form, demonstrating knowledge of linguistic norms	**demonstrates (based on knowledge) the solution of practical issues and problems** the use of basic reference literature, explanatory and normative dictionaries of the Russian language, the use of various linguistic means in various situations of communication in oral and written form, demonstrating knowledge
				language norms

	owns (high)	– the skills of creating literate and logically consistent written and oral texts of educational and scientific topics of an abstract-research nature in Russian – the skills of a competent and reasoned presentation of their thoughts orally and in writing in any communication situations	**deep and solid possession of knowledge, skills and abilities** creation in Russian of literate and logically consistent written and oral texts of educational and scientific topics of an abstract-research nature, skills of competent and reasoned expressing your thoughts orally and in writing in any communication situations	**demonstrates skills** creation in Russian of literate and logically consistent written and oral texts of educational and scientific topics of an abstract-research nature, skills of competent and reasoned expressing your thoughts orally and in writing in any communication situations
OK-7 knowledge of a foreign language orally and in writing for the implementation of intercultural and foreign language communication	knows (threshold level)	– the main meanings of the studied lexical units (words, phrases, phraseological units, idiomatic expressions); the main ways of word formation; – grammatical rules and models that make it possible to understand rather complex texts in	**knowledge (basic material only)** the main meanings of the studied lexical units (words, phrases, phraseological units, idiomatic expressions); the main ways of word formation; grammatical rules and models that allow you to understand rather complex	**demonstrates knowledge** the main meanings of the studied lexical units (words, phrases, phraseological units, idiomatic expressions); the main ways of word formation; grammatical rules and models allowing

		in a foreign language and competently build your own speech (in oral and written form) in various types of temporal forms and in various modalities; – basic norms of speech etiquette (cliche remarks, the most common evaluative vocabulary), adopted in the country target language; features of the way of life, way of life, culture of the countries of the target language, similarities and differences in the traditions of their country and countries of the target language	texts in a foreign language and competently build your own speech (in oral and written form) in various kinds of temporal forms and in various modalities; the basic norms of speech etiquette (cliche remarks, the most common evaluative vocabulary), adopted in the country of the target language; peculiarities of lifestyle, everyday life, culture of the countries of the target language, similarities and differences in the traditions of their country and countries of the target language	understand rather complex texts in a foreign language and competently build their own speech (in oral and written form) in various types of temporal forms and in various modalities; basic norms of speech etiquette (cliche remarks, the most common evaluative vocabulary), adopted in the country of the target language; peculiarities of lifestyle, everyday life, culture of the countries of the target language, similarities and differences in the traditions of their country and countries of the target language
	can (advanced)	– communicate in most situations that may arise during a stay in the country of the target language without prior training; participate in	**the ability to use knowledge of the basic material in solving practical issues and problems and** communicate in most situations that may arise during	**demonstrates (based on knowledge) the solution of practical issues and problems** communication in most situations that may arise during your stay in
		– dialogues on a familiar or interesting topic (dialogue);	stay in the country of the target language without prior training;	the country of the target language without prior

		– build simple coherent statements about your personal impressions, events; justify and explain their views and intentions; tell a story or plot the plot of a book or film and express to it	participate in dialogues on a familiar or interesting topic (dialogue); build simple coherent statements about your personal impressions, events; justify and explain their views and intentions; tell a story or	training; participation in dialogues on a familiar or interesting topic (dialogue); building simple coherent statements about your personal impressions, events; justification and explanation of their views and intentions; storytelling
		your attitude (monologue); – understand the main provisions of clearly pronounced statements within the literary norm on well-known topics that have to be dealt with in educational, professional activities and everyday life; understand what is going on in most radio and television programs about current events, as well as programs related to personal or professional	present the plot of a book or film and express your attitude towards it (monologue); understand the main provisions of clearly pronounced statements within the literary norm on well-known topics that have to be dealt with in educational, professional activities and everyday life; understand what is being discussed in most radio and television programs about current events, as well as programs,	or the presentation of the plot of a book or film and the expression of your attitude towards this (monologue); understanding of the main provisions of clearly pronounced statements within the literary norm on well-known topics that have to be dealt with in educational, professional activities and everyday life; understanding what is at stake

		–interests (listening); understand texts based on the frequency linguistic material of everyday and professional communication; understand the description of events, feelings, intentions in letters of a personal nature (reading); write simple, coherent texts on familiar or interesting topics; –write personal letters, informing them about their personal experiences and impressions	related to personal or professional interests (listening); understand texts based on the frequency linguistic material of everyday and professional communication; understand the description of events, feelings, intentions in letters of a personal nature (reading); write simple connected texts on familiar or interesting topics; write personal letters, informing them about their personal experiences and impressions	in most radio and television programs about current events, as well as programs related to personal or professional interests (listening); comprehension of texts built on the frequency linguistic material of everyday and professional communication; understanding descriptions of events, feelings, intentions in letters of a personal nature (reading); writing simple coherent texts on familiar or interesting topics; writing letters of a personal nature, informing them about their personal experiences and impressions
	owns (high)	–sufficient language knowledge (phonetic, spelling, lexical and grammatical) to take part in the conversation	**deep and solid possession of knowledge, skills and abilities** sufficient language skills to take part in the conversation	**demonstrates skills** sufficient language skills to take part in the conversation (start, maintain and end
		(start, support and end the conversation) with a certain	(start, support and end the conversation) with a certain	conversation) with a certain number of pauses and

		amount of pauses and descriptive expressions in familiar (learned) situations; – in a foreign language in oral and written form for the implementation of intercultural and foreign language communication	amount of pauses and descriptive expressions in familiar (learned) situations; a foreign language in oral and written form for the implementation of intercultural and foreign language communication	descriptive expressions in familiar (learned) situations; a foreign language in oral and written form for the implementation of intercultural and foreign language communication
OK-8 the ability to use the foundations of philosophical knowledge to form an ideological position	knows (threshold level)	– basic concepts and – the concept of philosophy, the history of the development of the main directions of human thought; – the foundations of philosophical knowledge for the formation of a worldview position	**knowledge (only basic material)** basic concepts and concepts of philosophy, the history of the development of the main directions of human thought; the foundations of philosophical knowledge for the formation of a worldview position	**demonstrates knowledge** basic concepts and concepts of philosophy, the history of the development of the main directions of human thought; the foundations of philosophical knowledge for the formation of a worldview position
	can (advanced)	– to conduct philosophical research in accordance with the set goal and objectives, to determine the logic of scientific research regarding the assessment of one's own activities;	**the ability to use knowledge of the basic material in solving practical issues and problems and** conduct philosophical research in accordance with the set goal and objectives, determine the logic	**demonstrates (based on knowledge) the solution of practical issues and problems using** the foundations of philosophical knowledge in the formation of a worldview position
		use the basics of philosophical knowledge to form a worldview position	conducting scientific research on the assessment of their own activities use the basics of philosophical knowledge to form a worldview position	

	owns (high)	–tools and methods of scientific philosophical research; –the basics of philosophical knowledge for the formation of a worldview position	**deep and solid possession of knowledge, skills and abilities** methods of scientific philosophical research; the foundations of philosophical knowledge for the formation of a worldview position	**demonstrates skills** the foundations of philosophical knowledge for the formation of a worldview position
OK-9 readiness to use the main methods of protecting production personnel and the population from the possible consequences of accidents, catastrophes, natural disasters	knows (threshold level)	–the main methods of protecting production personnel and the population from the possible consequences of accidents, catastrophes, natural disasters; –types of applicable standards and criteria, units of measurement, is guided in their values	**knowledge (basic material only)** the main methods of protecting production personnel and the population from the possible consequences of accidents, catastrophes, natural disasters; types of applicable standards and criteria, units of measurement, their values	**demonstrates knowledge** methods of protecting production personnel and the population from possible consequences of accidents, catastrophes, natural disasters; types of applicable standards and criteria, units of measurement, their values
	can (advanced)	–use basic protection methods	**skill in solving practical issues and**	**demonstrates (knowledge based) solution**

		–production personnel and the population from the possible consequences of accidents, catastrophes, natural disasters; –use hygienic criteria in the working environment and criteria in assessing damage to the natural environment	**tasks to use the knowledge of the basic material and** use the main methods of protecting production personnel and the population from the possible consequences of accidents, catastrophes, natural disasters; use hygiene criteria in the working environment and criteria in assessing damage to the natural environment	**practical issues and tasks,** using the main methods of protecting production personnel and the population from the possible consequences of accidents, catastrophes, natural disasters; using hygienic criteria in the working environment and criteria in assessing damage natural environment
	owns (high)	–the main methods of protecting production personnel and the population from the possible consequences of accidents, catastrophes, natural disasters; –methodology for assessing actual working conditions in comparison with regulatory requirements	**deep and solid possession of knowledge, skills and abilities** the main methods of protecting production personnel and the population from the possible consequences of accidents, catastrophes, natural disasters; methodologies for assessing actual working conditions in comparison with regulatory requirements	**demonstrates skills** the main methods of protecting production personnel and the population from the possible consequences of accidents, catastrophes, natural disasters; methodologies for assessing actual working conditions in comparison with regulatory requirements
OK-10 the ability to analyze the main stages and patterns of the historical development of	knows (threshold level)	–stages of the historical process (world and domestic), their objectivity and regularity, the latest achievements of domestic	**knowledge (basic material only)** stages of the historical process (world and domestic), their objectivity and regularity,	**demonstrates knowledge** stages of the historical process (world and domestic), their objectivity and regularity, the

society for the formation of civic position		and foreign historical science, debatable problems of history	the latest achievements of domestic and foreign historical science, debatable problems of history	latest achievements of domestic and foreign historical science, debatable problems of history
	can (advanced)	–pose a scientific problem, substantiate its relevance; –work with historical sources; –critically comprehend historical facts and events, overcome subjectivity and tendentiousness in their presentation, draw conclusions and argue their own position based on the analysis of available information	**the ability to use knowledge of the basic material in solving practical issues and problems and** pose a scientific problem, substantiate its relevance; work with historical sources; critically comprehend historical facts and events, overcome subjectivity and tendentiousness in their presentation, draw conclusions and argue their own position based on the analysis of available information	**demonstrates (based on knowledge) in solving practical issues and problems** opportunities to put a scientific problem, substantiate its relevance; work with historical sources; critically comprehend historical facts and events, overcome subjectivity and tendentiousness in their presentation, draw conclusions and argue their own position based on the analysis of available information
	owns (high)	–culture of thinking, the ability to generalize, analyze, perceive information; – general scientific methods in historical science, special	**deep and solid possession of knowledge, skills and abilities** culture of thinking, the ability to generalize, analyze, perceive information; general scientific	**demonstrates skills** culture of thinking, the ability to generalize, analyze, perceive information; general scientific methods in historical science,

		historical methods, methods borrowed from other sciences; – techniques of discussion and polemics	methods in historical science, special historical methods, methods borrowed from other sciences; techniques of discussion and polemics	special historical methods, methods borrowed from other sciences; techniques of discussion and polemics
OK-11 the ability to use the foundations of economic knowledge in various fields of activity	knows (threshold level)	– methods for calculating the economic efficiency of the development and implementation of new biotechnological products; – fundamentals of economic knowledge in various fields of activity	**knowledge (basic material only)** methods for calculating the economic efficiency of the development and implementation of new biotechnological products; fundamentals of economic knowledge in various fields of activity	**demonstrates knowledge** methods for calculating the economic efficiency of the development and implementation of new biotechnological products; fundamentals of economic knowledge in various fields of activity
	can (advanced)	– apply methods for calculating the technical and economic efficiency of the production of biotechnological products when choosing	**the ability to use knowledge of the basic material in solving practical issues and problems and** apply calculation methods	**demonstrates (based on knowledge) the solution of practical issues and problems** applying techniques for calculating technical

		– optimal technical and organizational solutions – collect and prepare initial data for the selection and justification of scientific, technical and organizational decisions based on economic analysis; use the basics of economic knowledge in various fields of activity	the technical and economic efficiency of the production of biotechnological products, when choosing the optimal technical and organizational solutions, to collect and prepare initial data for the selection and substantiation of scientific, technical and organizational decisions based on economic analysis; use the basics economic knowledge in various fields of activity	the economic efficiency of the production of biotechnological products when choosing the optimal technical and organizational solutions by collecting and preparing initial data for the selection and justification of scientific, technical and organizational decisions based on economic analysis; using the basics of economic knowledge in various fields of activity
	owns (high)	– the skills of calculating the economic efficiency of technological processes for the production of biotechnological products; – the basics of economic knowledge in various fields of activity	**deep and solid possession of knowledge, skills and abilities** calculating the economic efficiency of technological processes for the production of biotechnological products; the basics of economic knowledge in	**demonstrates skills** calculating the economic efficiency of technological processes for the production of biotechnological products; the basics of economic knowledge in various fields of activity
			various fields of activity	
OK-12 the ability to use the foundations	knows (threshold	– the system of normative legal acts in the Russian Federation;	**knowledge (basic material only)** systems of normative legal	**demonstrates knowledge** systems of normative legal

of legal knowledge in various fields of activity	level)	–basics of legal knowledge in various fields of activity	acts in the Russian Federation; foundations of legal knowledge in various fields of activity	acts in the Russian Federation; foundations of legal knowledge in various fields of activity
	can (advanced)	–use regulations in their activities; –use the basics legal knowledge in various fields of activity	**the ability to use knowledge of the basic material in solving practical issues and problems and** use regulations in their activities; use the basics of legal knowledge in various fields of activity	**demonstrates (based on knowledge) the solution of practical issues and problems** using regulatory legal acts in their activities; using the basics of legal knowledge in various fields of activity
	owns (high)	–skills in the application of regulatory legal acts in various spheres of life; –the basics of legal knowledge in various fields of activity	**deep and solid possession of knowledge, skills and abilities** application of normative legal acts in various spheres of life; the basics of legal knowledge in various fields of activity	**demonstrates skills** application of normative legal acts in various spheres of life; the basics of legal knowledge in various fields of activity

OK-13 the ability to work in a team, tolerant of social and cultural differences	knows (threshold level)	–principles of functioning of a professional team, understand the role of corporate norms and standards	**knowledge (basic material only)** principles of functioning of the professional team, the role of corporate norms and standards	**demonstrates knowledge** principles of functioning of the professional team, the role of corporate norms and standards

	can (advanced)	–work in a team, effectively fulfill the tasks of professional activity	**the ability to use knowledge of the basic material in solving practical issues and problems and** work in a team, effectively fulfill the tasks of a professional activities	**demonstrates (on the basis of knowledge) the solution of practical issues and problems of skills** work in a team, effectively fulfill the tasks of a professional activities
	owns (high)	–methods of interaction with a team performing various professional tasks and responsibilities	**deep and solid possession of knowledge, skills and abilities** interaction with a team performing various professional tasks and responsibilities	**demonstrates skills** interaction with a team performing various professional tasks and responsibilities
OK-14 ability for self-organization and self-education	knows (threshold level)	–the content of self-organization and self-education processes, their features and implementation technologies, based on the goals of improving professional	**knowledge (basic material only)** the content of the processes of self-organization and self-education, their features and implementation technologies, based on the goals	**demonstrates knowledge** the content of self-organization and self-education processes, their features and implementation technologies, based on the goals of improvement
		activities	improvement of professional activity	professional activity

	can (advanced)	–plan goals and set priorities when choosing methods of decision-making, taking into account the conditions, means, personal capabilities and the time perspective of achieving the implementation of activities	**the ability to use knowledge of the basic material in solving practical issues and problems and** plan goals and set priorities when choosing methods of decision-making, taking into account the conditions, means, personal capabilities and time perspective of achievement implementation of activities	**demonstrates (based on knowledge) in solving practical issues and problems** planning goals and setting priorities when choosing ways of making decisions, taking into account the conditions, means, personal capabilities and time perspective of achievement implementation of activities
	owns (high)	–technologies for organizing the process of self-education; methods of goal-setting in the time perspective, methods of planning, organization, self-control and self-assessment of activities	**deep and solid possession of knowledge, skills and abilities** technologies for organizing the process of self-education; methods of goal-setting in the time perspective, planning, organization, self-control and self-assessment of activities	**demonstrates skills** technologies for organizing the process of self-education; methods of goal-setting in the time perspective, planning, organization, self-control and self-assessment of activities
OK-15 ability to use methods and tools	knows (threshold level)	–general theoretical aspects of physical education, their role and significance	**knowledge (basic material only)** general theoretical aspects of	**demonstrates knowledge** general theoretical aspects of classes
physical culture to ensure full-fledged social and professional activity		in the formation of a healthy lifestyle; –principles and methods of organizing, refereeing physical culture and sports events	physical education, their role and importance in the formation of a healthy lifestyle; principles and methods of organization, refereeing of health and fitness	physical culture, their role and importance in the formation of a healthy lifestyle; principles and methods of organization,

			and sports events	refereeing of health and fitness and sports events
	can (advanced)	– independently build an individual trajectory of physical culture and sports achievements; – to use a variety of means and methods of physical culture to maintain and strengthen health, improve performance; – use methods of self-control of your physical condition; – work in a team to achieve common and personal goals	**the ability to use knowledge of the basic material in solving practical issues and problems and** independently build an individual trajectory of physical culture and sports achievements; to use a variety of means and methods of physical culture to maintain and strengthen health, improve performance; use methods of self-control of your physical condition; work in a team to achieve common and personal goals	**demonstrates (on the basis of knowledge) in solving practical issues and problems the possibilities** independently build an individual trajectory of physical culture and sports achievements; to use a variety of means and methods of physical culture to maintain and strengthen health, improve performance; use methods of self-control of your physical condition;
				work in a team to achieve common and personal goals

	owns (high)	–various forms and types of physical culture activities for the organization of a healthy lifestyle; –methods of self-control of individual indicators of health, physical fitness; –motor actions of basic sports and actively uses them in game and competitive activities; –a system of professionally and vital practical skills and abilities that ensure the preservation and strengthening of physical and mental health	**deep and solid possession of knowledge, skills and abilities** various forms and types of physical culture activities for the organization of a healthy lifestyle; ways of self-control of individual indicators of health, physical fitness; motor actions of basic sports and actively uses them in game and competitive activities; a system of professionally and vital practical skills and abilities that ensure the preservation and strengthening of physical and mental health	**demonstrates skills** various forms and types of physical culture activities for the organization of a healthy lifestyle; ways of self-control of individual indicators of health, physical preparedness; motor actions of basic sports and actively uses them in game and competitive activities; a system of professionally and vital practical skills and abilities that ensure the preservation and strengthening of physical and mental health

General professional competencies				
OPK-1 the ability to search, store,	knows (threshold	- information, computer and network technologies;	**knowledge (basic material only)** information, computer and	**demonstrates knowledge** information, computer and

process and analyze information from various sources and databases, to present it in the required format using information, computer and network technologies	level)	- ways search, storage, processing and analysis of information from various sources and databases	network technologies; wayssearch, storage, processing and analysis of information from various sources and databases	network technologies; wayssearch, storage, processing and analysis of information from various sources and databases
	can (advanced)	- search, store, process and analyze information from various sources and databases, present it in the required format	**the ability to use knowledge of the basic material in solving practical issues and problems and** search, storage, processing and analysis of information from various sources and databases, present it in the required format	**demonstrates (based on knowledge) in solving practical issues and problems** search, store, process and analysis of information from various sources and databases, present it in the required format
	owns (high)	– the ability to search, store, process and analyze information from various sources and databases, to present it in the required format using information, computer and network	**deep and solid possession of knowledge, skills and abilities** search, store, process and analyze information from various sources and databases, present it in the required format using	**demonstrates skills** search, storage, processing and analysis of information from various sources and databases, present it in the required format using information,
		technologies	information, computer and network technologies	computer and network technologies

OPK-2 the ability and willingness to use the basic laws of natural science disciplines in professional activities, to apply the methods of mathematical analysis and modeling, theoretical and experimental research	knows (threshold level)	−the main concepts, formulas and laws of natural sciences in professional activities, methods of mathematical analysis and modeling, theoretical and experimental research; −biotechnological aspects, used in biotechnology; −objects of biotechnology and their biotechnological functions, principles of cell cultivation; −the essence of the methods of molecular genetics, molecular and cellular biology; −stages of selection of target products	**knowledge (basic material only)** major concepts, formulas and laws of natural science in professional activities, methods of mathematical analysis and modeling, theoretical and experimental research; biotechnological aspects used in biotechnology; objects of biotechnology and their biotechnological functions, principles of cell cultivation; essence of molecular genetics methods; stages of selection of target products	**demonstrates knowledge** major concepts, formulas and laws of natural science in professional activities, methods of mathematical analysis and modeling, theoretical and experimental research; biotechnological aspects used in biotechnology; objects of biotechnology and their biotechnological functions, principles of cell cultivation; essence of molecular genetics methods; stages of selection of target products
	can (advanced)	−formulate the basic laws of natural science	−**skill in solving practical issues and**	**demonstrates (knowledge-based) skill**
		disciplines in professional activity; −use the basic laws of natural science disciplines in	**tasks to use the knowledge of the basic material and** to formulate the basic laws of natural science disciplines in	to formulate the basic laws of natural science disciplines in professional activities, to use the basic laws of natural

		professional activities; −apply methods of mathematical analysis and modeling, theoretical and experimental research −conduct experimental research and tests to use mathematical processing of experimental data; −use the language of molecular biotechnology; select biological objects	professional activities, to use the basic laws of natural science disciplines in professional activities; apply methods of mathematical analysis and modeling, theoretical and experimental research; conduct experimental research and tests according to a given method, use mathematical processing of experimental data;use the language of molecular biotechnology; select biological objects	science disciplines in professional activities; apply methods of mathematical analysis and modeling, theoretical and experimental research; conduct experimental research and tests according to a given method, use mathematical processing of experimental data;use the language of molecular biotechnology; select biological objects

	owns (high)	−methods and principles of improving molecular biotechnology; −the basic laws of natural sciences in molecular biotechnology, methods of mathematical analysis and modeling, theoretical and experimental research	**deep and lasting possession** methods and principles of improving molecular biotechnology; the basic laws of natural sciences in molecular biotechnology, methods of mathematical analysis and modeling, theoretical and experimental research	**demonstrates possession skills** methods and principles for improving molecular biotechnology; basic laws of natural sciences in molecular biotechnology, methods of mathematical analysis and modeling, theoretical and experimental research
OPK-3 the ability to use knowledge about the modern physical picture of the world, spatio-temporal laws, the structure of matter to understand the surrounding world and natural phenomena	knows (threshold level)	−the concept of the structure of matter; −the main directions and problems of modern ideas of Russian and foreign scientists about the physical picture of the world and the structure of matter for understanding the surrounding world and natural phenomena	**knowledge (basic material only)** the concept of the structure of matter; the main directions and problems of modern ideas of Russian and foreign scientists about the physical picture of the world and the structure of matter for understanding the surrounding world and natural phenomena	**demonstrates knowledge** the concept of the structure of matter; the main directions and problems of modern ideas of Russian and foreign scientists about the physical picture of the world and the structure of matter for understanding the surrounding world and natural phenomena

	can (advanced)	–to distinguish scientific knowledge from unscientific; to apply knowledge –physical and chemical laws to describe the natural science picture of the world; –to give a practical assessment of the modern physical picture of the world on the basis of certain provisions of the theory of the structure of matter	**skill in solving practical issues and** **tasks to use the knowledge of the basic material and** to distinguish scientific knowledge from unscientific; apply knowledge of physical and chemical laws to describe the natural science picture of the world; to give a practical assessment of the modern physical picture of the world on the basis of certain provisions of the theory of the structure of matter	**demonstrates skills** distinguish scientific knowledge from the unscientific; apply knowledge of physical and chemical laws to describe the natural science picture of the world; to give a practical assessment of the modern physical picture of the world on the basis of certain provisions of the theory of the structure of matter
	owns (high)	–the skills of analyzing natural phenomena and processes using ideas about the natural science picture of the world; –the ability to use knowledge about the modern physical picture of the world, spatio-temporal laws, the structure of matter to understand the surrounding world and natural phenomena	**deep and solid possession of knowledge, skills and abilities** analysis of natural phenomena and processes using ideas about the natural science picture of the world; use knowledge about the modern physical picture of the world, spatio-temporal laws, the structure of matter to understand the surrounding world and natural phenomena	**demonstrates possession skills** analysis of natural phenomena and processes using ideas about the natural-scientific picture of the world; knowledge about the modern physical picture of the world, spatio-temporal laws, the structure of matter for understanding the surrounding world and natural phenomena
OPK-4 the ability to understand the	knows (threshold	–principles of functioning of information systems, understand	**knowledge (basic material only)**	**demonstrates knowledge** principles of functioning of

meaning of information in the development of a modern information society, awareness of the danger and threat arising in this process, the ability to comply with the basic requirements of information security, including the protection of state secrets	level)	the role of legal norms and standards	principles of functioning of information systems, the role of legal norms and standards	information systems, the role of legal norms and standards
	can (advanced)	–work with information, effectively fulfill the tasks of professional activity	**the ability to use knowledge of the basic material in solving practical issues and problems and** work with information, effectively fulfill the tasks of professional activity	**demonstrates (knowledge-based) skills in solving practical issues and tasks** work with information, effectively fulfill the tasks of professional activity
	owns (high)	–methods of interaction with information that serves to perform various professional tasks and responsibilities	**deep and solid possession of knowledge, skills and abilities** interaction with information that serves to perform various professional tasks and responsibilities	**demonstrates skills** interaction with information that serves to perform various professional tasks and responsibilities
OPK-5 possession of basic methods, methods and means of obtaining, storing, processing information, skills of working with a computer as a means of information management	knows (threshold level)	–basic methods of obtaining, storing, processing information; –approaches to popularizing and presenting the results of biomedical, biochemical and biotechnological research in a popular and popular scientific form	**knowledge (basic material only)** basic methods of obtaining, storing, processing information; approaches to popularizing and presenting the results of biomedical, biochemical and biotechnological research in a	**demonstrates knowledge** basic methods of obtaining, storing, processing information; approaches to popularizing and presenting the results of biomedical, biochemical and biotechnological research in a

			popular and popular scientific form	popular and popular scientific form
	can (advanced)	–work with a computer as an information management tool	**the ability to use knowledge of the basic material in solving practical issues and problems and** work with a computer as an information management tool	**demonstrates (based on knowledge) in solving practical issues and problems** work with a computer as an information management tool
	owns (high)	–the skills of obtaining, storing, processing information using computer technologies and systems;	**deep and solid possession of knowledge, skills and abilities** receiving, storing, processing information using computer technology and	**demonstrates skills** receiving, storing, processing information using computer technologies and systems; analysis and processing
		–the skills of analyzing and processing scientific data and presenting them in popular science form	systems; analysis and processing of scientific data and their presentation in popular science form	scientific data and their presentation in scientific popular form
OPK-6 possession of the basic methods of protecting production personnel and the population from the possible consequences of accidents, catastrophes, natural disasters	knows (threshold level)	–principles, methods, means of ensuring the safety of life in industrial conditions and in emergencies of natural and man-made origin; –the main methods of protecting production personnel and the population from the possible consequences of accidents, disasters, natural	**knowledge (basic material only)** principles, methods, means of ensuring the safety of life in industrial conditions and in emergencies of natural and man-made origin; the main methods of protecting production personnel and the population from possible	**demonstrates knowledge** principles, methods, means of ensuring the safety of life in industrial conditions and in emergencies of natural and man-made origin; basic methods of protecting production
		disasters; means and methods of increasing the safety of technical	consequences of accidents, catastrophes, natural disasters;	personnel and population from possible consequences

		means and technological processes	means and methods of increasing the safety of technical means and technological processes	of accidents, catastrophes, natural disasters; means and methods of increasing the safety of technical means and technological processes
	can (advanced)	–to differentiate the principles, methods and means of ensuring safety applied in industrial and emergency conditions; –protect production –personnel and population from the possible consequences of accidents, catastrophes, natural disasters to monitor the parameters of air, noise, vibration, electromagnetic, thermal radiation	**the ability to use knowledge of the basic material in solving practical issues and problems and** differentiate used in production conditions and in emergencies, principles, methods and means of ensuring safety; protect production personnel and the population from possible consequences of accidents, catastrophes, natural disasters; monitor air parameters, noise, vibration, electromagnetic, thermal radiation	**demonstrates (based on knowledge) in solving practical issues and problems** differentiate used in industrial and emergency conditions principles, methods and means of ensuring safety; protect production personnel and the population from possible consequences of accidents, catastrophes, natural disasters; monitor air parameters, noise, vibration, electromagnetic, thermal radiation
	owns (high)	–tools and methods of analysis in industrial conditions and in emergencies of natural and man-	**deep and lasting possession** tools and methods of analysis in industrial conditions and in	**demonstrates possession skills** tools and methods of analysis in industrial

		made origin; −skills of protecting production personnel and the population from the possible consequences of accidents, catastrophes, natural disasters	emergencies of natural and man-made origin; skills of protecting production personnel and the population from the possible consequences of accidents, catastrophes, natural disasters	conditions and in emergencies of natural and man-made origin; skills of protecting production personnel and the population from the possible consequences of accidents, catastrophes, natural disasters
OPK-7 ability to find and evaluate new technological solutions, implement the results of biotechnological research and development	knows (threshold level)	−theoretical foundations of genetics, biotechnology and the foundations of biotechnological industries; −new and promising methods and techniques in the biotechnological field; −problems of the development of biotechnological methods in medical biology and biotechnology, priority directions for their solution; −the importance of biotechnology for the development of society, its social effect and bioeconomy	**knowledge (basic material only)** theoretical foundations of genetics, biotechnology and the foundations of biotechnological industries; problems of the development of biotechnological methods in medical biology and biotechnology, priority directions for their solution; the importance of biotechnology for the development of society, its social effect and bioeconomy	**demonstrates knowledge** theoretical foundations of genetics, biotechnology and the foundations of biotechnological industries; problems of the development of biotechnological methods in medical biology and biotechnology, priority directions for their solution; the importance of biotechnology for the development of society, its social effect and bioeconomy
	can (advanced)	−apply scientific and technical information on the development of new directions in biotechnology, genetics, including biomedicine and	**the ability to use knowledge of the basic material in solving practical issues and problems and** apply scientific and technical information on	**demonstrates (based on knowledge) the solution of practical issues and problems** application of scientific and technical information on development

				issues
		biopharmaceuticals; −work with scientific and technical information, use Russian and international experience in professional activities; −develop and implement new technological and methodological solutions	development of new directions in biotechnology, genetics, including biomedicine and biopharmaceuticals; work with scientific and technical information, use Russian and international experience in professional activities	new directions in biotechnology, genetics, including biomedicine and biopharmaceuticals; ability to work with scientific and technical information, use Russian and international experience in professional activities
	owns (high)	−a set of knowledge and skills in the field of modern goals and objectives of molecular biotechnology, main directions and development prospects; −principles and methods of finding and evaluating new technological solutions, the ability to implement results of biotechnological research and development	**deep and solid possession of knowledge, skills and abilities**in the complex of knowledge and skills in the field of modern goals and objectives of molecular biotechnology, main directions and development prospects; principles and methods for finding and evaluating new technological solutions, implementation of the results of biotechnological research and development	**demonstrates skills** a set of knowledge and skills in the field of modern goals and objectives of molecular biotechnology, main directions and development prospects; principles and methods of finding and evaluating new technological solutions, the possibility of implementing the results of biotechnological research and development

Professional competence				
production and technological activities:				
PC-1 the ability to carry out the technological process in accordance with the regulations and use technical means to measure the main parameters biotechnological processes, properties of raw materials and products	knows (threshold level)	−production technology and basic technological operations and operating modes of technological equipment for the production of biotechnological products; −rules for organizing and maintaining the technological process in the production of biotechnological products; −methods for controlling the main parameters of biotechnological processes, properties of raw materials and products	**knowledge (basic material only)** production technologies and main technological operations and operating modes of technological equipment for the production of biotechnological products; rules for organizing and maintaining the technological process in the production of biotechnological products; methods of control of the main parameters of biotechnological processes, properties of raw materials and products	**demonstrates knowledge** production technologies and main technological operations and operating modes of technological equipment for the production of biotechnological products; rules for organizing and maintaining the technological process in the production of biotechnological products; methods of control of the main parameters of biotechnological processes, properties of raw materials and products
	can (advanced)	−lead the main technological processes	**skill in solving practical issues and**	**demonstrates (based on knowledge) when solving**

		−production biotechnological products; −regulate technological processes production of biosynthesis products according to the indications of control and measuring devices and the results of analyzes based on the determination of technological parameters of the processes of production of biosynthesis products; −enjoy methods quality control of technological operations in the production of biotechnological products	**tasks to use the knowledge of the basic material and** lead the main technological processes of production biotechnological products; regulate technological processes production of biosynthesis products according to the indications of instrumentation and the results of analyzes based on the determination of technological parameters of processes production of biosynthetic products; use quality control methods for performing technological operations in the production of biotechnological products	**practical issues and tasks skills** lead the main technological processes of production biotechnological products; regulate technological processes production of biosynthesis products according to the indications of instrumentation and the results of analyzes based on the determination of technological parameters of production processes of biosynthesis products; use quality control methods for performing technological operations in the production of biotechnological products
	owns (high)	−the ability to carry out the technological process in accordance with the regulations and use technical means for measuring	**deep and solid possession of knowledge, skills and abilities** carry out the technological process in accordance with the regulations and	**demonstrates skills** implementation of the technological process in accordance with the regulations and
		main parameters of	use technical means to measure	use technical means to

		biotechnological processes, properties of raw materials and products; – skills in conducting research of the biotechnological process in pilot and pilot industrial installations	the main parameters of biotechnological processes, properties of raw materials and products; holding researchth biotechnological process on pilot and pilot industrial plants	measure the main parameters of biotechnological processes, properties of raw materials and products; conducting research on the biotechnological process at pilot and pilot plant installations
PC-2 ability to implement and manage biotechnological processes	knows (threshold level)	−basic principles of regulation of metabolism and growth rate of microorganisms, methods of cultivation of microorganisms, quantitative characteristics of the growth of cultures, −equipment for the cultivation of microorganisms, storage of microorganisms; −the main stages of the biotechnological process;	**knowledge (basic material only)** basic principles of regulation of metabolism and growth rate of microorganisms, methods of cultivation of microorganisms, quantitative characteristics of the growth of cultures, equipment for the cultivation of microorganisms, storage of microorganisms;the main stages of the biotechnological process; ways, methods and principles of implementation and management	**demonstrates knowledge** basic principles of regulation of metabolism and growth rate of microorganisms, methods of cultivation of microorganisms, quantitative characteristics of the growth of cultures, equipment for the cultivation of microorganisms, storage of microorganisms;the main stages of the biotechnological process; ways, methods and principles

		−ways, methods and principles of implementation and management of biotechnological processes; modern achievements in biological sciences and biomedical technologies	biotechnological processes; modern advances in biological sciences and biomedical technologies	implementation and management of biotechnological processes; modern advances in biological sciences and biomedical technologies
	can (advanced)	−regulate and improve the biotechnological process in order to obtain a high-quality final product; −to carry out biotechnological production processes and obtain biologically active substances and individual components of microbial cells; −to carry out isolation and purification of biologically active substances from biomass and culture liquid; −carry out stepwise control and standardization of the drugs obtained (determination of the antimicrobial activity of antibiotics,	**the ability to use knowledge of the basic material in solving practical issues and problems and** regulate and improve the biotechnological process in order to obtain a high-quality final product; to carry out biotechnological production processes and obtain biologically active substances and individual components of microbial cells; to carry out isolation and purification of biologically active substances from biomass and culture liquid; carry out stepwise control and standardization	**demonstrates (on the basis of knowledge) the solution of practical issues and tasks for** regulation and improvement of the biotechnological process in order to obtain a high-quality final product; implementation of biotechnological processes for the production and production of biologically active substances and individual components of microbial cells; for the isolation and purification of biologically active substances from biomass and culture liquid; implementation

		activity of enzyme preparations, viability of microorganisms); −ensure compliance with the rules of industrial hygiene, environmental protection −environment, labor protection and safety measures. choose the optimal storage conditions for biotechnological preparations and evaluate their quality during long-term storage	of the preparations obtained (determination of the antimicrobial activity of antibiotics, the activity of enzyme preparations, viability microorganisms); ensure compliance with the rules of industrial hygiene, environmental protection, occupational health and safety; choose the optimal storage conditions for biotechnological preparations and evaluate their quality during long-term storage	stepwise control and standardization of the obtained drugs (determination of the antimicrobial activity of antibiotics, the activity enzyme preparations, the viability of microorganisms); ensuring compliance with the rules of industrial hygiene, environmental protection, occupational health and safety; selection of optimal storage conditions for biotechnological products and assessment of their quality in the process long-term storage
	owns (high)	−methods of controlled cultivation of microorganisms; −methods of immobilization of cells of microorganisms; −technology of obtaining	**deep and lasting possession** methods of controlled cultivation of microorganisms; methods of immobilization of cells of microorganisms;	**demonstrates possession skills** methods of controlled cultivation of microorganisms; cell immobilization methods
		−biologically active substances and individual components of	technologies for obtaining biologically active substances	microorganisms; technologies for obtaining biologically

		microbial cells; the ability to implement and manage biotechnological processes	and individual components of microbial cells; the ability to implement and manage biotechnological processes	active substances and individual components of microbial cells; the ability to implement and manage biotechnological processes
PC-3 readiness to evaluate technical means and technologies taking into account the environmental consequences of their use	knows (threshold level)	−methods for assessing the means and methods for increasing the safety of technical means and technological processes; −methods of using technical means and technologies, taking into account the environmental consequences of their use; −methodology for the application of quality monitoring and safety of technical means and technologies in molecular and industrial biotechnology	**knowledge (basic material only)** methods for assessing means and methods for increasing the safety of technical means and technological processes; ways of using technical means and technologies, taking into account the environmental consequences of their use; methodologies for applying quality and safety monitoring technical means and technologies in molecular and industrial biotechnology	**demonstrates knowledge** methods for assessing means and methods for improving the safety of technical means and technological processes; ways of using technical means and technologies, taking into account the environmental consequences of their use; monitoring application methodologies quality and safety of technical means and technologies in molecular and industrial biotechnology
	can (advanced)	−understand and analyze information on the methods of assessing the means and methods of increasing the safety of technical means and technological processes; −apply the selected technical	**the ability (in solving practical issues and problems) to use the knowledge of the basic material and** understand, analyze information on methods of assessing means and methods of increasing the safety of	**demonstrates (based on knowledge) in solving practical issues and problems** understanding and analysis of information on methods of assessing means and methods of increasing the

		means and technologies, taking into account	technical means and	safety of technical means and technological
		−the environmental consequences of their use; apply knowledge about monitoring the quality and safety of technical means and technologies in molecular and industrial biotechnology	technological processes; apply the selected technical means and technologies, taking into account the environmental consequences of their use; apply knowledge about monitoring the quality and safety of technical means and technologies in molecular and industrial biotechnology	processes; application of the selected technical means and technologies, taking into account the environmental consequences of their use; application of knowledge about monitoring the quality and safety of technical means and technologies in molecular and industrial biotechnology
	owns (high)	−skills in assessing means and methods of improvement −safety of technical means and technological processes; −methods of searching and making decisions on the choice of technical means and technologies, taking into account the environmental consequences of their use; −skills in the use of monitoring the quality and safety of technical means and technologies in molecular and	**deep and lasting possession of knowledge, skills and** **skills** assessment of means and methods for increasing the safety of technical means and technological processes; methods of searching and making decisions on the choice of technical means and technologies, taking into account the environmental consequences of their use; skills in the use of monitoring the quality and safety of technical means and technologies in molecular and	**demonstrates possession skills** evaluating funds and methods of increasing the safety of technical means and technological processes; methods of searching and making decisions on the choice of technical means and technologies, taking into account the environmental consequences of their use; skills in the use of monitoring the quality and safety of technical means and technologies in molecular

		−industrial biotechnology; methods of assessing technical means and technologies, taking into account the environmental consequences of their use	industrial biotechnology; methods of assessing technical means and technologies, taking into account the environmental consequences of their use	and industrial biotechnology; methods of assessing technical means and technologies, taking into account the environmental consequences of their use
PC-4 the ability to ensure compliance with safety regulations, industrial sanitation, fire safety and labor protection	knows (threshold level)	−safety regulations, industrial sanitation, fire safety and labor protection; −hazards associated with anthropogenic impact on the biosphere	**knowledge (basic material only)** safety regulations, industrial sanitation, fire safety and labor protection; hazards associated with anthropogenic impact on the biosphere	**demonstrates knowledge** safety regulations, industrial sanitation, fire safety and labor protection; hazards associated with anthropogenic biosphere impact
	can (advanced)	−make conclusions about the sources of negative impact on the natural environment; −ensure compliance with safety regulations, industrial sanitation, fire safety and labor protection	**the ability to use knowledge of the basic material in solving practical issues and problems and** make conclusions about the sources of negative impact on the natural environment; ensure compliance with safety regulations, industrial sanitation, fire safety and labor protection	**demonstrates (on the basis of knowledge) in solving practical issues and problems the possibilities** make conclusions about the sources of negative impact on the natural environment; ensure compliance with safety regulations, industrial sanitation, fire safety and security
				labor

	owns (high)	–methodological approaches to assessing anthropogenic impact on the environment, methods of ensuring safety, industrial sanitation, fire safety and labor protection; –the ability to ensure compliance with safety regulations, industrial sanitation, fire safety and labor protection	**deep and solid possession of knowledge, skills and abilities** methodological approaches to assessing anthropogenic impact on the environment, methods of ensuring safety, industrial sanitation, fire safety and labor protection; ensure compliance with safety regulations, industrial sanitation, fire safety and labor protection	**demonstrates skills** methodological approaches to assessing anthropogenic impact on the environment, methods of ensuring safety, industrial sanitation, fire safety and labor protection; enforce rules safety engineering, industrial sanitation, fire safety and labor protection
organizational and management activities:				
PC-5 the ability to organize the work of performers, find and make managerial decisions in the field of organization and work rate setting	knows (threshold level)	–general approaches to organizing the work of performers; –basic concepts of labor organization; labor rationing	**knowledge (basic material only)** general approaches to organizing the work of performers; basic concepts of labor organization; labor rationing	**demonstrates knowledge** general approaches to organizing the work of performers; basic concepts of labor organization; labor rationing
	can (advanced)	–organize the work of performers, find and make managerial	**the ability to use knowledge of the basic material in solving**	**demonstrates (on the basis of knowledge) the solution**

		decisions in the field of organization and work rate setting	**practical issues and problems and** organize the work of performers, find and make managerial decisions in the field of organization and work rate setting	**of practical issues and problems, using skills** organize the work of performers, find and make managerial decisions in the field of organization and work rate setting
	owns (high)	–skills of organizing the work of performers; –the skills of making managerial decisions in the field of organization and work rate setting	**deep and solid possession of knowledge, skills and abilities** organization of the work of performers; adoption of managerial solutions in the field of organization and regulation of labor	**demonstrates skills** organization of the work of performers; making management decisions in the field of organization and labor rationing
PC-6 readiness to implement a quality management system for biotechnological products in accordance with the requirements of Russian and international quality standards	knows (threshold level)	–general provisions and medical and biological requirements for the quality of biotechnological products; –main directions of state policy in the field of biomedical cell products; –the main directions of technical progress in medical and pharmaceutical biotechnology, the creation of new biotechnologies and biomedical cell products	**knowledge (basic material only)** general provisions and medical and biological requirements for the quality of biotechnological products; main directions of state policy in the field of biomedical cell products; main directions of technological progress in medical and pharmaceutical biotechnology, new biotechnologies and biomedical cell products	**demonstrates knowledge** general provisions and medical and biological requirements for the quality of biotechnological products; main directions of state policy in the field of biomedical cell products; main directions of technological progress in medical and pharmaceutical biotechnology, new biotechnologies and biomedical cell products

	can (advanced)	– use and comply with the requirements of Russian and international quality standards; – apply advanced domestic and foreign experience in the field of progressive technologies for the production of new biotechnologies and biomedical cell products; – improve and optimize existing technological processes based on a systematic approach to the analysis of the quality of raw materials, technological process and requirements for the final product	**skill in solving practical issues and problems** use and comply with the requirements of Russian and international quality standards; apply advanced domestic and foreign experience in the field of advanced technology for the production of new biotechnologies and biomedical cell products; improve and optimize existing technological processes based on a systematic approach to the analysis of the quality of raw materials, technological process and requirements for the final	**demonstrates (on the basis of knowledge) the solution of practical issues and problems in** use and fulfillment of the requirements of Russian and international standards quality; when applying advanced domestic and foreign experience in the field of progressive technology for the production of new biotechnologies and biomedical cell products; when improving and optimizing existing technological processes based on a systematic approach
		–	products	to the analysis of the quality of raw materials, technological process and requirements for the final product

	owns (high)	–norms and requirements of medical, biotechnological science, quality and cost, safety and environmental friendliness for the creation of biomedical cell products; –methods and principles of the biotechnological quality management system products in accordance with the requirements of Russian and international quality standards; –the main principles of state policy in the field of biomedical cell technologies	**deep and lasting possession** norms and requirements of medical, biotechnological science, quality and cost, safety and environmental friendliness for the creation of biomedical cell products; methods and principles of the quality management system biotechnological products in accordance with the requirements of Russian and international quality standards; the main principles of state policy in the field of biomedical cell technologies;	**demonstrates possession skills** norms and requirements of medical, biotechnological science, quality and cost, safety and environmental friendliness for the creation of biomedical cell products; methods and principles of the management system the quality of biotechnological products in accordance with the requirements of Russian and international quality standards; the basic principles of state policy in the field of biomedical cell technologies;
PC-7 ability to organize and	knows (threshold level)	–the structure of technological solutions and their adjustment when carrying out	**knowledge (basic material only)** structure of technological solutions and	**demonstrates knowledge** structure of technological solutions and their

summarize information on the formation and use of enterprise resources		−industrial testing of progressive biotechnologies and new types of biotechnological products, taking into account cost optimization and improving the quality of products; the composition of production and non-production costs of operating and modernized production of biotechnological products; −indicators of the efficiency of technological processes for the production of biotechnological products; −methods and means of collecting, processing, storing, transferring and accumulating information using basic system software products and application packages in the production process	their correction during industrial tests of progressive biotechnologies and new types of biotechnological products, taking into account cost optimization and improving the quality of products; the composition of production and non-production costs of operating and modernized biotechnological production products; indicators of the efficiency of technological processes for the production of biotechnological products; methods and means of collecting, processing, storing, transferring and accumulating information using basic system software products and application packages in the production process	adjustment during industrial testing of progressive biotechnologies and new types of biotechnological products, taking into account cost optimization and improving the quality of products; the composition of production and non-production costs of operating and modernized biotechnological production products; indicators of the efficiency of technological processes for the production of biotechnological products; methods and means of collecting, processing, storing, transferring and accumulating information using basic system software products and application packages in
		biotechnological products;	biotechnological products;	the production process of

		resource provision of biotechnological production	resource support for biotechnological production	biotechnological products; resource support for biotechnological production
	can (advanced)	−apply the methods of calculating the technical and economic efficiency of the production of biotechnological products when choosing the optimal technical and organizational solutions; −use technologies for collection, placement, storage, accumulation, transformation and transmission of data in professionally oriented information systems for the production of biotechnological products	**the ability to use knowledge of the basic material in solving practical issues and problems and** apply methods for calculating the technical and economic efficiency of the production of biotechnological products when choosing optimal technical and organizational solutions; use technologies for collecting, placing, storing, accumulating, transforming and transmitting data in professionally oriented information systems for the production of biotechnological products	**demonstrates (based on knowledge) the solution of practical issues and problems** apply methods for calculating the technical and economic efficiency of the production of biotechnological products when choosing the best technical and organizational solutions; use technologies for collecting, placing, storing, accumulating, transforming and transmitting data in professionally oriented information systems for the production of biotechnological products
	owns (high)	−registration of changes in technical and technological documentation when adjusting technological processes, control	**deep and solid possession of knowledge, skills and abilities** registration of changes in technical and technological	**demonstrates possession skills** registration of changes in technical and technological documentation when

		systems for the production of biotechnological products; – preparation of proposals to improve the efficiency of production and competitiveness of products aimed at rational use and reduction of costs of raw materials, materials, reduction of labor intensity of production, increase in labor productivity, economical use of energy resources at the enterprise, introduction of waste-free and low-waste technologies for the production of biotechnological products	documentation when adjusting technological processes, control systems for the production of biotechnological products; preparation of proposals to improve production efficiency and competitiveness of products aimed at the rational use and reduction of costs of raw materials, materials, reducing the labor intensity of production, increasing labor productivity, economical use of energy resources at the enterprise, introducing waste-free and low-waste technologies for the production of biotechnological	adjusting technological processes, control systems for the production of biotechnological products; preparation of proposals to improve the efficiency of production and competitiveness of products aimed at the rational use and reduction of costs of raw materials,
		–	products	low-waste technologies for the production of biotechnological products
research activities:				

PC-8 ability to work with scientific and technical information, use Russian and international experience in professional activities	knows (threshold level)	–principles and features of the organization and accumulation of scientific information; –mechanisms and means necessary for solving professional problems in the field of means of obtaining, storing, processing information	**knowledge (basic material only)** principles and characteristics of the organization and accumulation of scientific information; mechanisms and means necessary for solving professional problems in the field of means of obtaining, storing, information processing	**demonstrates knowledge** principles and characteristics of the organization and accumulation of scientific information; mechanisms and means necessary for solving professional problems in the field of means of obtaining, storing, processing information
	can (advanced)	–extract scientific evidence from relevant sources; solve typical educational and research tasks in the field of methods, methods and means of obtaining, storing, processing information; –work with scientific and technical information, use Russian and international experience in professional	**the ability to use knowledge of the basic material in solving practical issues and problems and** extract scientific evidence from relevant sources; solve typical educational and research tasks in the field of methods, methods and means of obtaining, storing, processing information; work with scientific	**demonstrates (based on knowledge) in solving practical issues and problems** extract scientific evidence from relevant sources; solve typical educational and research tasks in the field of methods, methods and means of obtaining, storing, processing information; work with
		activities	technical information, use Russian and international experience in professional activities	scientific and technical information, use Russian and international experience in professional activities

	owns (high)	−skills of independent work with educational and scientific literature on the topic of research; −the skills of analyzing and assessing the reliability of scientific information; −ability to work with scientific and technical information, use Russian and international experience in professional activities	**deep and lasting possession of knowledge, skills and** skills of independent work with educational and scientific literature on the topic of research; the skills of analyzing and assessing the reliability of scientific information; skills in working with scientific and technical information, using Russian and international experience in professional activities	**demonstrates skills** independent work with educational and scientific literature on the topic of research; the skills of analyzing and assessing the reliability of scientific information; skills work with scientific and technical information, use of Russian and international experience in professional activities
PC-9 mastery of the basic methods and techniques of conducting experimental research in their professional field	knows (threshold level)	−objects of biotechnology and their biotechnological functions; −biological systems used in molecular biotechnology; −the chemical composition of living organisms and	**knowledge (basic material only)** objects of biotechnology and their biotechnological functions; biological systems used in molecular biotechnology;	**demonstrates knowledge** objects of biotechnology and their biotechnological functions; biological systems used in molecular biotechnology;

		−physiological function the most important chemical elements, biochemical characteristics of the main subcellular components, cell nutrition elements used in biotechnological production; −main directions of development of biotechnology and modern achievements of biological sciences and biomedical technologies; −traditional microbial technologies and the main stages of biotechnological processes; −methods of biosynthesis of basic biologically active substances; −basic methods and techniques for conducting experimental research in molecular biotechnology	the chemical composition of living organisms and the physiological functions of the most important chemical elements, the biochemical characteristics of the main subcellular components, cell nutrition elements used in biotechnological production; main directions of development of biotechnology and modern achievements of biological sciences and biomedical technologies; ways of biosynthesis of basic biologically active substances; methods and techniques for conducting experimental research in molecular biotechnology	the chemical composition of living organisms and the physiological functions of the most important chemical elements, the biochemical characteristics of the main subcellular components, cell nutrition elements used in biotechnological production; main directions of development of biotechnology and modern achievements of biological sciences and biomedical technologies; ways of biosynthesis of basic biologically active substances; methods and techniques for conducting experimental research in molecular biotechnology
	can (advanced)	−apply fundamental theoretical knowledge to	**skill in solving practical issues and**	**demonstrates (knowledge-based) skills**

		−solving practical problems in the field of molecular biotechnology and conducting research to improve the biotechnological process; −solve standard tasks of professional activity using information, bibliographic resources, biomedical and biotechnological terminology, information and communication technologies and taking into account the basic requirements of information security; −work with scientific and technical information, use Russian and international experience in professional activities;	**tasks to use the knowledge of the basic material and** apply fundamental theoretical knowledge in the field of molecular biotechnology and conduct research to improve the biotechnological process; solve standard tasks of professional activity using information, bibliographic resources, biomedical and biotechnological terminology, information and communication technologies and taking into account the basic requirements of information security; work with scientific and technical information, use Russian and international	apply fundamental theoretical knowledge to solve practical problems in the field of molecular biotechnology and conduct research to improve the biotechnological process; solve standard tasks of professional activity using information, bibliographic resources, biomedical and biotechnological terminology, information and communication technologies and taking into account the basic requirements of information security; work with scientific and technical

		−conduct research and analyze the state of living systems, process the results of biological research; −conduct experimental research in molecular biotechnology	experience in professional activities; conduct research and analyze the state of living systems, process the results of biological research; conduct experimental research in molecular biotechnology	information, use Russian and international experience in professional activities; conduct research and analyze the state of living systems, process the results of biological research; conduct experimental research in molecular biotechnology
	owns (high)	−the main methods and techniques for conducting experimental research in molecular biotechnology; −methods of obtaining producers of useful substances, studying their physiological and biochemical characteristics; −skills in planning and performing experimental tasks for	**deep and lasting possession** the main methods and techniques for conducting experimental research in molecular biotechnology; methods of obtaining producers of useful substances, studying their physiological and biochemical characteristics; skills in planning and performing experimental tasks to obtain target	**demonstrates possession skills** basic methods and techniques for conducting experimental research in molecular biotechnology; methods of obtaining producers of useful substances, studying their physiological and biochemical characteristics; skills
		obtaining target products, studying the patterns and conditions of their biosynthesis,	products, studying the patterns and conditions of their biosynthesis, optimizing the	planning and performing experimental tasks for obtaining target products,

		optimizing the bioprocess	bioprocess	studying the patterns and conditions of their biosynthesis, optimizing the bioprocess
PC-10 ability to conduct standard and certification tests of raw materials, finished products and technological processes	knows (threshold level)	−fundamentals and principles of standardization, the process of preparing products for the conformity confirmation procedure; −operating in the industry and on −enterprise standards and technical conditions, legislative and regulatory legal acts; −the current system of state attestation and certification of products; −standard test methods for raw materials, finished biotechnological products and technological processes; −process quality management systems	**knowledge (basic material only)** the basics and principles of standardization, the process of preparing products for the confirmation procedure compliance; standards and technical conditions in force in the industry and at the enterprise, legislative and regulatory legal acts; the current system of state attestation and certification of products; standard test methods for raw materials, finished biotechnological products and technological processes; process quality management systems	**demonstrates knowledge** the basics and principles of standardization, the process of preparing products for the confirmation procedure compliance; standards and technical conditions in force in the industry and at the enterprise, legislative and regulatory legal acts; the current system of state attestation and certification of products; standard test methods for raw materials, finished biotechnological products and technological
		production and finished biotechnological products	production and finished biotechnological products	processes; quality management systems for production processes and finished biotechnological products

	can (advanced)	−process current production information, analyze the obtained data for use in the management and quality assurance and safety of biotechnological products; −conduct standard and certification tests of raw materials, finished products and technological processes	**the ability to use knowledge of the basic material in solving practical issues and problems and** process current production information, analyze the obtained data for use in the management and quality assurance and safety of biotechnological products; conduct standard and certification tests of raw materials, finished products and technological processes	**demonstrates (knowledge-based) skills in solving practical issues and tasks** process current production information, analyze the obtained data for use in the management and quality assurance and safety of biotechnological products; conduct standard and certification tests of raw materials, finished products and technological processes
	owns (high)	−methods of organizing an effective quality control system for raw materials, semi-finished products and finished	**deep and solid possession of knowledge, skills and abilities** methods of organizing effective	**demonstrates possession skills** methods of organizing an effective quality control system
		biotechnological products; methods of standard and certification testing of raw materials, finished products and technological processes	quality control systems for raw materials, semi-finished products and finished biotechnological products; methods of standard and certification testing of raw materials, finished products and	raw materials, semi-finished products and finished biotechnological products; methods of standard and certification testing of raw materials, finished products and technological processes

			technological processes	
PC-11 proficiency in the methods of experiment planning, processing and presentation of the results	knows (threshold level)	−a system for conducting experiments according to a given methodology and analyzing the results −measurement, observation and compilation methods −descriptions of ongoing research; compilation of data for the compilation of reviews, reports and scientific publications; −scheme for the implementation of research and development results protection scheme for intellectual property objects, research and development results	**knowledge (basic material only)** systems for conducting experiments according to a given methodology and analyzing the results; methods measuring, observing and compiling a description of the research being carried out; compilation of data for the compilation of reviews, reports and scientific publications; schemes for the implementation of research and development results; schemes for the protection of intellectual property objects, research and development results	**demonstrates knowledge** systems for conducting experiments according to a given methodology and analyzing the results; methods measuring, observing and compiling a description of the research being carried out; compilation of data for the compilation of reviews, reports and scientific publications; schemes for the implementation of research and development results; schemes for the protection of intellectual property objects, research and development results

	can (advanced)	−design and conduct research; −design a study; −conduct experiments according to a given method; −process the results of research and development; −prepare reports on the completed assignment	**the ability to use knowledge of the basic material in solving practical issues and problems and** design and conduct research; design a study; conduct experiments according to a given method; process the results of research and development;	**demonstrates (based on knowledge) the solution of practical issues and problems** design and conduct research; design a study; conduct experiments according to a given method; process the results of research

			prepare reports on the completed assignment	and development; prepare reports on the completed assignment
	owns (high)	−methods of experiment planning, processing and presentation of the results obtained	**deep and solid possession of knowledge, skills and abilities** planning an experiment, processing and presenting the results obtained	**demonstrates skills** planning an experiment, processing and presenting the results obtained
PC-12 willingness to use modern information technologies in their professional field, including databases and application packages	knows (threshold level)	−a system of modern information technologies, modern software, including databases and application packages, taking into account the basic requirements of information security	**knowledge (basic material only)** systems of modern information technologies, modern software, including databases and application packages, taking into account the basic requirements of information	**demonstrates knowledge** systems of modern information technologies, modern software, including databases and application packages, taking into account the basic requirements
			security	information security
	can (advanced)	−solve standard tasks of professional activity using information technologies and taking into account the basic requirements of information security	**skill in solving** standard tasks of professional activity with the use of information technology and, taking into account the basic requirements of information security, use the knowledge of the basic material	**demonstrates (based on knowledge) when solving** standard tasks of professional activity with the use of information technology and taking into account the basic requirements of information security, use of knowledge of the basic material
	owns (high)	−skills in the use of modern information technologies in their	**deep and solid possession of knowledge, skills and abilities**	**demonstrates skills** the use of modern information

		professional field, including databases and application packages	the use of modern information technologies in their professional field, including databases and application packages	technologies in their professional field, including databases and application packages
project activity:				
PC-13 ability to participate in the development of technological	knows (threshold level)	−concepts, concepts, principles and methodology of modern	**knowledge (basic material only)** concepts, concepts, principles and	**demonstrates knowledge** concepts, concepts, principles and methodology
projects as part of the team of authors		−information systems and technological projects; −stages of technological design in biotechnological production; − basic procedures for the development of technological projects as part of the team of authors	methodology of modern information systems and technological projects; stages of technological design in biotechnological production; basic procedures for the development of technological projects as part of the author's team	modern information systems and technological projects; stages of technological design in biotechnological production; basic procedures for the development of technological projects as part of the author's team

	can (advanced)	–spend collection of initial data for the design of technological processes and installations; –lead the development of the main stages of the technological scheme	**the ability to use knowledge of the basic material in solving practical issues and problems and** collect initial data for the design of technological processes and installations; lead the development of the main stages of the technological scheme	**demonstrates (based on knowledge) in solving practical issues and problems** collect initial data for the design of technological processes and installations; lead the development of the main stages of the technological scheme
	owns (high)	–skills of working on technological projects as part of the author's team; –research methods of the technological process on	**deep and lasting possession of knowledge, skills and** skills of working on technological projects as part of the author's team; methods	**demonstrates skills** work on technological projects as part of the team of authors; research methods
		pilot and pilot industrial installations	research of the technological process on pilot and pilot-industrial installations	technological process on pilot and pilot industrial plants

PC-14 readiness to use modern computer-aided design systems	knows (threshold level)	–concepts, concepts, principles and methodology of modern computer-aided design systems and technological projects; –standard computer-aided design programs; –principles of application of standard programs –computer-aided design; main stages of computer-aided design	**knowledge (basic material only)** concepts, concepts, principles and methodology of modern computer-aided design systems and technological projects; standard computer-aided design programs; principles of using standard computer-aided design programs; the main stages of computer-aided design	**demonstrates knowledge** concepts, concepts, principles and methodology of modern computer-aided design systems and technological projects; standard computer-aided design programs; principles of using standard computer-aided design programs; the main stages of computer-aided design
	can (advanced)	–use modern computer-aided design systems and standard design automation tools; –work with programs,	**skill in solving practical issues and problems** use modern CAD systems and standard tools	**demonstrates (based on knowledge) in solving practical issues and problems** use of modern computer-aided design systems and

		–necessary for computer-aided design; –apply the acquired knowledge to specific computer-aided design systems; –systematize and develop projects for automated biotechnological production	design automation; work with programs required for computer-aided design; apply the knowledge gained to specific computer-aided design systems to systematize and develop projects for automated biotechnological production	standard design automation tools; ability to work with programs required for computer-aided design; the ability to apply the knowledge gained to specific computer-aided design systems to systematize and develop projects of automated biotechnological industries
	owns (high)	–skills in using modern computer-aided design systems	**deep and lasting possession of knowledge, skills and** skills in using modern computer-aided design systems	**demonstrates skills** use of modern computer-aided design systems
PK-15 ability to design technological processes using automated systems	knows (threshold level)	–the principles of drawing up technological calculations for the design of new or modernization of existing industries and	**knowledge (basic material only)** principles of drawing up technological calculations when designing new or modernization	**demonstrates knowledge** principles of drawing up technological calculations when designing new or modernization

technological preparation of production as part of the team of authors		production sites for the production of biotechnological products; – calculation methods for the design of biotechnological products production, technological lines, workshops, individual sections of enterprises using computer-aided design systems and software, – information technologies in the creation of projects for newly built and reconstruction of existing enterprises	existing industries and production sites for the production of biotechnological products; calculation methods for the design of biotechnological products production, technological lines, workshops, individual sections of enterprises using computer-aided design systems and software, information technology when creating projects for newly built and reconstruction of existing enterprises	existing industries and production sites for the production of biotechnological products; calculation methods for the design of biotechnological products production, technological lines, workshops, individual sections of enterprises using computer-aided design systems and software, information technology when creating projects for newly built and reconstruction of existing enterprises
	can (advanced)	– calculate and design individual stages of the technological process using automated systems	**the ability to use knowledge of the basic material in solving practical issues and problems and** calculate and	**demonstrates (based on knowledge) in solving practical issues and problems** calculate and design individual
		technological preparation of	design of individual stages of the	stages of the technological

		production	technological process using automated systems for technological preparation of production	process using automated systems for technological preparation of production
	owns (high)	–the skills of calculating when designing the production of biotechnological products, technological lines, workshops, individual sections of enterprises using computer-aided design systems and software, information technology when creating projects for newly built and reconstruction of existing enterprises	**deep and solid possession of knowledge, skills and abilities** making calculations when designing the production of biotechnological products, technological lines, workshops, individual sections of enterprises using computer-aided design systems and software, information technology when creating projects for newly built and reconstruction of existing enterprises	**demonstrates skills** making calculations when designing the production of biotechnological products, technological lines, workshops, individual sections of enterprises with the use of computer-aided design systems and software, information technology in the creation of projects for newly built and reconstruction of existing enterprises
PC-16 willingness to negotiate with design organizations and suppliers	knows (threshold level)	–regulatory requirements for technological equipment, for	**knowledge (basic material only)** regulatory requirements for	**demonstrates knowledge** regulatory requirements for technological
technological equipment, to evaluate the design results of biotechnological enterprises at		design of biotechnological enterprises	technological equipment, for the design of biotechnological enterprises	equipment, for the design of biotechnological enterprises

the project stage	can (advanced)	−evaluate the design results of biotechnological enterprises at the project stage	**the ability to use knowledge of the basic material in solving practical issues and problems and** evaluate the design results of biotechnological enterprises at the project stage	**demonstrates (on the basis of knowledge) the solution of practical issues and problems the ability** evaluate the design results of biotechnological enterprises at the project stage
	owns (high)	−skills in assessing a technological project carried out by a design organization	**deep and solid possession of knowledge, skills and abilities** evaluation of the technological project carried out by the design organization	**demonstrates skills** evaluation of the technological project carried out by the design organization
PC-17 the ability to design the main stages of the biotechnological process	knows (threshold level)	−fundamentals of biotechnology and molecular biotechnology, laws underlying the technological processes of biotechnology; −operating biotechnological production, their technical	**knowledge (basic material only)** the foundations of biotechnology and molecular biotechnology, the laws underlying the technological processes of biotechnology; acting	**demonstrates knowledge** the foundations of biotechnology and molecular biotechnology, the laws underlying the technological processes of biotechnology; acting

		−equipment, placement of technological equipment; −the main stages of industrial production and management of the main stages of existing biotechnological industries; −production technology andorganization of production and technological processes of biotechnological products	biotechnological industries, their technical equipment, placement of technological equipment; the main stages of industrial production and management of the main stages of existing biotechnological industries; production technologies and organization of production and technological processes of biotechnological products	biotechnological industries, their technical equipment, placement of technological equipment; the main stages of industrial production and management of the main stages of existing biotechnological industries; production technologies and organization of production and technological processes of biotechnological products
	can (advanced)	−develop the main stages of the biotechnological process using optimal and rational technological schemes; −lead the main technological processes for the production of biotechnological products;	**the ability to use knowledge of the basic material in solving practical issues and problems and** lead the main technological processes for the production of biotechnological products; develop the main stages of biotechnological	**demonstrates (on the basis of knowledge) the solution of practical issues and problems in** maintaining the main technological processes of the production of biotechnological products; in the development of the main stages of biotechnological

		−apply biotechnology using genetically engineered producers - microorganisms, cells of plant and animal origin; −apply progressive methods of selection and operation of technological equipment in the production of biotechnological products	process using optimal and rational technological schemes; apply biotechnology using genetically engineered producers - microorganisms, cells of plant and animal origin; apply progressive methods of selection and operation of technological equipment in production biotechnological products	process using optimal and rational technological schemes; when using biotechnology using genetically engineered producers - microorganisms, cells of plant and animal origin; when using progressive methods of selection and operation of technological equipment for the production of biotechnological products
	owns (high)	−methods and principles for the development of the main stages of the biotechnological process; −methods and principles for the development of plans for the placement of equipment, technical equipment and organization of workplaces within the framework of the	**deep and lasting possession** methods and principles for the development of the main stages of the biotechnological process; methods and principles for the development of plans for the placement of equipment, technical equipment and organization of workplaces in	**demonstrates possession skills** methods and principles for the development of the main stages of the biotechnological process; methods and principles for the development of plans for the placement of equipment, technical equipment and
		enterprise technology for the production of biotechnological	within the framework of the technology of production of	organization of workplaces within the framework of the

		products	biotechnological products adopted at the enterprise	technology of production of biotechnological products adopted at the enterprise
PK-18 willingness to participate in research of the biotechnological process in pilot and pilot industrial installations	knows (threshold level)	– theoretical foundations for the creation of production processes for obtaining products of biotechnological industries; – principles of designing biotechnological products with desired properties; – scientific foundations of the latest biotechnologies based on the use of populations of microbial, animal and plant cells obtained by selection and genetic methods; – principles of functioning of the main types of scientific equipment used in molecular biological experiments	**knowledge (basic material only)** theoretical foundations for the creation of production processes for obtaining products of biotechnological industries; principles of designing biotechnological products with desired properties; scientific foundations of the latest biotechnologies based on the use of populations of microbial, animal and plant cells obtained by selection and genetic methods; principles of functioning of the main types of scientific equipment used in molecular biological	**demonstrates knowledge** theoretical foundations for the creation of production processes for obtaining products of biotechnological industries; principles of designing biotechnological products with desired properties; scientific foundations of the latest biotechnologies based on the use of populations of microbial, animal and plant cells obtained by selection and genetic methods; principles of functioning of the main types of scientific equipment,
			experiments	used in molecular biological experiments

	can (advanced)	–correctly interpret data received on scientific equipment; –analyze the indicators of the technological process for compliance with the original scientific developments; –plan and conduct biotechnological process research at pilot and pilot industrial plants	**the ability to use knowledge of the basic material in solving practical issues and problems and** correctly interpret data received on scientific equipment; analyze the indicators of the technological process for compliance with the initial scientific developments; plan and conduct research on the biotechnological process in pilot and pilot industrial installations	**demonstrates (based on knowledge) the solution of practical issues and problems** correctly interpret data received on scientific equipment; analyze the indicators of the technological process for compliance with the original scientific developments; plan and conduct research on the biotechnological process in pilot and pilot industrial installations
	owns (high)	–skills in mastering new types of devices / equipment, possesses basic maintenance skills and careful attitude to scientific equipment	**deep and solid possession of knowledge, skills and abilities** mastering new types of devices / equipment, has basic skills	**demonstrates skills** mastering new types of devices / equipment, possesses basic maintenance skills and an accurate attitude to
		methods of analyzing the indicators of the technological process for compliance with the original scientific developments	maintenance and careful treatment of scientific equipment; methods of analyzing the indicators of the technological process for	scientific equipment; methods of analyzing the indicators of the technological process for compliance with the initial scientific developments

			compliance with the original scientific developments	
PK-19 willingness to participate in the development of design and working technical documentation	knows (threshold level)	−requirements of regulatory documents for the implementation of the design of production of biotechnological products	**knowledge (basic material only)** requirements of regulatory documents for the implementation of the design of production of biotechnological products	**demonstrates knowledge** requirements of regulatory documents for the implementation of the design of production of biotechnological products
	can (advanced)	−develop normative and technical documentation based on the results of the implementation of technological processes and control systems of advanced technologies for the production of biotechnological products	**the ability to use knowledge of the basic material in solving practical issues and problems and** develop normative and technical documentation based on the results of the implementation of technological processes and control systems of advanced technologies for the production of biotechnological products	**demonstrates (knowledge-based) skill** develop normative and technical documentation based on the results of the implementation of technological processes and control systems of advanced technologies for the production of biotechnological products

	owns (tall)	−the main types of regulatory and technical documentation drawn up based on the results of the implementation of technological processes and control systems for advanced technologies for the production of biotechnological products; −regulatory documents that determine the requirements for the design of manufacturing enterprises −biotechnological products; −methods of principles for the development of design and working technical documentation	**deep and lasting mastery of the main** types of regulatory and technical documentation drawn up based on the results of the implementation of technological processes and control systems for advanced technologies for the production of biotechnological products; regulatory documents that define the requirements for the design of enterprises for the production of biotechnological products; methods of principles for the development of design and working technical documentation	**demonstrates skills in basic** types of regulatory and technical documentation drawn up based on the results of the implementation of technological processes and control systems for advanced technologies for the production of biotechnological products; regulatory documents defining requirements for the design of enterprises for the production of biotechnological products; methods of principles for the development of design and working technical documentation
Unique professional competencies				
UK-1 the ability to apply knowledge of the principles of cellular organization of biological	knows (threshold level)	−the basics of the cellular organization of biological objects, biophysical and biochemical foundations,	**knowledge (basic material only)** the foundations of the cellular organization of biological objects, biophysical	**demonstrates knowledge** the foundations of the cellular organization of biological objects, biophysical and

			and	
objects, biophysical and biochemical bases, membrane processes and molecular mechanisms of life		membrane processes – molecular mechanisms of life	biochemical bases, membrane processes, molecular mechanisms of life	biochemical bases, membrane processes, molecular mechanisms of life
	can (advanced)	– apply knowledge of the principles of the foundations of the cellular organization of biological objects, biophysical and biochemical foundations, membrane processes and molecular mechanisms of life	**the ability to use and apply knowledge when solving practical issues and problems** principles of the foundations of the cellular organization of biological objects, biophysical and biochemical bases, membrane processes and molecular mechanisms life activity	**demonstrates (on the basis of knowledge) the solution of practical issues and problems using knowledge** principles of the foundations of the cellular organization of biological objects, biophysical and biochemical bases, membrane processes and molecular mechanisms life activity
	owns (high)	– methods of molecular genetics when describing the functioning of organisms; – the skills of applying knowledge of the principles of the foundations of the cellular organization of biological objects, biophysical and biochemical foundations, membrane processes and molecular mechanisms of life;	**deep and lasting possession** methods of molecular genetics in describing the functioning of organisms; skills in applying the principles of the foundations of the cellular organization of biological objects, biophysical and biochemical foundations, membrane processes and molecular mechanisms	**demonstrates skills in working with** methods of molecular genetics when describing the functioning of organisms; skills in applying the principles of the foundations of the cellular organization of biological objects, biophysical and biochemical foundations, membrane processes and

		– the basics of organizing experimental and research work	life activity; the basics of organizing experimental and	molecular mechanisms of life; the basics of organizing

		of molecular genetic objects	research work of molecular genetic objects	experimental and research work of molecular genetic objects
UK-2 ability and willingness to understand and analyze biochemical, physicochemical, molecular biological mechanisms of the development of pathological processes in cells and tissues	knows (threshold level)	–biochemical, physicochemical, molecular biological mechanisms of the development of pathological processes in the cells and tissues of the human body	**knowledge (basic material only)** biochemical, physicochemical, molecular biological mechanisms of the development of pathological processes in the cells and tissues of the human body	**demonstrates knowledge** biochemical, physicochemical, molecular biological mechanisms of the development of pathological processes in the cells and tissues of the human body
the human body	can (advanced)	–analyze biochemical, physicochemical, molecular biological mechanisms of the development of pathological processes in the cells and tissues of the human body	**the ability to use knowledge of the basic material in solving practical issues and problems and** analyze biochemical, physicochemical, molecular biological mechanisms of the development of pathological processes in the cells and tissues of the human body	**demonstrates (on the basis of knowledge) the solution of practical issues and problems, analyzing** biochemical, physicochemical, molecular biological mechanisms of the development of pathological processes in the cells and tissues of the human body
	owns (high)	–skills in the analysis of biochemical, physical	**deep and lasting possession of knowledge, skills and**	**demonstrates skills** biochemical analysis,
		chemical, molecular biological mechanisms of the development of pathological processes in the cells and tissues of the human body	**skills** analysis of biochemical, physicochemical, molecular biological mechanisms of the development of pathological processes in the cells and tissues of the human body	physicochemical, molecular biological mechanisms of the development of pathological processes in the cells and tissues of the human body

UK-3 the ability to apply basic ideas about the basic laws and modern achievements of genetics and breeding, about genomics, proteomics	knows (threshold level)	–basic ideas about the basic laws and modern achievements of genetics and breeding, about genomics, proteomics; –chromosomal theory of heredity	**knowledge (basic material only)** basic ideas about the basic laws and modern achievements of genetics and breeding, about genomics, proteomics; chromosome theory heredity	**demonstrates knowledge** basic ideas about the basic laws and modern achievements of genetics and breeding, about genomics, proteomics; chromosomal theory of heredity
	can (advanced)	–to connect the data of genetics and evolutionary theory, as well as data of genetics with the achievements of the biochemistry of nucleic acids, cytology, the biological basis of the reproduction of plants and animals, with the success in the study of the laws of ontogenesis, molecular biology, genetic engineering and	**the ability to use knowledge of the basic material in solving practical issues and problems and** to connect the data of genetics and evolutionary theory, as well as data of genetics with the achievements of the biochemistry of nucleic acids, cytology, the biological basis of the reproduction of plants and animals, with success in	**demonstrates (on the basis of knowledge) in solving practical issues and tasks the ability** to connect the data of genetics and evolutionary theory, as well as data of genetics with the achievements of the biochemistry of nucleic acids, cytology, the biological basis of the reproduction of plants and animals, with
		–biotechnology; solve genetic problems of different types	the field of studying the patterns of ontogenesis, molecular biology, genetic engineering and biotechnology; solve genetic problems of different types	successes in the study of the patterns of ontogenesis, molecular biology, genetic engineering and biotechnology; solve genetic problems of different types

	owns (high)	–modern ideas about the basics of genetics and selection; –principles for solving theoretical and practical typical and systemic tasks related to professional activities; –the main methods of genetics (prepare temporary preparations, analyze them)	**deep and lasting possession** modern ideas about the basics of genetics and selection; principles for solving theoretical and practical typical and systemic tasks related to professional activities; the main methods of genetics (prepare temporary preparations, analyze them)	**demonstrates possession skills** modern ideas about the basics of genetics and selection; principles of solving theoretical and practical typical and systemic tasks related to professional activities; the main methods of genetics (prepare temporary preparations, analyze them)
UK-4 the ability to assess morphofunctional, physiological conditions and pathological processes in	knows (threshold level)	–morphofunctional, physiological conditions and pathological processes in the human body for the solution of professional	**knowledge (basic material only)** morphofunctional, physiological conditions and pathological processes in	**demonstrates knowledge** morphofunctional, physiological conditions and pathological processes
the human body to solve professional problems		tasks	the human body to solve professional problems	in the human body for solving professional problems
	can (advanced)	–to evaluate morphofunctional, physiological conditions and pathological processes in the human body to solve professional problems	**the ability to use knowledge of the basic material in solving practical issues and problems and** to evaluate morphofunctional, physiological conditions and pathological processes in the human body	**demonstrates (based on knowledge) when solving practical issues and problems** to evaluate morphofunctional, physiological conditions and pathological processes in the

				human body
	owns (high)	–principles and methods of assessing morphofunctional, physiological states and pathological processes in the human body for solving professional problems	**deep and lasting possession** principles and methods of assessing morphofunctional, physiological states and pathological processes in the human body for solving professional problems	**demonstrates possession skills** principles and methods of assessing morphofunctional, physiological states and pathological processes in the human body for solving professional problems
UK-5 ability and readiness to implement applied and practical projects for the study of biochemical, biophysical and	knows (threshold level)	–biochemical, biophysical and physiological processes and phenomena occurring at the cellular, organ and systemic levels in	**knowledge (basic material only)** biochemical, biophysical and physiological processes and phenomena occurring on the cellular, organ and	**demonstrates knowledge** biochemical, biophysical and physiological processes and phenomena occurring on
physiological processes and phenomena occurring at the		human body	systemic levels in the human body	cellular, organ and systemic levels in the human body

cellular, organ and systemic levels in the human body	can (advanced)	–carry out applied and practical projects for the study of biochemical, biophysical and physiological processes and phenomena occurring at the cellular, organ and systemic levels in the human body	**the ability to use knowledge of the basic material in solving practical issues and problems and** carry out applied and practical projects for the study of biochemical, biophysical and physiological processes and phenomena occurring at the cellular, organ and systemic levels in the human body	**demonstrates (on the basis of knowledge) in solving practical issues and problems the possibilities** carry out applied and practical projects for the study of biochemical, biophysical and physiological processes and phenomena occurring at the cellular, organ and systemic levels in the human body
	owns (high)	–principles and methods of applied and practical projects for the study of biochemical, biophysical and physiological processes and phenomena occurring at the cellular, organ and systemic levels in the human body	**deep and lasting possession** principles and methods of applied and practical projects for the study of biochemical, biophysical and physiological processes and phenomena occurring at the cellular, organ and systemic levels in the human body	**demonstrates possession skills** principles and methods of applied and practical projects for the study of biochemical, biophysical and physiological processes and phenomena occurring at the cellular, organ and systemic levels in
				human body
UK-6 the ability to apply knowledge about the basics of	knows (threshold level)	–fundamentals of biotechnological and biomedical industries, microbiological	**knowledge (basic material only)** fundamentals of biotechnological and biomedical	**demonstrates knowledge** fundamentals of biotechnological and

biotechnological and biomedical industries, microbiological synthesis, biocatalysis, genetic engineering, nanobiotechnology, molecular modeling		synthesis, biocatalysis, genetic engineering, nanobiotechnology, molecular modeling	industries, microbiological synthesis, biocatalysis, genetic engineering, nanobiotechnology, molecular modeling	biomedical industries, microbiological synthesis, biocatalysis, genetic engineering, nanobiotechnology, molecular modeling
	can (advanced)	–apply knowledge about the basics of biotechnological and biomedical industries, microbiological synthesis, biocatalysis, genetic engineering, nanobiotechnology, molecular modeling	**the ability to use knowledge of the basic material in solving practical issues and problems and** apply knowledge about the basics of biotechnological and biomedical industries, microbiological synthesis, biocatalysis, genetic engineering, nanobiotechnology, molecular modeling	**demonstrates (knowledge-based) skills in solving practical issues and tasks** use knowledge of the basics of biotechnological and biomedical industries, microbiological synthesis, biocatalysis, genetic engineering, nanobiotechnology, molecular modeling
	owns (high)	–the basics of biotechnological and biomedical industries,	**deep and lasting possession** fundamentals of biotechnological and biomedical industries,	**demonstrates possession skills** foundations of biotechnological and
		microbiological synthesis, biocatalysis, genetic engineering, nanobiotechnology, molecular modeling	microbiological synthesis, biocatalysis, genetic engineering, nanobiotechnology, molecular modeling	biomedical production, microbiological synthesis, biocatalysis, genetic engineering, nanobiotechnology,

				molecular modeling
UK-7 the ability and readiness to apply new research methods in research activities in the field of biotechnology, taking into account the rules observance of copyright	knows (threshold level)	–new research methods in the field of biotechnology and the possibility of their application in research activities; –copyright rules	**knowledge (basic material only)** new research methods in the field of biotechnology and the possibilities of their application in research activities; rules observance of copyright	**demonstrates knowledge** new research methods in the field of biotechnology and the possibilities of their application in research activities; copyright rules
	can (advanced)	–apply new research methods in the field of biotechnology	**the ability to use knowledge of the basic material in solving practical issues and problems and** apply new research methods in the field of biotechnology	**demonstrates (on the basis of knowledge) the solution of practical issues and problems in** application of new research methods in the field of biotechnology
	owns (high)	–the skills of applying new methods in research activities in the field of biotechnology	**deep and solid possession of knowledge, skills and abilities** applications in research	**demonstrates skills** applications in research activities in the field
		research subject to copyright rules	activities in the field of biotechnology, new research methods, taking into account the rules of compliance with copyright	biotechnology new research methods subject to copyright rules

UK-8 knowledge of the principles of production, research and use of enzymes, viruses, microorganisms, cell cultures of animals and plants, products of their biosynthesis and biotransformation	knows (threshold level)	–theoretical foundations for obtaining various biotechnological products; –regularities of the kinetics of the growth of microorganisms and the formation of metabolic products; –microbial culture methods –classification of enzymes, –enzyme activity units; methods of obtaining enzyme preparations; areas of application of enzymes in medicine	**knowledge (basic material only)** theoretical foundations for obtaining various biotechnological products; regularities of the kinetics of the growth of microorganisms and the formation of metabolic products; methods of cultivation of microorganisms; classification of enzymes, units of enzyme activity; methods of obtaining enzyme preparations; areas of application of enzymes in medicine	**demonstrates knowledge** theoretical foundations for obtaining various biotechnological products; regularities of the kinetics of the growth of microorganisms and the formation of metabolic products; methods of cultivation of microorganisms; classification of enzymes, units of enzyme activity; methods of obtaining enzyme preparations; areas of application of enzymes in medicine
	can (advanced)	–to conduct the process of cultivation of microorganisms, cell cultures of plants and animals; –select optimal conditions that stimulate	**the ability to use knowledge of the basic material in solving practical issues and problems and** conduct the process of cultivation of microorganisms, cellular	**demonstrates (based on knowledge) the solution of practical issues and problems** conduct the process of cultivating microorganisms,

		maximum accumulation of the target product; – to carry out the isolation, identification and cultivation of microorganisms producing biomass and various metabolic products; – work with pure cultures of microorganisms, plants and animals; isolate enzymes from various objects, investigate properties and determine kinetic – enzyme parameters; evaluate the quantitative characteristics of the growth of microorganisms	crops of plants and animals; select the optimal conditions that stimulate the maximum accumulation of the target product; to carry out the isolation, identification and cultivation of microorganisms producing biomass and various metabolic products; work with pure cultures of microorganisms, plants and animals; isolate enzymes from various objects, investigate the properties and determine the kinetic parameters of enzymes; evaluate the quantitative characteristics of the growth of microorganisms	cell cultures of plants and animals; select the optimal conditions that stimulate the maximum accumulation of the target product; to carry out the isolation, identification and cultivation of microorganisms, producers of biomass and various metabolic products; work with pure cultures of microorganisms, plants and animals; to isolate enzymes from various objects, to investigate the properties and to determine the kinetic parameters of enzymes; evaluate the quantitative characteristics of the growth of microorganisms
	owns (high)	– methods of working with microorganisms, cell cultures of plants and animals; rules	**deep and solid possession of knowledge, skills and abilities** techniques for working with microorganisms,	**demonstrates skills** techniques for working with microorganisms, cell cultures

		−safe work in the laboratory; −methods for calculating the main parameters of biotechnological processes; −biotransformation methods; principles of production, research and use of enzymes, viruses, microorganisms, cell cultures of animals and plants, products of their biosynthesis and biotransformation	plant and animal cell cultures; rules for safe work in the laboratory; methods for calculating the main parameters of biotechnological processes; biotransformation methods; principles of production, research and use of enzymes, viruses, microorganisms, cell cultures of animals and plants, products of their biosynthesis and biotransformation	plants and animals; rules for safe work in the laboratory; methods for calculating the main parameters of biotechnological processes; biotransformation methods; principles of obtaining, research and use of enzymes, viruses, microorganisms, cell cultures of animals and plants, products of their biosynthesis and biotransformation
UK-9 possession of modern approaches to the design of medicines and diagnostic products	knows (threshold level)	−innovative ways of creating medicines based on the use of data from genomics, proteomics and bioinformatics; −new methods and techniques in the development, production and circulation of medicines; −methods for determining the goodness of microorganisms -	**knowledge (basic material only)** innovative ways of creating medicines based on the use of data from genomics, proteomics and bioinformatics; new methods and techniques in the development, production and circulation of medicines; methods for determining the goodness	**demonstrates knowledge** innovative ways of creating medicines based on the use of data from genomics, proteomics and bioinformatics; new methods and techniques in the development, production and circulation of medicines; methods of determining
		producers, determination of the concentration of viable cells and their enzymatic activity	producing microorganisms, determining the concentration of viable cells and their enzymatic	the good quality of producing microorganisms, determining the concentration of viable

			activity	cells and their enzymatic activity
	can (advanced)	−conduct research to improve the biotechnological process; −use new methods and techniques in the field of drug design and	**the ability to use knowledge of the basic material in solving practical issues and problems and** conduct research to improve the biotechnological process; use new	**demonstrates (on the basis of knowledge) the solution of practical issues and problems in** conducting research to improve the biotechnological process; in use
		diagnostic drugs	methods and techniques in the design of medicines and diagnostic products	new methods and techniques in the design of medicines and diagnostic products
	owns (high)	−new methods and techniques in the design of medicines and diagnostic products; −physicochemical, microbiological and biochemical methods	**deep and solid possession of knowledge, skills and abilities** new methods and techniques in the design of medicines and diagnostic products; physical and chemical,	**demonstrates skills** new methods and techniques in the design of medicines and diagnostic products; physicochemical, microbiological and
		−analysis to confirm the purity of the producer, the authenticity of drugs, the detection of impurities and quantitative assessment; −the ability to participate in scientific research; −skills in the implementation of new methods and techniques in the design of medicines and diagnostic products	microbiological and biochemical methods of analysis to confirm the purity of the producer, the authenticity of drugs, the detection of impurities and quantitative assessment; participation in scientific research; skills in the implementation of new methods and techniques in the design of medicines and	biochemical analysis methods to confirm the purity of the producer, the authenticity of drugs, the detection of impurities and quantitative assessment; participation in scientific research; introduction of new methods and techniques in the design of medicines and diagnostic products

			diagnostic products	

4. The structure of the state final certification

4.1 The purpose of the state final certification. The purpose of the state final certification is to establish the compliance of the level and quality of professional training of the graduate in the direction of training 03.19.01 Biotechnology with the requirements of the educational standard independently established by the federal state autonomous educational institution of higher professional education "Far Eastern Federal University" and employers.

State final certification is designed to help systematize and consolidate the knowledge and skills of the student in the field of training in solving specific professional problems, to determine the level of preparation of the graduate for independent work.

4.2 Tasks of the state final certification. The objectives of the final state certification in the field of training 03/19/01 Biotechnology (profile Molecular biotechnology) are:

- assessment of the theoretical training of the graduate in the program "Molecular Biotechnology";
- assessment of the graduate's practical training in the program "Molecular Biotechnology";
- assessment of skills of independent work;
- resolving the issue of awarding qualifications based on the results of state final certification and issuing a graduate of a diploma of higher education.

At the same time, the purpose of holding a state exam on program "Molecular Biotechnology" preparation is:

- assessment of knowledge, abilities, skills and competencies acquired by the graduate during the study of educational cycles of EP, in accordance with the requirements of the OS VO FEFU.

The purpose of the preparation and defense of the final qualifying work is:

- determination of the level of preparation of a graduate to perform professional tasks in accordance with the requirements of the OS of VO FEFU to the qualification characteristics and the level of training of a graduate under the program "Molecular Biotechnology".

4.3 Forms of state final certification

The structure of the state final certification includes the defense of the final qualifying work (WQP), including preparation for the defense procedure and the defense procedure, as well as preparation for passing and passing the state exam.

5. The procedure for filing and considering appeals based on the results of state certification tests

5.1. Based on the results of state certification tests, the student has the right to appeal.

The student has the right to submit to the appeal commission a written appeal about the violation, in his opinion, of the established procedure for conducting the state certification test and (or) his disagreement with the results of the state certification test (the form of the appeal is given in Appendix 1).

5.2. The appeal is submitted to the student personally to the appeal commission no later than the next working day after the announcement of the results of the state certification test. Information about the place of work of the appeal commission is brought to the students on the day of the defense of the FQP.

5.3. To consider the appeal, the secretary of the state examination commission sends to the appeal commission the minutes of the meeting of the state examination commission, the conclusion of the chairman of the state examination commission on the observance of procedural issues during the state certification test (Appendix 2), as well as written answers of the student (if any) (for consideration of the appeal on the state examination) or the final qualifying work, feedback and review (reviews) (for consideration of the appeal for the defense of the final qualifying work).

5.4. The appeal is considered no later than 2 working days from the date of the appeal at a meeting of the appeal commission, to which the chairman of the state examination commission and the student who submitted the appeal are invited.

5.5. The decision of the appeal commission is drawn up in a protocol (Appendix 3) and communicated to the student who filed the appeal within 3 working days from the date of the meeting of the appeal commission. The fact of familiarization of the student who has filed the appeal with the decision of the appeal commission is certified by the student's signature.

5.6. When considering an appeal on a violation of the procedure for conducting a state attestation test, the appeal commission makes one of the following decisions:

- on the rejection of the appeal, if the information contained in it about violations of the procedure for conducting the state final certification of the student was not confirmed and (or) did not affect the result of the state certification test;
- on the satisfaction of the appeal, if the information contained in it about the violations of the procedure for conducting the

state final certification of the student was confirmed and influenced the result of the state certification test.

5.7. If a decision is made to satisfy the appeal on a violation of the procedure for conducting the state certification test, the result of the state certification test is subject to cancellation, in connection with which the protocol on the consideration of the appeal is transferred to the state examination commission no later than the next working day to implement the decision of the appeal commission. The student is given the opportunity to pass the state certification test within the time frame set by the university.

5.8. When considering an appeal on disagreement with the results of the state attestation test, the appeal commission makes one of the following decisions:

– on the rejection of the appeal and preservation of the result of the state certification test;

– on satisfying the appeal and setting another result of the state certification test.

5.9. The decision of the appeal commission is submitted to the state examination commission no later than the next working day. The decision of the appeal commission is the basis for the cancellation of the previously exposed result of the state attestation test and the issuance of a new one.

5.10. The decision of the appeal committee is final and not subject to revision.

5.11. Re-conducting the state certification test is carried out in the presence of one of the members of the appeal commission no later than July 15.

5.12. An appeal for a repeated state certification test is not accepted.

6. Requirements for final qualifying works **and the order of their execution**

The final qualifying work (hereinafter - FQP) is a mandatory type of final certification tests. General requirements for FQP are determined by educational standards, the Regulations on state final certification for educational programs of higher education - bachelor's, specialist's, master's programs of the federal state autonomous educational institution of higher education "Far Eastern Federal University" dated November 27, 2015 No. 12-13-2285. The final qualifying work is carried out in the form of a bachelor's work. The bachelor's work is an independent analytical research work related to solving an urgent research problem in accordance with the activities provided for in the direction03.19.01 Biotechnology (profile "Molecular Biotechnology")... The final qualification work is aimed at systematization, generalization and consolidation of theoretical

knowledge, practical skills, assessment of the formation of the student's competencies in accordance with the requirements of the educational standard.

The preparation and defense of the FQP is aimed at solving problems that make it possible to determine:

- the professional competence of the student in the process of solving research problems;
- the ability to apply theoretical knowledge to solve research problems in the field of molecular biotechnology;
- the ability to formulate research work, conduct scientific discussions and defend their own scientific ideas and positions.

During the preparation and defense of the FQP, the student must show possession of the following skills and abilities:

- substantiation of the relevance of the research topic;
- determination of the goals and objectives of the study;
- analysis of the literature on the research topic;
- clear and consistent presentation of research results based on evidence-based reasoning
- systematic consideration of the problem;
- the use of methods of scientific knowledge: the use of research planning methods and statistical processing of its results;
- high level of logical thinking.

The student must have a wide erudition and a rich outlook, master the methodology of scientific creativity, modern information technologies, methods of obtaining, processing, storing and using scientific information, be capable of production and technological, research and organizational and management activities

7. Requirements for the final qualifying work. Criteria for evaluation

The graduation work of a bachelor is a completed educational and scientific research carried out under the guidance of a scientific supervisor, which is relevant for modern medical information systems. The work should contain the following main sections: justification of the choice of the topic and its relevance, physical and mathematical formulation of the problem, justification of the choice and presentation of research methods and solution of the problem (feasibility study if necessary), analysis of the results obtained, list of used literature and conclusions.

The subject of the FQP is developed by the scientific supervisor, the joint student. The content of the FQP should correspond to the main areas of professional activity determined by the educational standard. The supervisor is assigned to the student from among the teaching staff with scientific degrees and / or academic titles. When the work on the FQP is considered completed by the student, it is submitted to its supervisor for verification, drawing up a written review containing instructions on:

- compliance of the results of the WRC with the set goals and objectives;
- the degree of development of the student's research qualities and professional competencies;
- the ability to work with scientific, methodological, reference literature and electronic information resources;
- personal qualities of the student, manifested in the process of working on the FQP.

In the response, the supervisor formulates his opinion about the work performed, evaluates it and recommends it for protection. If the supervisor considers the student's work not ready for defense, the discussion of this issue is brought to a meeting of the structural unit of the FEFU.

7.1 Content, volume and structure of the final qualifying work

During the implementation of the thesis, the student must:

- to study the state of the issue in the direction of research according to literary sources;
- carry out the analysis of information materials, formulate the purpose and objectives of the work;
- choose and master research methods that meet the assigned tasks;
- receive, process and generalize experimental data, formulate scientific and practical conclusions, proposals and recommendations.

The total volume of the explanatory note (60-110 pages of typewritten text).

Contents and sections of the explanatory note:

Introduction (goals and objectives of research)

1. Literary review (including the conclusion on the literary review)
2. Objects and methods of research
   2.1 objects of research (general scheme of work)
   2.2 research methods
   2.3 statistical data processing

3 Results of experimental studies and their discussion

conclusions

Bibliography

Applications

It is recommended to present the experimental scheme and research results on slides for demonstration during the defense.

7.2 Methods of performing scientific final qualifying work

The main stages of scientific SRS implementation consist of:

- collection, analysis and generalization of scientific and technical literature in the direction of research;
- clarifying the research tasks, formulating a working hypothesis, concretizing the likely ways to achieve the goal set in the work;
- selection of research objects and development of research methods;
- experimental research;
- analysis of the results obtained;
- formulation of scientific and practical conclusions and recommendations;
- registration of work.

FQP registration is carried out in accordance with GOST R 7.0.97-2016 Requirements for paperwork; GOST R 7.0.11-2011 SIBID. Dissertation and dissertation abstract. Structure and design rules; GOST 7.32-2017 SIBID. Research report. Structure and design rules.

8. General requirements for WRC

- independence and originality of the research;
- lack of compilation (borrowing);
- obtaining new significant results;
- exact match of the content of the work with the wording of the topic;
- logical sequence of presentation of the material;
- the validity of the results and conclusions.

9. Criteria for evaluating the final qualifying work

The mark "excellent" is given provided that the work:

– is of a research nature, is distinguished by novelty, originality and independence, shows the scientific and methodological maturity of the student;

– has positive reviews from the supervisor;

– shows the ability to work with literary sources, high culture of speech and spelling literacy;

– has a concrete practical result, passed approbation and positive external reviews.

The mark "good" is given if the work:

– is of a research nature, shows the scientific and methodological literacy of the student,

– differs in independence and contains elements of novelty;

– has positive reviews from the supervisor with minor remarks and wishes;

– shows the ability to work with literary sources, good culture of speech and spelling literacy;

– has a concrete practical result, which has passed approbation and positive feedback from the outside.

The mark "satisfactory" is given provided that the work:

- is of a research nature with minor elements of novelty, shows the scientific and methodological literacy of the student;

– the supervisor's reviews contain serious comments on the content of the work and the analysis method;

– shows insufficient ability to work with literary sources, low culture of speech, contains spelling errors, carelessly framed;

– practical results do not have positive feedback from the outside.

The mark "unsatisfactory" is given provided that the work:

– is not of a research nature, is not independent, does not contain novelty, shows a lack of scientific and methodological literacy;

– there are fundamental critical remarks in the responses of the supervisor;

– shows lack of ability to work with literary sources, low culture of speech, contains spelling errors, carelessly framed;

– the research results have no practical application.

Criteria for evaluating the results of the protection of WRC

Assessment	criteria for evaluating the results of the protection of WRC
"excellent"	
"OK"	
"satisfactorily"	
"Unsatisfactory"	

The final grade based on the results of the defense of the bachelor's work is entered in the record book and the minutes of the SEC meeting on the defense of the FQP, which are signed by the chairman and members of the examination committee.

Based on the results of the state final attestation, a decision is made to award students a qualification (degree) bachelor in the direction 03.19.01 Biotechnology (profile "Molecular Biotechnology") and the issuance of a bachelor's degree.

In case of receiving an unsatisfactory mark during the defense of the final qualifying work, repeated defense is carried out in accordance with the Regulations on the state final certification for educational programs of higher education - bachelor's, specialist's, master's programs of the federal state autonomous educational institution of higher education "Far Eastern Federal University" dated November 27, 2015 No. 12-13-2285.

10. Requirements for the organization and conduct of FQP defense

The bound bachelor's work, as well as the documentation for the work (task, schedule of execution, recall of the head, certificate of implementation - if any, etc.) must be prepared no later than 3 days before the defense and handed over to the secretary of the SEC.

The defense of the bachelor's work is carried out in order to check the quality of training of students, their ability to conduct public discussions and defend scientific ideas. The defense of the bachelor's work is carried out at an open meeting of the State Examination Commission with the participation of at least two-thirds of its composition (the presence of the chairman of the SEC or his deputy is mandatory), the scientific advisor, as well as everyone who wishes.

The procedure and procedure for the defense of the final qualification work is determined by the Regulations on the state final certification for educational programs of higher education - bachelor's, specialist's, master's programs of the Federal State Autonomous Educational Institution of Higher Education "Far Eastern Federal University" dated November 27, 2015 No. 12-13-2285. , after the

opening of the meeting by the chairman, announces the defense of the master's thesis, announces the title of the work, the names of the scientific adviser and the reviewer and gives the floor to the student, who makes a short report, usually up to 20 minutes long.

After the completion of the report, the GEC members ask him questions, both directly related to the topic of the final qualifying work, and closely related to it.

Questions can be asked by both members of the commission and all those present at the defense. When answering questions, the student has the right to use his work. Then the review of the scientific supervisor of the work is heard (the review is read by the secretary of the State Electoral Commission). After the final word, the procedure for defending the final qualifying work is considered completed. The duration of the defense of a bachelor's work is, as a rule, 45 minutes.

The results of the defense are discussed at a closed meeting of the SEC and are assessed by a simple majority of votes of the members of the commission. The supervisor and reviewer have an advisory vote if they are not members of the GEC. With an equal number of votes, the chairman's opinion is decisive. Then students are invited, and the secretary of the SEC announces the grades.

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

ШКОЛА БИОМЕДИЦИНЫ

Одобрено решением
Ученого совета Школы
протокол
от 04 декабря 2018 № 2

УТВЕРЖДАЮ
Директор
_____ Ю.С. Хотимченко
«04» декабря 2018 г.

PROGRAM
STATE EXAM
interdisciplinary
in the direction of bachelor's degree 19.03.01 Biotechnology
profile "Molecular Biotechnology"

Vladivostok
2019

1. Requirements for the procedure state examination

The form of the state interdisciplinary exam in the direction 19.03.01 Biotechnology (profile "Molecular Biotechnology") is oral. The questions of the state interdisciplinary exam cover the entire theoretical and practical course in the disciplines to be submitted for the exam.

Disciplines submitted for the state interdisciplinary exam:

B1.V.OD.2.6 Cellular and molecular biology;

B1.V.OD.1.5 Biomedical cell technologies;

B1.V.DV.1 Pharmaceutical biotechnology;

B1.V.DV.2 Industrial biotechnology.

Exam tickets must be issued in accordance with the requirements presented in Regulations on the state final certification for educational programs of higher education - bachelor's, specialist's, master's programs of the Federal State Autonomous Educational Institution of Higher Professional Education "Far Eastern Federal University" dated November 27, 2015 No. 12-13-2285.

The originals of tickets must have the appropriate signatures - the head of the PLO, the deputy director of the school for OIA.

Examination tickets must be reviewed and updated every 2 years, depending on the specifics of the disciplines.

Each exam ticket, as a rule, contains three questions to test the level of theoretical knowledge and to test the students' ability to apply theoretical knowledge in solving practical questions.

Each ticket for the interdisciplinary exam must include a question on the profile of the graduate.

It is recommended that when designing ticket questions, one should proceed from the content of the disciplines, taking into account the required level of knowledge and skills.

The wording of the points of the examination card is carried out in a narrative form.

One of the main conditions when drawing up tickets is to establish approximately the same volume of examination material, the degree of complexity and complexity of the questions.

The number of tickets required for the exam depends on the size of the group passing the exam, but not less than 25. At the same time, ticket issues must cover the entire scope of academic disciplines provided for by the didactic units of the state educational standard of higher professional education.

The procedure for conducting the state exam is approved in Regulations on the state final certification for educational programs of higher education - bachelor's, specialist's, master's programs of the Federal State Autonomous Educational Institution of Higher Professional Education "Far Eastern Federal University" dated November 27, 2015 No. 12-13-2285.

A student who does not have academic debt and who has fully completed the curriculum or individual curriculum for the corresponding educational program of higher education is admitted to the state exam. The draft order of the rector on the admission of students to the state exam is prepared by the administrator of the educational program no later than two calendar days before the day of the state exam.

When conducting an oral state examination, the student is given time to prepare an answer of at least 45 minutes. For students from among the disabled, the state examination is carried out taking into account their individual characteristics. At the written request of a student with a disability, the duration of the student's passing the state exam may be increased in relation to the established duration of its passing: the duration of preparing a student for answering the state exam, held orally, is no more than 20 minutes. When preparing the answer for the state exam, the student is allowed to use visual aids, reference, educational literature.

On the day of the state exam, before the start of the SEC meeting, the chairman of the SEC is presented with a copy of the rector's order on admitting students to the state exam. A meeting of the GEC is competent if it is attended by at least two thirds of the number of persons who make up the GEC. The decision of the GEC is made by a simple majority of votes from the number of persons who are part of the GEC participating in the meeting, and is drawn up in the minutes of the meeting of the GEC. With an equal number of votes, the chairman has a casting vote.

Regulations for the oral state examination: presentation of the student by the head of the graduating department or a member of the State Electoral Commission on written instructions from the head of the graduating department; preparation of an oral answer to students on the examination card; the student's oral answer to the questions of the examination card (as a rule, no more than 10 minutes); questions from the chairman and members of the SEC in writing and (or) orally after the student's answer; the student's answers to the questions asked.

The duration of the oral state examination should not exceed, as a rule, 20 minutes (excluding the time for preparing the answer).

After the attestation of the last student who appeared, a closed meeting of the SEC is held, at which, taking into account the opinion of the chairman and

members of the SEC who were present at the meeting, each student is given one of the marks in the minutes of the SEC meeting and examination sheet: "excellent", "good", "satisfactory", " unsatisfactory. " In the student's record book, the mark obtained at the state exam is also put forward, in addition to the mark "unsatisfactory".

When assessing the results of passing the state exam, the following aspects of preparation are taken into account:

1) understanding and degree of assimilation of the theory;
2) methodical training;
3) knowledge of factual material;
4) acquaintance with compulsory literature, with modern publications on this course in domestic and foreign literature;
5) the ability to apply theory to practice, solve problems, etc.
6) acquaintance with the history of science;
7) logic, structure and style of the answer, the ability to defend the proposed (hypothetical) assumptions.

Criteria for assessing the results of passing the state exam:

1. The mark "excellent" (in accordance with an excellent mark) is given to a student who has deeply and firmly mastered the program material, who is able to independently critically evaluate the basic concepts of disciplines, in whose answer theory is linked with practice; the student shows familiarity with the current literature, correctly defines all the basic concepts of disciplines, correctly applies theoretical principles in solving practical issues, and answers comprehensively additional questions.

2. The mark "good" is given to a student who is firmly aware of the program material, who expresses it competently and to the point, but admits minor inaccuracies in answering the question; the student correctly applies theoretical principles in solving practical questions and problems and answers most of the additional questions.

3. The mark "satisfactory" is given to a student who owns the basic material, but experiences some difficulties and makes inaccuracies in its presentation, does not correctly formulate the basic concepts of disciplines, and makes significant mistakes when performing practical tasks and answering additional questions.

4. The mark "unsatisfactory" is given to a student who does not know the basic material, makes significant mistakes, incorrectly answers most of the additional questions, and performs practical tasks with great difficulty.

2. Content of the state examination program

The final interdisciplinary exam program includes key and practically significant questions in the disciplines of general professional and special training, such as Cellular and Molecular Biology; Biomedical cell technologies; Pharmaceutical biotechnology; Industrial biotechnology.

2.1 Discipline B1.C. OD.2.6
Cellular and Molecular Biology

Definition of life and properties of living things. Organizational levels of living matter. The cell as the basis of heredity and reproduction. Nucleus structure and its role in heredity. The chemical composition of the cell (nucleic acids, proteins, polysaccharides, lipids, nucleoproteins, glycoproteins, lipoproteins, peptidoglycans, polyphosphates, mineral components and water). Cell structure and function (differences between prokaryotic and eukaryotic cells). The structure of the cell wall of bacteria.

Metabolism as a set of plastic and energy metabolism. Cell life cycle and types of cell division (amitosis, mitosis, meiosis).

Mendel's laws and their interpretation from the point of view of the chromosomal theory of heredity. Heredity and variability. Forms of variability. The main provisions of the evolutionary theory of Charles Darwin, its differences from the theory of Lamarck. Forms of selection, types of speciation, main paths of evolution.

Molecular basis of chromosome organization. histones, RNA in cellular metabolism. Clutch Recombination in bacteriophages.

The position of microorganisms among other organisms. Saprophytes, parasites, pathogenic forms. The principles of classification of bacteria: eubacteria, cyanobacteria, archaea. General biology of protists: algae, protozoa. Mushrooms. Viruses. Viral infections, lysogeny.

The mechanism of entry into the cells of eukaryotes and prokaryotes of exogenous substances. Physiology of nutrition. Nutrients, their importance for the biosynthesis process. A variety of types of nutrition for microorganisms (autotrophy, heterotrophy, photolithotrophy, photoorganotrophy, chemolithotrophy, chemoorganotrophy). A variety of sources of carbon, nitrogen, phosphorus, sulfur and other elements used by microorganisms. The theory of limiting and inhibiting cell growth by nutrients.

Physiology of energy metabolism: the use of energy-supplying processes by cells, their efficiency and dependence on environmental conditions. Economic

coefficient and its relationship with growth conditions. The interaction of cells and the environment, the influence of external physical and physicochemical factors on the growth and biosynthesis of microorganisms. Norm and stress, the problem of maintaining the ability to over-synthesize. Physiology of withering away.

Relationship between structure and function. Functional cytology, issues of differentiation and conditions causing it.

Methods for cultivating microorganisms (periodic, continuous, immobilization of cells and enzymes). Mixed cultures, consortia. The principles of their cultivation.

Microorganism metabolism. The relationship between biosynthetic and energy processes. The concept of "biological oxidation". Features of electron transport systems of microorganisms. Anaerobic oxidation processes. Anaerobic breathing. Fermentation. Aerobic breathing. A variety of substrates oxidized by microorganisms (natural biopolymers, hydrocarbons, xenobiotics, etc.). Complete aerobic oxidation of the substrate, incomplete oxidation and transformation of organic substrates. Oxidation of inorganic substrates. Features of bacterial photosynthesis. Biosynthetic processes. Assimilation nitrate reduction, sulfate reduction, nitrogen fixation.

The main monomers of constructive metabolism. Ways of education and their further use. Significance of the tricarboxylic acid cycle and glyoxylate shunt in constructive metabolism. Synthesis of lipids, polysaccharides and other components of the cell. The practical significance of these processes. Formation of biologically active substances by microorganisms: enzymes, antibiotics, vitamins, toxins. Primary and secondary metabolites. Their role in nature. Practical use.

Selection, genetic basis of selection. The concept of genotype and phenotype. Heredity, variability, selection of microorganisms. Recombination. The concept of population genetics and population variability. Selection methods. Selection of microorganisms. Production fermenter as an ecological niche. Biosphere and the spread of microorganisms. Participation of microorganisms in the cycles of carbon, nitrogen, oxygen, sulfur. Forms of relationships between microorganisms.

The concept of a gene in "classical" and molecular genetics, its evolution. Contribution of genetic engineering methodology to the development of molecular genetics. Applied value of genetic engineering for biotechnology.

Molecular basis of heredity. The nature of the genetic material. Features of the structure of the genetic material of pro- and eukaryotes. Transcription dik, its components. RNA polymerase and promoter. Translation, its stages, the function of ribosomes. Genetic code and its properties. Dick replication and its genetic

control. Recombination, its types and models. DNA repair mechanisms. The relationship between the processes of replication, recombination and repair.

Mutational process. The role of biochemical mutants in the formation of the "one gene - one enzyme" theory. Classification of mutations. Spontaneous and induced mutagenesis. Classification of mutagens. Molecular mechanism of mutagenesis. Identification and selection of mutants. Suppression: intragenic, intergenic and phenotypic.

Extrachromosomal genetic elements. Plasmids, their structure and classification. Sexual factor F, its structure and life cycle. The role of factor F in the mobilization of chromosomal transfer. Formation of donors such as Hfr and F. Mechanism of conjugation. Bacteriophages, their structure and life cycle. Virulent and moderate bacteriophages. Migrating genetic elements: transposons and IS-sequences, their role in genetic exchange. Study of the structure and function of the gene.

Elements of genetic analysis. Cis-trans-complementation test. Genetic mapping. Physical analysis of the structure of the gene. Restriction analysis. Sequencing methods. Identifying gene function. Regulation of gene expression. Operon and Regulon concepts. Control at the level of transcription initiation. Promoter, operator and regulatory proteins.

Positive and negative control of gene expression. Control at the level of transcription termination. Polar effect and its suppression. Catabolite-controlled operons: a lactose operon model. Attenuator-controlled operons: a model of the tryptophan operon. Multivalent regulation of gene expression. Post-transcriptional control.

Fundamentals of Genetic Engineering. The mechanism of gene mutations, genetic control. Restriction and modification enzymes. Isolation and cloning of genes. Vectors for molecular cloning. Principles for the construction of recombinant DNA and their introduction into recipient cells.

2.2 Discipline B1.C. OD.1.5
Biomedical cell technologies

Improvement of biological objects used in the production of medicines and diagnostic products. Selection methods.

Improvement of biological objects used in the production of medicines and diagnostic products. Methods for introducing foreign genes: transformation, transduction, conjugation.

Biomedical cell technology is the process of obtaining a cell product for the restoration of the structures and functions of human tissues and organs by replacing the cells of these tissues and organs with cells introduced from outside,

or by activating the own recovery processes of the human body, to create tissues and organs by bioengineering methods (tissue engineering) with their subsequent use in medical activities, as well as for targeted delivery of drugs in the human body.

Biomedical cell product - a complex consisting of a cell line (cell lines) and excipients or of a cell line (cell lines) and excipients in combination with state-registered medicinal products for medical use (hereinafter referred to as medicinal products) and (or) medical products.

Realization of a biomedical cell product - transfer of a biomedical cell product on a reimbursable basis and / or free of charge.

Autologous biomedical cell product - a biomedical cell product containing in its composition a cell line (cell lines) obtained from the biological material of a particular person, and intended for use by the same person.

Allogeneic biomedical cell product - a biomedical cell product that contains a cell line (cell lines) obtained from the biological material of a specific person and intended for use by other people.

Combined biomedical cell product - a biomedical cell product containing cell lines obtained from biological material of several people and intended for use by one of them.

A sample of a biomedical cell product is a biomedical cell product or a part thereof obtained for the purpose of studying its properties, including for assessing the quality of a biomedical cell product and its safety.

A cell line is a standardized population of cells of the same type with a reproducible cellular composition, obtained by removing biological material from the human body, followed by culturing cells outside the human body.

Excipients are substances of inorganic or organic origin used in the development and production of a biomedical cell product.

Biological material - biological fluids, tissues, cells, secrets and products of human vital activity, physiological and pathological secretions, smears, scrapings, swabs, biopsy material;

A donor of biological material (hereinafter also referred to as a donor) is a person who, during his lifetime, provided biological material, or a person from whom biological material was obtained after his death, ascertained in the manner prescribed by the legislation of the Russian Federation.

Donation of biological material - the process of posthumous provision of biological material (hereinafter - posthumous donation) or intravital provision of biological material (hereinafter - intravital donation).

The effectiveness of a biomedical cell product is a characteristic of the degree of positive influence of a biomedical cell product on the course, duration of

a disease or condition, or on their prevention, on the maintenance of pregnancy, on the patient's medical rehabilitation.

Preclinical study of a biomedical cell product - biological, microbiological, immunological, toxicological, pharmacological, physical, chemical and other studies of a biomedical cell product in order to identify the specific mechanism of action of such a product, to obtain evidence of its safety, quality and efficacy, preceding a clinical study of a biomedical cell product.

Clinical study of a biomedical cell product - the study of the preventive, diagnostic, therapeutic, rehabilitation properties of a biomedical cell product in the process of its use in humans in order to obtain evidence of its safety and efficacy, data on the side effects of such a product and adverse reactions associated with its use, as well as on the effect of the interaction of the investigated biomedical cell product with other biomedical cell products, drugs and (or) medical devices, food products.

A multicenter clinical study of a biomedical cell product is a clinical study of a biomedical cell product carried out in two or more medical organizations under a single protocol for a clinical study of a biomedical cell product.

An international multicenter clinical trial of a biomedical cell product is a clinical trial of a biomedical cell product carried out in different countries according to a single protocol for a clinical trial of a biomedical cell product.

Post-registration clinical study of a biomedical cell product is a clinical study of a biomedical cell product, circulation of which in the Russian Federation is carried out after state registration, in order to additionally collect data on its safety and efficacy, expand indications for the use of such a biomedical cell product, as well as identify unwanted reactions to it. application.

2.3 Discipline B1.V.DV.2
Industrial biotechnology

Polydisciplinarity of modern biotechnology. Biotechnology as a direction of scientific and technological progress, based on interdisciplinary biological knowledge (genetics, biochemistry, biophysics, microbiology, virology, physiology of plant and animal cells, etc.), chemical (chemical technology, physical (biophysical) chemistry, organic chemistry, bioorganic chemistry , computer and combinatorial chemistry, etc.), technical (processes and devices, monitoring and control systems, automated complexes, modeling and optimization of processes, etc.). The concept of biotechnology as a technological method for obtaining modified biological objects in order to give them new properties and / or the ability to produce new substances.

The main areas of application of modern biotechnology and its main aspects (biological, chemical, technological). Scientific bases of engineering design of biotechnology.

The main biological objects of biotechnology: industrial plants, animals and humans, microorganisms, cells and tissues, biocatalysts, including reconstructed producers of biologically active substances (selection, recombinant DNA method, hybridoma technology).

Raw materials for biosynthesis and assessment of its biological value. The main sources of carbon, nitrogen, phosphorus, trace elements. Research of new sources of raw materials (including issues of its preliminary processing), development of new nutrient media, including those including biostimulants and other elements of control and optimization of biosynthesis processes. Methods for optimization of culture media. Typical technological methods and features of the cultivation of microorganisms, cells and tissues of plants, animals and humans.

Continuous cultivation processes. Chemostat theory. Auto selection in chemostat. Semi-continuous (fed batch culture) and batch cultivation processes. Kinetic description of batch culture.

Specific rates of biomass growth, product biosynthesis and substrate consumption. The concept of C-mole of biomass. The influence of the substrate costs on the maintenance of vital functions, on the value of the apparent economic coefficient.

Models of the kinetics of biosynthesis of metabolic products depending on the specific growth rate, culture age, concentration of substrates and metabolites in the medium. Scaling principles for fermentation processes. Large-scale transition criteria.

Features of obtaining immobilized biological objects and their application in biotechnology. Diffusion restrictions when using immobilized enzymes and cells. Methods for controlling specific parameters of the fermentation process.

Typical technological methods of the stage of isolation and purification of biosynthesis products. Flotation of cells and protein products from the culture liquid. Extraction of biosynthesis products from biomass of microorganisms by liquids and supercritical liquids. Centrifugal extraction of labile products from the culture liquid. Drying of labile biological products and living biological products.

Testing of biologically active substances according to standard schemes. Reliability and safe operating conditions, bioprocess control, environmental protection. Modern approaches to the creation of resource and energy saving biotechnologies.

Sterilization of technological streams and equipment. Classification of biosynthesis industries in relation to contamination. Possible ways of penetration

of foreign microflora into the bioreactor. Aseptic cultivation. Methods of separation and destruction of contaminants, their comparative analysis. Methods for sterilizing liquids, solid substrates and air. Thermal sterilization. Stage hardware design. Decontamination of air and equipment in industrial premises.

Material and energy balances of the biosynthesis process. The influence of the cultivation conditions of the producer on the heat release, the value of the economic coefficient and the degree of substrate utilization. Oxygen consumption by microorganisms. Oxygen mass transfer from air to cells. Mass transfer of carbon dioxide. Mass transfer characteristics of fermentation equipment. Foaming and defoaming. Stirring during fermentation and its types. Basic fermentation equipment, its types and preliminary selection.

Batch and continuous bioreactors, complete mixing, complete displacement and intermediate type. Bioreactors for aseptic, conditionally aseptic and non-aseptic operations.

Classification of bioreactors according to the method of energy input: apparatus with mechanical stirring, bubbling, airlift. Basics of bioreactor modeling. Stages of modeling. Modeling parameters and their comparison. Modeling by the input specific energy, by the intensity of oxygen mass transfer. Research and development of principles and algorithms for optimal computer design of biotechnological systems.

Equipment for the separation of microbial suspensions, liquid and solid phases (sedimentation and filtration centrifuges with periodic and continuous discharge of sediment; supercentrifuges; separators for filtering and squeezing out sediments).

Equipment for the concentration of culture liquids and native solutions by vacuum evaporation (apparatus with rising and falling film; rotary film evaporators). Equipment for carrying out sedimentation processes (the effect of the initial concentration of the deposited substance, temperature on the rate of sediment formation).

Equipment for carrying out the processes of extraction from the solid phase and organic solvent (the influence of the phase ratio, the contact time of the phases on the efficiency of the process).

Equipment for baromembrane separation and purification of biosynthesis products and air (microfiltration, ultrafiltration; reverse osmosis; selectivity of baromembrane processes; gelation concentration).

Equipment for chromatographic concentration and separation of native solution components (ion exchange and gel filtration; purification of biosynthesis products on hydrophobic sorbents). Equipment for drying biotechnological

products (spray, roller-belt, drum, fluidized bed, pneumatic, sublimation, vacuum and pressure boost vacuum dryers).

Equipment for the treatment of gas-air emissions and wastewater (Venturi pipes, wet scrubbers, sedimentation tanks, biofilters, aeration tanks, oxytanks, digesters).

Principles of regulation, control and automatic control of biosynthesis processes. Creation and operation of devices, systems for measuring physicochemical, physiological and biophysical parameters, computerized technological complexes.

2.4 discipline B1.V.DV.1
Pharmaceutical biotechnology

Medical biotechnology (biotechnology for medicine). The use of methods of immobilization of biological objects in medical biotechnology and in the diagnosis of diseases. Fundamentals of modern immunobiotechnology. Hybridoma technology. The use of antibodies for the purification of biological fluids. Types of vaccines and their design. Cultural and genetically engineered vaccines. Serum production. Modern vaccinations. Preparations based on live cultures microorganisms (normal flora and probiotics). Immunosensors. Enzyme-based biosensor production. In vitro diagnostic tools for clinical trials. Probiotic production. Production of enzymes for medical use. Generating enzymes using genetic engineering techniques. Production of preparations based on a mixture of L-amino acids for oral and parenteral nutrition. Technologies of drugs based on stable targeted liposomes. Design and production of genetically engineered insulin. Other genetically engineered drugs and drugs. Production of immunomodulators, immunostimulants and immunosuppressants. Microbiological production of antibiotics of various classes for medicine. Semi synthetic antibiotics. Microbiological production of vitamins for health care.

Technologies for transformation products of organic compounds by enzymes of microbial cells: sorbitol in the production of ascorbic acid; hydrocortisone and its conversion to prednisolone; products of dehydrogenation, reduction and hydroxylation of steroids; oxidation products of indole and pyridine derivatives. Technologies for the cultivation of ip vitro cells and plant tissues for the production of phytopreparations and therapeutic and prophylactic additives.

3. List of questions

state examination in the direction of bachelor's degree

19.03.01 Biotechnology

profile "Molecular Biotechnology"

1. History of molecular biology, tasks and research area.
2. Molecular basis of the structure of living matter. Chemical elements contained in living organisms. Chemicals found in living organisms.
3. Metabolism as a set of plastic and energy metabolism. Cell life cycle and types of cell division (amitosis, mitosis, meiosis).
4. Proteins. Protein structure. Protein classification. Protein properties. Functions of proteins. Structural function. Catalytic or enzymatic function. Protective function. Regulatory function. Transport function. Energy function. Buffer function. Nutritional function.
5. Nucleic acids. The structure of nucleic acids. Organization of genetic material. Gene classification
6. The concept of a gene in "classical" and molecular genetics, its evolution. Contribution of genetic engineering methodology to the development of molecular genetics. Applied value of genetic engineering for biotechnology.
7. Transfer of genetic information. DNA replication. DNA repair. DNA recombination. Movable (mobile) genetic elements: transposons. Extrachromosomal genetic elements.
8. Realization of genetic information. Protein synthesis. DNA transcription. DNA synthesis on an RNA template (reverse transcription). Broadcast.
9. Heredity and variability. Mutagenesis. Classification of mutations. Mutagenic factors.
10. Fundamentals of Genetic Engineering. The mechanism of gene mutations, genetic control. Restriction and modification enzymes. Isolation and cloning of genes. Vectors for molecular cloning.
11. Principles for the construction of recombinant DNA and their introduction into recipient cells.
12. Plant cells. Application in the biotechnological process for the transformation of medicinal substances.

13. Suspension culturing of plant cells: parameters of a biological object that need to be taken into account; apparatus for cultivation.

14. Improvement of biological objects used in the production of medicines and diagnostic products. Selection methods.

15. Improvement of biological objects used in the production of medicines and diagnostic products. Methods for introducing foreign genes: transformation, transduction, conjugation.

16. The concept of biotechnology as a technological method for obtaining modified biological objects in order to give them new properties and / or the ability to produce new substances.

17. The main areas of application of modern biotechnology and its main aspects (biological, chemical, technological). Scientific bases of engineering design of biotechnology.

18. Modern biotechnology. The concept of a bioobject. General information about biological objects. The main groups of biological objects used in biotechnology.

19. The main biological objects of biotechnology: industrial microorganisms, cells and tissues of plants, animals and humans, biocatalysts, including reconstructed producers of biologically active substances (selection, recombinant DNA method, hybridoma technology).

20. Cultures of plant cells and tissues: concept, types, characteristics, areas of practical application. Phytohormones: auxins and cytokinins, their importance for obtaining a culture of plant tissues.

21. Biological objects of animal origin. Characteristic. Examples of biologically active substances obtained on their basis.

22. Biotechnology as a basic stage and as one of the intermediate stages in obtaining a finished product. A biotechnological process that fully ensures the receipt of the target product.

23. Components of biotechnological production. Preparatory and main stages of production.

24. Raw materials for biosynthesis and assessment of its biological value. The main sources of carbon, nitrogen, phosphorus, trace elements. Research of new sources of raw materials (including issues of its preliminary processing), development of new nutrient

media, including those including biostimulants and other elements of control and optimization of biosynthesis processes.

25. Raw materials for biosynthesis and assessment of its biological value Methods for optimization of culture media.

26. Requirements for raw materials (including issues of its preliminary processing), biostimulants and other elements. Optimization of biosynthesis processes.

27. Techniques for sterilizing process air, equipment and culture media in biotechnological production.

28. Thermal sterilization of culture media. Deindorfer-Humphrey test. Preservation of biological usefulness of media during sterilization.

29. Typical technological methods and features of the cultivation of microorganisms, cells and tissues of plants, animals and humans. Continuous cultivation processes. Chemostat theory.

30. Models of the kinetics of biosynthesis of metabolic products depending on the specific growth rate, culture age, concentration of substrates and metabolites in the medium. Scaling principles for fermentation processes. Large-scale transition criteria.

31. Conditions required for higher organisms and microorganisms in biotechnological systems during production. Life support systems.

32. Criteria characterizing the process of biosynthesis.

33. The influence of physical, chemical, and biological factors on fermentation processes.

34. Distinctive differences between submerged and surface fermentation.

35. Industrial bioreactors and main types of bioreactors.

36. General information about the device of different types of bioreactors. What types of bioreactors are used to work with industrial biocatalysts.

37. Fermentation apparatus (fermenters). Process regulation systems.

38. Features of the isolation of target products from the culture liquid, distinguishing the process from the isolation of target products in organic synthesis.

39. Chemostat and turbidostat cultivation modes. Characteristics of the hardware design of the processes.

40. Centrifugation and separation in biotechnological

production. Types of centrifuges. Types of separators. Specificity of application when working with biological objects and biosynthesis products.

41. Drying methods applied to biological objects and biosynthetic products. Spray dryers. Freeze dryers. Physical phenomena in the cell during freezing.

42. Plant cell culture methods. Callus and suspension cultures. Immobilization of plant cells.

43. Filtration methods in biotechnological production. Specificity associated with biological objects and parameters of culture fluids. Pretreatment of culture liquids. Filter presses. Leaf filters.

44. Membrane separation methods in biotechnological production. Microfiltration. Electrodialysis. Reverse osmosis. Ultrafiltration.

45. Immobilization of enzymes and whole cells of biological objects in biotechnological production. Environmental and economic benefits.

46. General classification of biotechnological products. Classification of biotechnological pharmaceutical products.

47. Biosynthesis and organic synthesis are complementary ways of creating drugs (for example, antibiotics and hormones).

48. Using the properties of a biological object for its improvement in order to create an effective and safe production of medicines.

49. Biotechnological production of medicines based on plant cell cultures. Totipotency. Benefits of using cell cultures.

50. Biotechnology of amino acids. Chemical-enzymatic method of obtaining. Microbiological synthesis.

51. Intracellular regulation of amino acid biosynthesis and ways of intensifying this process in production.

52. Construction of amino acid-producing strains and ways of intensifying the process by optimizing fermentation conditions.

53. Obtaining vitamins and coenzymes by biotechnology methods. Vitamin B12 production. Producers. Genetically engineered strain.

54. Vitamin B2 production. Producers. Genetically engineered strain.

55. Ascorbic acid production. Combination of chemical

synthesis and bioconversion steps. Microorganisms that carry out bioconversion in various schemes for the production of ascorbic acid. The stage of converting D-sorbitol to L-sorbose.

56. Obtaining vitamin PP. Producers OVER. Ways to increase the yield of the target product.

57. Producers of ergosterol, β-carotene, ubiquinones. Biotechnological production schemes.

58. Microbiological transformation of steroids in the creation of medicinal steroid preparations. The main sources of raw materials for the production of steroid drugs.

59. Physiological feasibility of biotransformations of steroid compounds. Bioconversion of steroids. Biological objects used for 11-hydroxylation, 1, 2-dehydrogenation, side chain cleavage.

60. General data on the biosynthesis of antibiotics. Antibiotic producers. Precursors of β-lactam antibiotics, aminoglycosides, erythromycin, tetracycline. Multienzyme complexes in cells of antibiotic producers.

61. Regulation of antibiotic biosynthesis. Carbon and nitrogen catabolite regulation. Feedback inhibition (retro-inhibition).

62. Molds are antibiotic producers. The main features of the cell structure and development cycle during fermentation. Antibiotics produced by fungi.

63. Actinomycetes are antibiotic producers. Features of the structure and development cycle during fermentation. Antibiotics produced by actinomycetes.

64. Bacteria (eubacteria) are antibiotic producers. Cell structure. Antibiotics produced by bacteria.

65. Semi-synthetic antibiotics. Biosynthesis and organic synthesis in the creation of semi-synthetic antibiotics (examples).

66. Mechanisms of resistance to β-lactam antibiotics. New β-lactam antibiotics effective against resistant forms of bacteria. Purposeful transformation.

67. Mechanisms of the development of resistance to aminoglycoside antibiotics. New effective aminoglycosides. Purposeful transformation.

68. Liposomal dosage forms of antibiotics. Advantages over traditional forms. Receiving methods.

69. Natural sources of antibiotic resistance genes. Organizational measures as one of the ways to combat antibiotic

resistance.

70. Lactic acid bacteria. Mechanisms of suppressive action on pathogenic and putrefactive bacteria. Other functions that are beneficial to the human body. Preparations based on lactic acid bacteria.

71. Recombinant proteins. Construction and peculiarities of cultivation of microorganisms-producers of proteins foreign to them.

72. Purification of recombinant proteins obtained by microbiological synthesis. Specific impurities in the final product: control and disposal.

73. Insulin. Sources of raw materials. Recombinant human insulin. Reasons for obtaining by microbiological synthesis. Production process diagram. Construction of human insulin-producing strains. Benefits of Escherichia coli as a producer.

74. Vaccines. Classification. Characteristics of each individual type of vaccine: live, inactivated, subunit, DNA vaccines.

75. Features of the technology for obtaining vaccines. Control of specific activity. Storage.

Recommended reading
and information and methodological support

Main literature
(electronic and printed editions)

1. Gorlenko V.A. Scientific foundations of biotechnology. Part 1. Nanotechnology in biology [Electronic resource]: tutorial / VA Gorlenko, NM Kutuzova, SK Pyatunina. - Electron. text data.http://www.iprbookshop.ru/24003.html... - M .: Prometheus, 2013 .-- 262 p. - Access mode:http://lib.dvfu.ru:8080/lib/item?id=IPRbooks:IPRbooks-24003&theme=FEFU

2. Lukanin, A.V. Engineering biotechnology: the basics of microbiological production technology: Textbook / A.V. Lukanin - M.: SRC INFRA-M, 2016 .-- 304 p .:http://lib.dvfu.ru:8080/lib/item?id=Znanium:Znanium-527386&theme=FEFU

3. Lukanin, A.V. Engineering biotechnology: processes and devices of microbiological production: textbook / A.V. Lukanin. - M .: NITs INFRA-M, 2016 .-- 451 p .:http://lib.dvfu.ru:8080/lib/item?id=Znanium:Znanium-527535&theme=FEFU

4. Genetic foundations of plant breeding. Volume 3. Biotechnology in plant breeding. Cellular engineering [Electronic resource] / V.S. Anokhin [and others]. - Electron. text data.http://www.iprbookshop.ru/29441.html... - Minsk: Belarusian Science, 2012 .-- 490 p. - Access mode:-http://lib.dvfu.ru:8080/lib/item?id=IPRbooks:IPRbooks-29441&theme=FEFU

5. Genetic foundations of plant breeding. Volume 4. Biotechnology in plant breeding. Genomics and genetic engineering [Electronic resource] / O.Yu. Urbanovich [and others]. - Electron. text data.http://www.iprbookshop.ru/29578.html- Minsk: Belarusian Science, 2014 .-- 654 p. - Access mode:http://lib.dvfu.ru:8080/lib/item?id=IPRbooks:IPRbooks-29578&theme=FEFU

6. Molecular biology of the cell [in 3 volumes]: vol. 3 / Bruce Alberts, Alexander Johnson, Julian Lewis [and others]; with problems of J.

Wilson, T. Hunt; per. from English A.N. Dyakonova, A.V. Duba, A. Svetlova. - Moscow, Izhevsk: Institute of Computer Research, Regular and Chaotic Dynamics, 2013. - p. 1737-2764.http://lib.dvfu.ru:8080/lib/item?id=chamo:772786&theme=FEFU

7. Molecular biology of the cell [in 3 volumes]: vol. 3 / Bruce Alberts, Alexander Johnson, Julian Lewis [and others]; with problems of J. Wilson, T. Hunt; per. from English A.N. Dyakonova, A.V. Duba, A. Svetlova. - Moscow, Izhevsk: Institute of Computer Research, Regular and Chaotic Dynamics, 2013. - p. 1737-2764.http://lib.dvfu.ru:8080/lib/item?id=chamo:772786&theme=FEFU

8. Pinaev, G.P. Cellular biotechnology: teaching aid / G.P. Pinaev, M.I. Blinov, N.S. Nikolaenko, G.G. Polyanskaya, T.N. Efremova, N.S. Sharlaimova, N.A. Shubin. - St. Petersburg: Polytechnic University, 2011 .-- 224 p.

9. Regenerative potential of mesenchymal stem cells / B.V. Popov. - St. Petersburg: Medical book "ELBI", 2015. - 287 p.http://lib.dvfu.ru:8080/lib/item?id=chamo:803153&theme=FEFU

10. Ryabkova, G.V. Biotechnology (Biotechnology) [Electronic resource]: teaching aid / G.V. Ryabkova - Electron. text data.http://www.iprbookshop.ru/61942.html... - Kazan: Kazan National Research Technological University, 2012. - 152 p. - Access mode:http://lib.dvfu.ru:8080/lib/item?id=IPRbooks:IPRbooks-61942&theme=FEFU

11. A.S. Sirotkin Theoretical foundations of biotechnology [Electronic resource]: teaching aid / Sirotkin AS, Zhukova VB. - Electron. text data.http://www.iprbookshop.ru/63475.html... - Kazan: Kazan National Research Technological University, 2010. - 87 p. - Access mode:http://lib.dvfu.ru:8080/lib/item?id=IPRbooks:IPRbooks-63475&theme=FEFU

12. Tsoglin, L.N. Biotechnology of microalgae / L.N. Tsoglin, N.A. Pronina. - Moscow: Scientific world, 2012 .-- 182 p.http://lib.dvfu.ru:8080/lib/item?id=chamo:706085&theme=FEFU

13. Chentsov, Yu.S. Introduction to cell biology: a textbook for universities in biological specialties / Yu.S. Chentsov. - ed. 4th, rev. and additional, erased, reprinted. with ed. 2005. - Moscow: Alliance, 2015 .-- 494 p.http://lib.dvfu.ru:8080/lib/item?id=chamo:776847&theme=FEFU

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2. Stem cell biology and cell technologies: for medical universities in 2 volumes: vol. 1 / M. A. Paltsev, R. S. Akchurin, M. A. Aleksandrova [and etc.]; ed. M. A. Paltseva. - Moscow: Medicine, Shiko, 2009 .-- 272 p.http://lib.dvfu.ru:8080/lib/item?id=chamo:779352&theme=FEFU

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9. Bratus, A.S. Dynamical systems and models of biology / A.S. Bratus, A.S. Novozhilov, A.P. Platonov. - Moscow: FIZMATLIT, 2009 .-- 400 p.http://e.lanbook.com/books/element.php?pl1_id=2119

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14. Microbial enzymes and biotechnology / Ed. M.V. Fogarty. - M .: Agropromizdat, 1986 .-- 318 p.

15. Nanostructures in biomedicine / ed. K. Gonsalves[and etc.]; per. from English - Moscow: Binom. Knowledge Laboratory, 2013 .-- 519 p.http://e.lanbook.com/books/element.php?pl1_id=8685

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1. Comprehensive program for the development of biotechnologies in the Russian Federation for the period up to 2020 VP-P8-2322: approved by the Chairman of the Government of the Russian

Federation V. Putin on April 24, 2012 N 1853p-P8 [Electronic resource]: // GARANT: information and legal system. - Access mode:http://www.garant.ru/

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3. Good practice rules for working with biomedical cell products (approved by order of the Ministry of Health of the Russian Federation of August 8, 2018 N 512n) GARANT: information and legal system. - Access mode:http://www.garant.ru/

4. On the basics of protecting the health of citizens in the Russian Federation [Electronic resource]: Federal Law No. 323-FZ of November 21, 2011: adopted by the State Duma on November 1, 2011 - last. rev. 03 July 2016 // GARANT: information and legal system. - Access mode:http://www.garant.ru/

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1. Ministry of Health of the Russian Federation - official website: https://www.rosminzdrav.ru/
2. Central Research Institute of Organization and Informatization of Health Care - official website: http://mednet.ru/
3. Research Institute of Biomedical Chemistry. V.N. Orekhovich - official site:http://www.ibmc.msk.ru
4. Ministry of Health of the Russian Federation - official website: https://www.rosminzdrav.ru/
5. Central Research Institute of Organization and Informatization of Health Care - official website: http://mednet.ru/
6. Research Institute of Biomedical Chemistry. V.N. Orekhovich - official site:http://www.ibmc.msk.ru/
7. Technological platform BioTech2030 - official website: http://biotech2030.ru/
8. Federal Research Center "Fundamentals of Biotechnology" of the Russian Academy of Sciences "(FRC Biotechnology RAS) - official site: http://fbras.ru/
9. International Biotechnological Center "Generium" - official site:http://ibcgenerium.ru/
10. Institute of Molecular Genetics RAS - official website: https://img.ras.ru/ru

Attachment 1

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

SCHOOL OF BIOMEDICINE
Department of Medical Biology and Biotechnology

STATE EXAM
in the field of training 03.19.01 Biotechnology
Profile Molecular Biotechnology
_____ academic year

Examination ticket number __1__

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3. _____

Department Director _____

Head of OP _____

Deputy school principal for OIA _____

M.P. (schools)