

**«Molecular Biotechnology» по направлению подготовки 19.03.01
«Биотехнология»**

Дисциплины	Содержание
1 семестр	
1. Foreign language (university-wide module)	<p>Discipline allows students to acquire skills and abilities of self-command of a foreign language in order to achieve successful communication in real life situations.</p> <p>расширение кругозора о культуре стран изучаемого языка.</p> <p>Discipline increases level of spoken English from an intermediate level (A2) to an advanced level (B1) according to the European system of proficiency in foreign languages (A, B, C); improving the literacy of conversational speech; Improving your listening comprehension skills; vocabulary expansion, enriching it with idioms; mastering everyday speech etiquette; broadening the outlook on the culture of native speakers countries.</p>
2. Foreign language	<p>Practical training of students in written English, writing texts, articles, ESSE, essays; practicing reading skills of scientific literature, from the professional field as well.</p>
3. Physical education (university-wide module)	<p>Theoretical and practical skills of general physical training, basic types of physical activity, review of healthy lifestyle problems and the role of physical culture in the development and preservation of his health; review of the basics of motor actions, the basics of education of physical qualities, hygienic rules and regimes, the history of physical education</p>
4. Physical culture and sport	<p>Learning general theoretical aspects of physical culture, the practical learning (exercises) from the basic types of motor activity (athletics, sport games (volleyball)) for the formation of the individuals' physical culture.</p>
5. Russian language and speech culture (Business communication)	<p>To instill in students the mastery of the norms of the modern Russian literary language, the theoretical foundations of the culture of speech as an aggregate and system of communicative qualities (correctness, purity, accuracy, consistency, relevance, clarity, expressiveness and richness of speech); the disclosure of the functional and stylistic richness of the Russian literary language (the specifics of elements of all language levels in scientific speech, genre differentiation, selection of language means in the journalistic style; language and style of instructional and methodological documents and commercial correspondence in the official business style, etc.); development of linguistic intuition and evaluative attitude both to one's own and to someone else's speech; formation of an open person for communication with a high rating in the system of modern social values; studying the rules of language design of documents of various genres; deepening the skills of independent work with dictionaries and reference materials.</p>
6. IT	<p>Analytical processing of experimental data; hardware and software implementation of information processes; principles of algorithmization and programming. Acquisition of knowledge and skills that ensure the ability to perform analytical processing of experimental data, to present the information obtained in the form</p>

	of a scientific report, written essa.
7. Higher Mathematics	Mathematical analysis (fundamentals of set theory, functions of one variable, limit and continuity of a function, differential and integral calculus of a function of one variable), theory of odds and mathematical statistics.
8. Physics	Formation of system of physical concepts; the formation of the basic ideas of the modern world physical picture based on the studying basic and the most important physical theories; students are acquainted with the most important applied aspects of physics; familiarizing students with the humanitarian aspects of physical knowledge, forming the basis for enhancing the student's general culture, his environmental education; acquisition with physical methods of research and product quality control .
9. General and inorganic chemistry	<p>The study of the structure and properties of substances, their reactivity, the basic laws of chemistry, the concepts of the classification of substances, the mechanisms of chemical reactions. Consideration of the prospects for the use and practical application of chemicals.</p> <p>The structure of matter, quantitative relationships in chemistry, chemical symbols and formulas, atom structure, early models of the atom, quantum-mechanical model of the structure of the atom, chemical bonding, the method of valence bonds, the method of molecular orbitals Calculation of equilibrium constants. Solubility and redox equilibria Experimental bases of chemical kinetics. Theoretical foundations of chemical kinetics. Some simple reactions of organic compounds. Calculation of thermodynamic functions. Calculation of thermodynamic functions from molecular data. Molecular movement and dynamic equilibria.</p>
10. Biology	<p>Studying the chemical composition of the cell, the structure and functions of proteins, carbohydrates, lipids, nucleic acids; Studying the physico-chemical nature of life, manifested in the process of metabolism; Studying the central dogma of molecular biology in the essence of genetic information and the mechanism of its implementation (protein biosynthesis); Studying the mechanisms of gene activity regulation.</p> <p>Studying the forms and mechanisms of reproduction, the periodization of ontogenesis, the characteristics of human ontogenesis; fundamentals of anthropogenesis and anthropogenic evolution of the biosphere, review of strategic objectives for the preservation of biodiversity and nature conservation.</p>
11. Introduction to biotechnology and professional activities	Изучение значения биотехнологии для развития общества, её социального эффекта и биоэкономики; изучение основ молекулярной биотехнологии, значения молекулярно-биотехнологической революции, возникновения и развития молекулярной биотехнологии; изучение терминов и определений в области биотехнологий, а также классификации биотехнологической продукции; ознакомление с основными тапами биотехнологического процесса и с управлением основных стадий действующих биотехнологических производств; изучение научно-технической информации по вопросам развития новых направлений в биотехнологии, в том числе биомедицины и

	биофармацевтики; изучение объектов биотехнологии и их биотехнологических функций; изучение биологических систем, использующихся в молекулярной биотехнологии.
12. Basics of medical knowledge	Studying and considering of human anatomy, physiology, hygiene and first aid for emergency conditions. The study of terminological concepts, general and special data on the structure and functions of the human body.
2 семестр	
13. Foreign language (university-wide module)	Discipline allows students to acquire skills and abilities of self-command of a foreign language in order to achieve successful communication in real life situations. расширение кругозора о культуре стран изучаемого языка. Discipline increases level of spoken English from an intermediate level (A2) to an advanced level (B1) according to the European system of proficiency in foreign languages (A, B, C); improving the literacy of conversational speech; Improving your listening comprehension skills; vocabulary expansion, enriching it with idioms; mastering everyday speech etiquette; broadening the outlook on the culture of native speakers countries.
14. Foreign language	Practical training of students in written English, writing texts, articles, ESSE, essays; practicing reading skills of scientific literature, from the professional field as well.
15. History	Studying and reviewing the problems of world history with a primary focus on the history of Russia. Studying the ancient history of mankind, Middle Ages, New and Newest time. Studying Russian history, European history, review of the histories of Asian and American countries, taking into account the synchronicity and non-synchronism of the process of historical development and its unevenness.
16. Logics	Formation of correct thinking and other general cultural competencies. Studying traditional and symbolic logic, instilling skills of reasoned and evidentiary reasoning, disclosure of the main trends and directions of science about the laws of thinking, review of examples of the logic application in everyday life and professional activities.
17. Economy	Изучение основных понятий, показателей, принципов расчета в экономической теории; формирование представления о тенденциях развития мировой и отечественной экономики с целью выявления проблемы и способов их решения в практике управления предприятием; ознакомление с инструментами экономического прогнозирования социально-экономического развития; формирование навыков системного подхода к анализу проблем общества; овладение экономическими методами анализа социально-экономических проблем и процессов развития.
18. Higher Mathematics	Mathematical analysis (fundamentals of set theory, functions of one variable, limit and continuity of a function, differential and integral calculus of a function of one variable), theory of odds and mathematical statistics.
19. Physics	Formation of system of physical concepts; the formation of the

	<p>basic ideas of the modern world physical picture based on the studying basic and the most important physical theories; students are acquainted with the most important applied aspects of physics; familiarizing students with the humanitarian aspects of physical knowledge, forming the basis for enhancing the student's general culture, his environmental education; acquisition with physical methods of research and product quality control .</p>
20. Organic chemistry	<p>The chemical composition of living organisms; pattern, structure, properties and biological functions of the main organic compounds; main types of metabolic processes in the body and their relationship; the relationship between the structure and properties of organic compounds and their changes during processing.</p>
21. Computer engineering graphics	<p>Studying methods and algorithms of modern computer engineering graphics, the study of the fundamentals of applied computer graphics, mastering the important terminology in the field of computer engineering graphics. Consideration of specific engineering problems (design, circuit engineering), solved using computer graphics technology.</p> <p>Outlines the basics of computer creation of design documentation based on the professional version of the KOMPAS system. Creation in the KOMPAS system of various drawings using the libraries of this system, specifications of assembly units and tables. Features and basic operations of creating volumetric models of parts using the KOMPAS-3D system, creating three-dimensional assemblies and building assembly drawings on their basis. Exporting drawings to the AutoCAD system and importing drawings from this system.</p>
22. Biology	<p>Studying the chemical composition of the cell, the structure and functions of proteins, carbohydrates, lipids, nucleic acids; Studying the physico-chemical nature of life, manifested in the process of metabolism; Studying the central dogma of molecular biology in the essence of genetic information and the mechanism of its implementation (protein biosynthesis); Studying the mechanisms of gene activity regulation.</p> <p>Studying the forms and mechanisms of reproduction, the periodization of ontogenesis, the characteristics of human ontogenesis; fundamentals of anthropogenesis and anthropogenic evolution of the biosphere, review of strategic objectives for the preservation of biodiversity and nature conservation.</p>
23. Physiology with the basics of anatomy	<p>The study and examination of human anatomy, physiology. Review of current data on the general principles of the structural and functional organization of body systems, studying characteristics of each of them. The study of detailed information about the structure and mechanisms of functioning. General structural and physiological properties of the organism. The study of the cell, the elements of embryology, the study of tissues, the musculoskeletal system, blood and lymph, blood circulation, respiration, digestion, metabolism and energy. nutrition. thermoregulation, secretion, internal secretion, reproduction, muscle physiology, structure and physiological properties of the peripheral nervous system, vegetative nervous system, central</p>

	nervous system, sensory organs, higher nervous activity
24. Элективные курсы по физической культуре и спорту	Практическое освоение средств (упражнений) из базовых видов двигательной деятельности (легкая атлетика, спортивные игры (волейбол)) для формирования физической культуры личности.
3 семестр	
25. Foreign language (university-wide module)	Discipline allows students to acquire skills and abilities of self-command of a foreign language in order to achieve successful communication in real life situations. расширение кругозора о культуре стран изучаемого языка. Discipline increases level of spoken English from an intermediate level (A2) to an advanced level (B1) according to the European system of proficiency in foreign languages (A, B, C); improving the literacy of conversational speech; Improving your listening comprehension skills; vocabulary expansion, enriching it with idioms; mastering everyday speech etiquette; broadening the outlook on the culture of native speakers countries.
26. English for Specific Purposes	Discipline allows students to acquire skills and abilities of self-command of a foreign language in order to achieve successful communication in real life situations. расширение кругозора о культуре стран изучаемого языка. Discipline increases level of spoken English from an intermediate level (A2) to an advanced level (B1) according to the European system of proficiency in foreign languages (A, B, C); improving the literacy of conversational speech; Improving your listening comprehension skills; vocabulary expansion, enriching it with idioms; mastering everyday speech etiquette; broadening the outlook on the culture of native speakers countries.
27. Philosophy	Creating a holistic system view of the world and a person's place in it; stimulating the need for philosophical assessments of historical events and facts of reality; expanding the knowledge of future specialists and enriching their spiritual world; assistance in the formation of personal responsibility and independence; development of interest in fundamental knowledge.
28. Organic chemistry	The chemical composition of living organisms; pattern, structure, properties and biological functions of the main organic compounds; main types of metabolic processes in the body and their relationship; the relationship between the structure and properties of organic compounds and their changes during processing.
29. Analytical chemistry	Fundamentals of analytical chemistry, theoretical foundations and practical possibilities of chemical and physico-chemical methods of analysis, identification of chemicals, chemical methods of analysis, including gravimetric and titrimetric, methods of separation and concentration, as well as chromatographic and electrochemical methods of analysis. Statistical processing of analysis results, metrological characteristics of methods.
30. Biology	Studying the chemical composition of the cell, the structure and functions of proteins, carbohydrates, lipids, nucleic acids; Studying the physico-chemical nature of life, manifested in the process of

	<p>metabolism; Studying the central dogma of molecular biology in the essence of genetic information and the mechanism of its implementation (protein biosynthesis); Studying the mechanisms of gene activity regulation.</p> <p>Studying the forms and mechanisms of reproduction, the periodization of ontogenesis, the characteristics of human ontogenesis; fundamentals of anthropogenesis and anthropogenic evolution of the biosphere, review of strategic objectives for the preservation of biodiversity and nature conservation.</p>
31. Microbiology	<p>The issues of classical microbiology are covered, including morphology, systematics, physiology, biochemistry, ecology and evolution of representatives of different taxonomic groups: prokaryotes, yeast and mycelial fungi, algae, protists, viruses, and also other non-cellular life forms. The influence of environmental factors on the vital activity of microorganisms. Food microorganisms. Fundamentals of microscopic examination and computer processing of microscopy results, methods for obtaining enrichment cultures from natural sources and industrial raw materials, and laboratory research of microorganisms used in industry</p>
32. Biochemistry	<p>Amino acids and proteins. The structure of proteins. Functions of proteins. Carbohydrates and nucleic acids. Enzymes, coenzymes, vitamins and cofactors. Lipids and biomembranes. Bioenergy and photosynthesis. Metabolism of carbohydrates and lipids. Metabolism of proteins and nucleic acids. Metabolism regulation.</p>
33. General pathology and fundamentals of nosology	<p>Morphofunctional patterns of the emergence and development of pathological reactions, processes and conditions underlying diseases (general pathology); violations of the main functional indicators of human life in various forms of pathology; mechanisms of pathology formation for “targeted” and the most effective medicinal effects.</p>
34. Molecular and cellular biology	<p>Theoretical training and deepening of students' knowledge in the field of cells' molecular biology (it is a section of biology, the subject of which is a cell, the elementary unit of the living). A cell is considered as a system that includes individual cellular structures, their participation in general cellular physiological processes, ways of regulating these processes, and also studying the basic properties and manifestations of life at the molecular level.</p>
35. Elective courses in physical culture and sports	<p>Practical development of exercises from the basic types of motor activity (athletics, sports (volleyball)) for the formation of the individuals' physical culture.</p>
4 семестр	
36. Foreign language (university-wide module)	<p>Discipline allows students to acquire skills and abilities of self-command of a foreign language in order to achieve successful communication in real life situations.</p> <p>расширение кругозора о культуре стран изучаемого языка.</p> <p>Discipline increases level of spoken English from an intermediate level (A2) to an advanced level (B1) according to the European system of proficiency in foreign languages (A, B, C); improving the literacy of conversational speech; Improving your listening</p>

	comprehension skills; vocabulary expansion, enriching it with idioms; mastering everyday speech etiquette; broadening the outlook on the culture of native speakers countries.
37. English for Specific Purposes	Discipline allows students to acquire skills and abilities of self-command of a foreign language in order to achieve successful communication in real life situations. расширение кругозора о культуре стран изучаемого языка. Discipline increases level of spoken English from an intermediate level (A2) to an advanced level (B1) according to the European system of proficiency in foreign languages (A, B, C); improving the literacy of conversational speech; Improving your listening comprehension skills; vocabulary expansion, enriching it with idioms; mastering everyday speech etiquette; broadening the outlook on the culture of native speakers countries.
38. Jurisprudence	Consideration of a range of issues allowing to form a comprehensive view on the main legal phenomena, civil rights and obligations, law of the Russian Federation and its violation.
39. Physical and colloid chemistry	The main sections of physical chemistry: the theory of substances aggregation state, chemical thermodynamics, the theory of solutions, electrochemistry, etc. Colloid systems, as well as high-molecular compounds and their solutions. Fundamental ideas about the laws of colloid chemistry as a science about surface phenomena and disperse systems. Features, production and properties of nanoparticles as objects of colloid chemistry. The composition, structure and properties of colloidal particles; interaction of particles with a dispersion medium (mainly with liquids); contact interactions of particles with each other, leading to the formation of colloidal structures.
40. Biochemistry	Amino acids and proteins. The structure of proteins. Functions of proteins. Carbohydrates and nucleic acids. Enzymes, coenzymes, vitamins and cofactors. Lipids and biomembranes. Bioenergy and photosynthesis. Metabolism of carbohydrates and lipids. Metabolism of proteins and nucleic acids. Metabolism regulation.
41. Scientific design and research methodology	The study of the structure and main stages of research. Mastering the methods of theoretical and practical research in the field of biotechnology, Consideration of the issues of modeling in scientific research and the choice of the direction of scientific research. Mastering the system of scientific knowledge, methods of searching, accumulating and analyzing scientific information, acquiring skills for processing, designing and presenting the results of experimental research.
42. Fundamentals of biotechnology	Studying the possibility of using living organisms, their systems or their metabolic products to solve technological problems, as well as the possibility of creating living organisms with the necessary properties by genetic engineering. Formation of a scientific world outlook and modern biochemical thinking, sufficient theoretical basis for successful mastering of general professional and special disciplines.
43. Molecular and cellular biology	Theoretical training and deepening of students' knowledge in the field of cells' molecular biology (it is a section of biology, the subject of which is a cell, the elementary unit of the living). A cell is considered as a system that includes individual cellular

	structures, their participation in general cellular physiological processes, ways of regulating these processes, and also studying the basic properties and manifestations of life at the molecular level.
44. Elective courses in physical culture and sports	Practical development of exercises from the basic types of motor activity (athletics, sports (volleyball)) for the formation of the individuals' physical culture.
45. Bioethics	Biomedical ethics addresses the challenges posed by advances in medical science and biomedical technology..
5 семестр	
46. Mathematical modeling	Elements of modeling and optimization based on linear and dynamic programming: the general problem of nonlinear programming, admissible sets, optimization criterion and objective function, geometric interpretation; linear programming problem (LP), examples of LP problems; normal (standard) and canonical forms of LP; admissible set of the LP problem, properties. Elements of decision-making theory and multi-criteria optimization: criterion language of choice description, quantitative and qualitative scales for measuring criteria; formulations of typical optimization problems of multi-criteria choice, a variety of alternatives; examples of multi-criteria linear programming problems; binary relations on the set of alternatives, their types and properties. Elements of network planning and management in an enterprise: typical tasks of network planning and management (SPU), a design approach to planning technological and business processes, CPM and PERT methods; network schedule, elements and rules of construction; the main temporal characteristics of the network schedule and its key elements, critical indicators and paths; Gantt line chart and resource utilization charts; SPU optimization tasks, optimization of the costs of accelerating projects; optimization of the use of resources in network processes with their shortage; optimization of classical flows on networks and other tasks.
47. Bioorganic chemistry	Biologically important classes of organic compounds. Structure and reactivity of organic compounds, including biopolymers, metabolites and low molecular weight bioregulators. The characteristic properties of poly-and heterofunctional compounds, specified via mutual influence of various functional groups that are simultaneously represented in their molecules. Biologically important hetero-functional compounds (amino acids, peptides, proteins, carbohydrates, nucleic acids and lipids), structural features and their specific chemical properties
48. Fundamentals of biotechnological production design	Formation of a system of knowledge about the methods and design stages; reinforcement of biotechnology production design skills; mastering the methods of designing technological processes.
49. Electrical Engineering and Electronics	Theoretical training in the field of electrical engineering and electronics, acquisition of practical skills in assembling and calculating electrical circuits, reading diagrams, getting acquainted with the principles of measuring devices operation

	and electrical safety rules, developing the engineering thinking necessary to study special disciplines related to the operation of electrical and electronic equipment.
50. Technologies of medical laboratory diagnostics	Consideration of a range of issues related to specific technological solutions underlying the laboratory diagnosis. The course covers: the mechanisms and physical bases for the functioning of laboratory equipment, general principles and methods for the implementation of laboratory research, the fundamental biological principles underlying laboratory research.
51. Biomedical Cell Technology	Study of the possibilities of using cellular technologies in medical practice and considering the use of stem cells in the treatment and therapy of a wide range of nosological forms, using methods of genetic engineering and bioengineering in clinical practice, modern techniques to combat infertility.
52. Molecular pharmacology	Mastering basic information on general pharmacology, mechanisms of effects of drugs on biological targets, pharmacokinetics, pharmacodynamics and use of major groups of drugs; analysis of the action of drugs at the level of the organism, organ, cell, subcellular structures and molecules; study of the principles of action of the main pharmacotherapeutic groups of medicinal substances, questions of the molecular mechanism of their action and safety profile; study of drug toxicology, prediction and prevention of adverse drug reactions, based on the aspects of the molecular action of drugs
53. General genetics	Studying the theoretical basics of genetics, the principles of genetic analysis, methods and means of genetic research, mastering the solution of genetic problems; Studying the nature of human hereditary diseases, their etiology, pathogenesis, causes of wide clinical polymorphism of etiologically unified forms and genetic heterogeneity of a clinically similar condition; Mastering modern methods of cytogenetic, biochemical and molecular genetic diagnostics.
54. Elective courses in physical culture and sports	Practical development of exercises from the basic types of motor activity (athletics, sports (volleyball)) for the formation of the individuals' physical culture.
6 семестр	
55. Processes and devices of biotechnology	Basics of technological processes in biotechnology; classification, purpose and scope of modern devices in individual technological processes of biotechnology; methods of calculation of technological processes and biotechnology apparatus.
56. Genetic engineering	DNA structure, DNA functions. An experiment in genetic engineering. DNA extraction methods. Methods of molecular DNA cloning. DNA sequencing. DNA insertion into living cells (transformation). Technique of obtaining and cultivation of bacterium strains and viruses, isolation of bacteriophage λ DNA and plasmid DNA; Characteristics of enzymes used in molecular cloning. Methods for the isolation, purification and analysis of

	mRNA. identification and analysis of recombinant DNA clones, expression vectors of cloned DNA in E. coli.
57. Bioinformatics	The principles of bionics - biomimetics, as a field of engineering, focusing on the structure of living systems; basic methods of genetic engineering; cell and tissue technology and the basics of transplantology; basics of bioinformatics approach to modern biomedical sciences.
58. Biophysics	Physical and physico-chemical processes occurring in organisms at the molecular level; physical patterns of living systems functioning; physical and physico-chemical parameters used to objectively diagnose the functional state of the body; methods and principles of modern medical equipment operation , with the help of which laboratory diagnostics of the biomaterial (fluids, tissues, cells) of the human body is carried out to detect or confirm the presence of pathology.
59. Medical genetics	Features of the device and functioning of the human genetic apparatus, methods of studying heredity and variability in normal and pathology, main types of variability, types of mutations in humans, causes and mechanisms of development of the main groups of hereditary diseases, as well as modern recommendations on the organization of programs for the prevention and treatment of hereditary diseases, approaches to the rehabilitation of patients. Questions of general genetics, features of clinical and morphological examination and analysis, research methods used in general practice and specific, indications for their conduct, classification and characterization of hereditary diseases, congenital malformations.
60. Elective courses in physical culture and sports	Practical development of exercises from the basic types of motor activity (athletics, sports (volleyball)) for the formation of the individuals' physical culture.
61. Pharmaceutical biotechnology	Modern methods of obtaining medical products in industrial biopharmaceutical production. Biotechnological aspects of the production of antibiotics. Microbiological methods for determining the sensitivity and concentration of antibiotics. Industrial production of drugs of various pharmacological groups (vitamins and coenzymes, amino acids, steroid hormones, etc.) using biotechnology. Obtaining recombinant structures in the laboratory. Technological techniques used to assess the quality of finished vaccines. Theoretical material on the main issues of biotechnological processes in the production of a number of pharmacological preparations used in human and veterinary medicine: enzymes, vaccines, antibiotics. The main medicinal preparations obtained with the help of microorganisms, the processes occurring during the creation of pharmaceutical preparations, and their practical use in professional activities.
62. Industrial Microbiology and Biotechnology	Basics of industrial microbiology and biotechnology, the laws underlying the technological processes of biotechnology; scientific and technical information on the development of new directions in industrial biotechnology; study of biotechnology objects and their biotechnological functions; biological systems used in molecular

	biotechnology.
7 семестр	
63. Life Safety	Studying types of harmful factors affecting worker during process of activity; the study of the principles, methods and means of ensuring security; study of regulatory requirements for working conditions; study of methods for assessing conditions by degree of hazard and danger;
64. Industrial ecology	Fundamentals of industrial ecology; main rules, regulations and standards in the field of industrial ecology; types of measures for the protection of air and water basins, land resources; basic methods for the treatment of waste gases and sewage, the main industrial processing methods and the use of waste, as well as methods for the disposal and disposal of hazardous industrial waste.
65. Labor protection and production sanitation	Labor safety legislation. Microclimate production room. Heat radiation. Heat exchange of a person with the environment. Harmful substances (HS) in the industry. Carcinogenic substances. Industrial dust. Hygienic regulation of microclimate parameters. Ventilation of industrial premises. Natural ventilation. Mechanical ventilation. Calculation of air flow in general ventilation. Local ventilation. Methods of air purification from harmful substances
66. Bioengineering	The principles of bionics - biomimetics, as a field of engineering, focusing on the structure of living systems; basic methods of genetic engineering; cell and tissue technology and the basics of transplantology; basics of bioinformatics approach to modern biomedical sciences.
67. Protein engineering	Theoretical and practical bases of directional changes in the structure of proteins, in order to give them new and improve existing properties, in the most diverse spheres of human activity from food to the pharmaceutical industry. The course covers methods and technologies of protein engineering, as well as equipment used for this purpose. Biotechnological processes involving purified enzymes or enzymes inside cells that are artificially unable to grow; designing and subsequent usage of biocatalysts with desired properties in biotechnology.
68. Medical Biotechnology	Modern and classical biological technologies used in the diagnosis, treatment and prevention of human diseases. Basic methods of working with genetic engineering structures and the formation of a comprehensive understanding of molecular biology techniques application in biomedical research. Specialized materials, devices, artificial organs, the cultivation of human cells in vitro as designers of tissues.
69. Marine biotechnology	Hydrobiology, aquaculture, marine bioecology, marine biomedicine (development of new pharmaceutical products), materials technology, bioremediation, molecular genetics, genomics and bioinformatics. Extraction, cultivation and processing of hydrobionts, raw biological materials, biotechnologies for the processing of aquatic organisms in the World Ocean and aquaculture and mariculture production.

70. Management and Economics in Biotechnology	Ways to build cost-effective and efficient models of biotechnological production, management methods and management of such enterprises.
71. Bioeconomics	Building an economy based on biotechnology, allowing usage of renewable biological raw materials: energy-efficient technologies, methods of recycling, building logistics chains in biotechnological production.
72. Quality and safety of biotechnological products	The main parameters and indicators of the quality of products of biotechnological production, the reasons for the deviation of these indicators from the standards related to the technological support of enterprises, the actions of workers, ways to assess product safety
73. Methods of control and certification of biotech products	Methods of products control manufactured at biotechnological production, the practical application of these methods, the legislative framework and product certification
8 семестр	
74. Biostatistics	Application of the laws of mathematics and statistics in biology, medicine, the development of new statistical methods in natural science research. The purpose and essence of the widely used mathematical-statistical methods for the description and analysis of biomedical research. Quantitative assessment and analysis of processes and events accompanied by changes in health status.
75. Plant biotechnology	Theoretical foundations and methodological principles of cultivation of isolated cells, tissues, plant organs on artificial nutrient media under aseptic conditions. Biotechnology of plant reproduction (including cultures of cells, tissues, organs and clones of plants). Methods for cultivating plants in vitro: apical meristem method; obtaining calluses, suspensions and plants - regenerants at both diploid and haploid levels. Mastering fundamentally new ways to form a new and valuable for human genetic diversity of plants through the selection of forms and clones with the desired features.
76. Biotechnology of hydrobionts	Characteristics of hydrobionts as a raw material for the production of drugs, dietary supplements with biological activity. The main indicators for assessing the biopotential of organs and tissues of hydrobionts for the purposes of biotechnology, the rationality of their processing for bioproduction. Protein products, biologically active compositions based on lipids of hydrobionts, preparations based on fish enzymes and non-fish objects, biopolymers of the polysaccharide nature of hydrobionts, vitamin complexes, highly mineralized compositions. General and partial technologies for obtaining bioproducts from fish and invertebrates, which highlight the biochemical characteristics of the raw materials used, the processes of formation of quality and safety.
77. Aquaculture biotechnology	Theoretical approaches to the development and evaluation of scientific and technical developments in aquaculture, modern methods of economic work at the fish farm. Characteristics of fish farming technologies based on the level of intensification and the impact of natural and artificial selection. Differentiation of production processes in the breeding and cultivation of aquatic organisms taking into account the

	<p>peculiarities of the technology of growing each species, technical and resource support, organizational and economic management methods.</p> <p>The use of gene constructs (cassettes) that ensure growth acceleration (growth hormone gene - GHG) or the body's resistance to adverse conditions (antifreeze protein gene - APG).</p>
<p>78. Agri-food biotechnology</p>	<p>Modern technological advances, with the opportunities and risks arising from the use of the latest biotechnology; the global food chain with the consequences of excessive industry concentration; review of intellectual property regulation in the light of established international and national regulatory systems; analysis of best practices of foreign countries in the field of biotechnology industry regulation (in the USA and BRICS countries), correlating it with the experience of agrobiotechnology regulation in Russia.</p> <p>Market analysis of major bioproducts used in crop production. Modern methods and technologies for the production of biopesticides, bio-fertilizers and plant growth stimulants based on microorganisms and biologically active substances (BAS). Modern biological products (areas of their application, manufacturers), produced in Russia and abroad, allowed for use in organic farming, as well as equipment for low-tonnage production of microbiological plant protection products. The effectiveness of the use of agrobiotechnologies in the regions of Russia.</p> <p>The main changes in the properties of the raw materials during processing (canning, drying, freezing, etc.) and the packaging technologies used, including scientific principles and practical recommendations. Processing the most common types of vegetables and edible mushrooms. New technologies for processing vegetables and fruits, including ozonation, irradiation treatment, processing in a pulsed high-intensity electric field and processing under high pressure, as well as frying in vacuum and using edible coatings. The problems of UV processing and application of membrane technologies, enzymatic maceration, freezing concentration and freezing, described the influence of applied technologies on the organoleptic properties and nutritional value of fruits and vegetables, as well as the use of fruit juices as carriers of probiotic microorganisms and prebiotic oligosaccharides.</p>