Kazakh Humanitarian Juridical Innovative University

Department of Information and Technology and Economics

Economy and Management Department

6B05121 - BIOTECHNOLOGY
THE CATALOGUE OF ELECTIVE SUBJECTS

Year of entrance - 2019

Semey, 2019 y.

Awarded degree: Bachelor of Natural Science in the educational program 6B05121 "Biotechnology"

№	Name of discipline or module	Number of credits	Pre requisites	Post requisites	Short description of the content, the aims of education, expected results
GENERAL EDUCATIONAL DISCIPLINES					
Elective courses (EC)					
Module of economic and legal knowledge					
1	**Basics of a Market Economy and Entrepreneurship**	3	School course basics of entrepreneurship and business	-	The purpose of teaching this discipline is the formation of systemic economic thinking to understand the logic of the economic laws of society, processes and phenomena that occur at all levels, with the possibility of applying knowledge in practice in any situation and in any economic system. Mastering the skills of the scientific and practical foundations of the organization of entrepreneurial activity, the methods of its planning and implementation in modern market conditions. **Content:** consideration of the institution of entrepreneurship; mastering the economic skills of organizing entrepreneurial activities and evaluating its effectiveness; definition and use of state mechanisms of regulation and support of entrepreneurship. The study of processes, phenomena of the economic life of society; the development of methods, methods, principles, approaches for the study of economic processes; **Learning Outcome:** Know: the functions of money, the reasons for the differences in the level of remuneration; main types of taxes; organizational and legal forms of entrepreneurship; types of securities; economic growth factors; current state of the theory and practice of entrepreneurial activity; specifics of entrepreneurial activity; To be able to: give examples of factors of production and factor income, public goods, Kazakhstani enterprises of various organizational forms, global economic problems; describe the effect of the market mechanism, the main forms of wages and labor incentives, inflation, the main articles of the state budget of Kazakhstan, economic growth, use the basic terminology of modern entrepreneurship; use methods of entrepreneurial activity; Skills: obtaining and evaluating economic information; drawing up a family budget; assessment of their own economic activities as a consumer, family member and citizen.
	Fundamentals of law and anti-corruption	2	School course basics of law	-	**The purpose of studying the discipline**: Studying the course and introducing students to the formation of a knowledge system on combating corruption and developing a civic position on this basis in relation to this phenomenon. **Content:** Fundamentals of the anti-corruption culture is a holistic interdisciplinary system of knowledge for all specialties and areas of bachelor training. **Expected result:** As a result of studying the discipline, students should know: the essence of corruption and the reasons for its origin, the measure of moral and legal responsibility for corruption offenses. To be able to: possess the skills to acquire new knowledge about the anti-corruption culture is a holistic interdisciplinary system of knowledge. Competencies: general education.
Module of economic and natural knowledge					
2	**Basics of a Market Economy and Entrepre-**	3	School course basics of entrepreneurship and busi-	-	The purpose of teaching this discipline is the formation of systemic economic thinking to understand the logic of the economic laws of society, processes and phenomena that occur at all levels, with the possibility of applying knowledge in practice in any situation and in any economic system. Mastering the skills of the scientific and practical foundations of the organization of en-

	neurship		ness		trepreneurial activity, the methods of its planning and implementation in modern market conditions. **Content:** consideration of the institution of entrepreneurship; mastering the economic skills of organizing entrepreneurial activities and evaluating its effectiveness; definition and use of state mechanisms of regulation and support of entrepreneurship. The study of processes, phenomena of the economic life of society; the development of methods, methods, principles, approaches for the study of economic processes; **Learning Outcome:** Know: the functions of money, the reasons for the differences in the level of remuneration; main types of taxes; organizational and legal forms of entrepreneurship; types of securities; economic growth factors; current state of the theory and practice of entrepreneurial activity; specifics of entrepreneurial activity; To be able to: give examples of factors of production and factor income, public goods, Kazakhstani enterprises of various organizational forms, global economic problems; describe the effect of the market mechanism, the main forms of wages and labor incentives, inflation, the main articles of the state budget of Kazakhstan, economic growth, use the basic terminology of modern entrepren eurship; use methods of entrepreneurial activity; Skills: obtaining and evaluating economic information; drawing up a family budget; assessment of their own economic activities as a consumer, family member and citizen.
	Basics of life safely and ecology	2	School course of primary military and technological training	-	**Aim.** To form ideas about the safety of life in human life and the possibility of regulating the processes of mutual influence of the environment and man. **Content.** The study of the basic concepts of life safety, ecology, problems of modern civilization and the environmental consequences of economic and other human activities in the intensification of environmental management, emergencies, civil defense. Disclosure of principles and methods of protection of the population from various environmental factors, legislative and legal acts in the field of bzh. Preservation of the environment and biological resources **Expected results:** students must know: legislative framework of safety and environmental control, as well as methods for identification, eliminating the influence of harmful factors on human beings and the environment, and ensure comfortable conditions for life and human activities; to be able: to systematize safety standards for use in professional activity; to choose methods of protection against hazards in relation to their professional activities and select methods for providing comfortable living conditions; to own skills of life safety in production conditions and in emergency situations, skills of first aid.
BASIC DISCIPLINES					
Elective courses (EC)					
1	**Cytology and Histology**	3	Biotechnology objects	Cell biotechnology	**Aim.** To form ideas about the structure, functions, chemical composition of cells and tissues of all living organisms as objects of biotechnology. **Contents**. This discipline examines the basics of cytology and histology, cell research methods, chemical structure of cells, especially the structure of prokaryotic cells and eukaryotes: cytoplasm, plasma membrane, cytoplasmic organoids, the structure of the cell nucleus, as well as protein biosynthesis, epithelial and connective tissues, muscle tissue, nervous system tissue, histogenesis and methods of preparation of fixed preparations of cells and tissues. **Expected results**: the student should know: the main features of the structure, metabolism, patterns of reproduction, specialization of cells, the main features of the structure, development, functioning and evolution of animal and plant tissues, tissue types; General patterns of the structure of cells of different types, tissues and non-cellular structures; the role of cellular organoids in the processes of cell functioning; various theories of the origin of eukaryotic cells; the main methods of studying Cytology and histology; to be able to: define micro specimens and electron microphotos of cells of different tissues and their characteristic structures for performing inherent functions; identify the

					various components of the cells in the study of histological specimens and electron microphotos; use the knowledge gained from the study of various types of cells and tissues for evidence of the unity of living matter; to explain the evolution of the cell from the position of evolutionary theory; to explain the properties of cells and tissues with the system approach to the study of biological objects; possess: the conceptual apparatus of the discipline; the basic methods of preparation of temporary preparations; methods of microscopic examination of histological objects; skills with specialized laboratory equipment and devices for solving practical problems.
1	**Cell and tissue biology**	3	Biotechnology objects	Cell selection of plants	**Aim.** Introduction to the fundamentals and modern concepts of the structure, molecular organization, Executive and regulatory mechanisms of the functions of Pro - and eukaryotic cells and tissues. **Contents.** This discipline examines the theoretical foundations and objects of cell and tissue biology, especially the structure of plant, animal, fungal and prokaryotic cells, plant culture, animal cells and their use, the biology of cultured cells, protoplast as an object of biological design, somatic hybridization, cell biology of microbiological systems., cellular, tissue and genetic engineering. **Expected results**: students should know: the similarities and differences in the structure and functioning of bacterial, plant, fungal and animal cells; the characteristics of all tissues in comparison with each other; be able to: analyze the composition of cell populations of a multicellular organism; own methods of cell biology, histology: ultrastructural microscopy, analytical Cytology, cytogenetic methods, molecular biology; use skills with specialized laboratory equipment and devices to solve practical problems.
2	**Phyto and zoological resources in biotechnology**	6	School biology course	Human and animal physiology	**Aim.** To equip the future biotechnologist with knowledge of species composition, classification, brief description and use of representatives of the kingdoms of plants, fungi and animals as raw materials or objects of research in biotechnological processes. **Contents.** During the course study, the following content of the discipline is revealed: representatives of the plant and animal world as phyto-and zo-resources in human life; species composition and ecological characteristics of plants and animals of the Earth, the Republic of Kazakhstan, East Kazakhstan and Semey cities used in biotechnology and the prospects for their use; Biotechnology industries that use biological objects. **Expected results:** students should know: species composition and environmental characteristics of plants and animals of the Earth, the Republic of Kazakhstan, East Kazakhstan region and the city of Semey, used in biotechnology and the prospects for their use; be able to: give a brief description of the objects of flora and fauna used in the biotechnological process; possess the skills to work with specialized laboratory equipment and devices for solving practical problems.
2	**Biotechnology raw materials**	6	School biology course	General physiology	**Aim.** To give an idea of the main features of the distribution of raw materials of Kazakhstan and biological resources as raw materials for industries. **Contents.** During the course study, the following content of the discipline is revealed: biotechnology raw materials resources; general principles for the selection of sources of raw materials for biotechnological production; main types of raw materials, auxiliary materials; primary, secondary raw materials; sources of carbon, nitrogen, phosphorus, as components of nutrient media; characteristic of complex nutrient dressers; classification of culture media for the cultivation of microorganisms used in biotechnology. **Expected results:** students should know the theoretical and methodological foundations of the use of raw materials; be able to apply this knowledge to solve environmental problems; possess the skills to work with specialized laboratory equipment and devices for solving practical problems.
3	**Microbiology and virology**	6	School biology course	Biotechnology of microorganisms	**Aim.** To Acquaint students with the features of the most important prokaryotes and eukaryotes for biotechnology. To show the General biological significance of achievements in the field of Microbiology and Virology, to highlight the role of microorganisms in the development of biotechnology, food industry. **Expected results.** During the course study, the following content of the discipline is revealed: morphology, structure, physiology, nutrition, reproduction, differentiation, growth, cultivation, cultural properties, genetics,

					selection of microorganisms; microbiological laboratory; microscope device; immersion system; paints; preparation of bacterial preparations; methods of staining, research; nutrient media; the role of microorganisms; properties, structure, chemical composition, architecture, reproduction, cultivation of viruses; bacteriophages; practical use of microorganisms. **Expected results:** students should know: the main properties of the classification, the role, the possibility of use in the production of microorganisms; biological characteristics of microorganisms that cause spoilage of food; the main properties, structure and classification, the role of viruses, bacteriophages; be able to: use the literature in the field of Microbiology and Virology; maintain production cultures of microorganisms; possess: methods for determining the properties of microorganisms, isolation of pure cultures of microorganisms, methods of microbiological studies used to assess environmental objects; skills with specialized laboratory equipment and devices for solving practical problems.
3	**General Microbiology**	6	School biology course	Industrial Microbiology	**Aim.** To form modern scientific ideas about the basic biological properties of microorganisms, their role in the circulation of substances in nature, in production, in the occurrence of diseases of humans, animals and plants. **Contents.** During the course study, the following content of the discipline is revealed: general microbiology; morphology and structural and functional organization of cells and systematics of microorganisms, their tinctorial properties; growth, development, types of food and respiration, microorganisms; methods of cultivation, indication and identification of microorganisms; bacteria genome; bacterial plasmids, their functions and properties; use in genetic engineering. **Expected results:** students should know: the principles of classification of microorganisms, especially the structure and functioning; methods of isolation of pure cultures of aerobic and anaerobic bacteria; basics of genetics of microorganisms; composition of microflora and its values; basic laws of microorganisms and their relationships with each other, morphology, principles of systematics and physiology of the main groups of microorganisms; be able to: isolated from natural substrates of physiological groups of microorganisms, to produce temporary drugs and microscopical them at different zooms to be able to work with immersion system of the microscope; to possess: identification of microorganisms to specific morphological or ecological group, their physiological state; the skills of working with microbiological material, specialized laboratory equipment and devices to solve practical problems.
4	**Cell biotechnology**	5	Cytology and Histology	Plant physiology	**Aim.** To equip the future biotechnologist with modern ideas about the most promising directions of development of cell biotechnology in the world, to show its relationship with the achievements in the field of molecular biology, cell and molecular Biophysics, biochemistry, molecular genetics, Microbiology, molecular immunology and bioinformatics. **Contents.** During the course study, the following content of the discipline is revealed: a brief history, stages of development of cell biotechnology; theoretical foundations of cell biotechnology; genomics, proteomics, bioinformatics; objects of cell biotechnology; cells and subcellular macromolecular structures, their use; somatic hybridization; cell biotechnology of microbiological systems; the use of cell biotechnology in eukaryotic systems; cell biotechnology in medicine; commercialization of cell biotechnology. **Expected results:** the student should know about: the subject, the problems of the history of development, objects, methods of cell biotechnology, trends in cell biotechnology in the modern world and its most promising areas, cell biotechnology microbiological systems, genetic engineering of plants and animals, the achievements of cell biotechnology in medicine, environmental aspects of biotechnology; be able to: critically analyze scientific experiments; possess the skills to work with specialized laboratory equipment and devices for solving practical problems.
4	**Cell selection of**	5	Cell and tissue biology	Anatomy and morphology	**Aim.**To form an idea of students in the field of plant cell selection, as well as to promote genetic thinking of students. **Contents.** During the course study, the following content of the discipline is

	plants			of plants	revealed: the goals and objectives of the plant cell selection, main directions, methods of cell selection; variety and source material in plant breeding; obtaining mutant forms when using selection at the cellular level; intraspecific and distant hybridization; selection methods in plant breeding. **Expected results:** students should know the purpose and objectives of plant cell selection, the main directions, methods of cell selection; variety and source material in plant breeding; obtaining mutant forms when using selection at the cellular level; intraspecific and remote hybridization; selection methods in plant breeding; be able to use theoretical and practical material in practice; possess the skills of organizing and conducting experiments using the knowledge and skills of working with various objects of biotechnology.
5	**General and Molecular Genetics**	5	School biology course	Fundamentals of Genetic Engineering	**Aim.** To give students an idea of genetics, its problems, the current state and the latest achievements, as well as to develop students ' genetic thinking. **Contents**. During the course study, the following content of the discipline is revealed: the subject, tasks of general and molecular genetics, history of development; the material basis of heredity, variability; structure, nucleic acids; reproduction types of organisms; mono-, di- and polybreeding; patterns of inheritance of characters; basics of genetic analysis; chromosomal theory of heredity; species, causes of variability of organisms; gene structure; current state of the problems of genetics. **Expected results:** student must know: object, tasks of General and molecular genetics, the history of its development; material basis of heredity and variation, structure and types of nucleic acids, the implementation of genetic information (protein biosynthesis), patterns of inheritance, the basis of genetic analysis, chromosome theory of heredity, structure of the gene, the main molecular-cellular mechanisms, current status of genetics; be able to solve genetic tasks into mono-, di - and polyhybrid crossing; competently conduct experiments on the study of heredity and variability; learn to use the studied techniques and methods of genetics for the needs of biotechnology; use the basic laws of heredity and variability, features of genetic material, the basics of genetic analysis, chromosomal theory of heredity, types and causes of variability of organisms in solving practical problems for biotechnological processes; have the skills: building a second DNA chain; building mRNA; determining the amino acid composition of proteins in accordance with the nucleotide composition of DNA or mRNA; using the hybridological method of studying the laws of inheritance of signs; drawing up pedigrees, presenting them in a graphical form and analyzing the type of inheritance of a pathological sign; forecasting the development of hereditary disease in the carrier of a pathological gene or predicting the birth of a child with hereditary pathology.
5	**Genetics with the basics of breeding**	5	School biology course	Basics of Molecular Biotechnology	**Aim.** To study the material basis of heredity, variability, patterns of inheritance of traits, the relationship of the influence of genotype and environmental factors on the development of the organism, the basis of modern methods of genetics, genetic engineering, selection. **Contents.** During the course study, the following content of the discipline is revealed: the material basis of heredity; cell cycle; mitosis; meiosis; patterns of inheritance of characters, principles of heredity; variability; the influence of physical environmental factors on the mutation process; genetic bases of ontogenesis; plant developmental genetics; population genetics; non-chromosomal inheritance; mutational variability; the influence of physical factors and chemical agents of the environment on the mutation process. **Expected results**: the student should know: the material basis of heredity, variability and mechanisms of their implementation; patterns of inheritance of signs; the influence of genotype and environmental factors on the development of the organism; be able to: apply the basic laws of heredity and patterns of inheritance of signs to the analysis of inheritance of normal and pathological signs, as well as for breeding; use the basic laws of heredity and variability, features of genetic material, the basis of genetic analysis, chromosomal theory of heredity, types and causes of variability of organisms in solving practical problems in the field of breeding; own: methods of genetic, cytogenetic and population analysis of the phenomena of heredity and variability; skills description of karyotypes of plants and animals.
6	**Plant**	4	Cell bio-	Plant	**Aim.** To equip the future biotechnologist with knowledge about the laws of

	physiol-ogy		technol-ogy	Biotech-nology	life processes occurring in plant organisms and the relationship of these processes with the surrounding environment. **Contents.** During the course study, the following content of the discipline is revealed: the physiology of the plant cell; objects of plant physiology; water exchange; the importance of water, the mechanism of movement of water throughout the plant; transpiration; photosynthesis; the value of photosynthesis; the light stage of photosynthesis of photosystem I, II; breath; the importance of respiration in plant life; respiratory chain; mineral nutrition; macronutrients and microelements; physiological basis of fertilizer application. **Expected results:** students should know: about the subject and objectives of plant physiology; scientific and theoretical foundations of the study of life processes in plants; totipotentnosti plant cells and its use in biotechnology; water metabolism of plants; the process of photosynthesis, leaf pigments, light and dark phase; mineral nutrition; plant respiration; growth and development of plants; physiological basis of protection and sustainable development; be able to: make experiments on the removal of physiological parameters of plants; compare and find differences between experimental and control plants; possess the skills of working with a microscope, specialized laboratory equipment and preparation of micropreparations; sketching objects from nature and under a microscope; observation of processes in a plant cell.
6	**Anatomy and mor-mor-phology of plants**	4	Cell se-lection of plants	Biotech-nology in plant protec-tion	**Aim.** Formation of students ' ideas about the structure of the body of plants, related functions and their evolutionary changes. **Contents.** During the course study, the following content of the discipline is revealed: similarities, differences between plants and their cells with other living organisms; plant cell structure; plant tissue; vegetative and generative organs of plants, their anatomy, morpho-functional features; types and types of plant breeding; flower and its structure; formulas, flower diagrams; the arrangement of flowers on the plant; seed, fruit. **Expected results:** students should know the basic Botanical terms underlying the anatomy and morphology of plants; know the structure of cells, tissues and organs of plants; the formation of the structure of plant organisms in ontogeny and phylogeny; be able to use equipment and devices to solve practical problems.
7	**Human and an-imal physiol-ogy**	4	Phyto and zoo-logical resources in bio-technol-ogy	Animal Biotech-nology	**Aim.** To equip the future biotechnologist with knowledge about the laws of life processes occurring in the human body and animals, as well as the processes of life of the animal organism and its constituent parts in their unity and relationship with the environment. **Contents.** During the course the following content of the discipline is revealed: research methods in physiology; General physiology; physiology of excitable tissues; muscle physiology; mechanisms of regulation of body functions; private physiology of the Central nervous system; structure, functions of the spinal cord; the brain; sensory systems; nervous regulation of vegetative functions; the internal environment of the body; internal organs; heat production, heat transfer; lactation. **Expected results:** students should know about the subject and objectives of human and animal physiology, history, theoretical and methodological foundations of physiology; physiology of excitable tissues, analyzers, private CNS physiology, qualitative differences in physiological functions in animals at different levels of evolutionary development; mechanisms that ensure the interaction of individual parts of the organism and the organism as a whole with the environment; be able to carry out anthropometric measurements; determine the basic physiometric indicators; to use skills of working with specialized laboratory equipment and devices for solving practical problems and research activities in the field of biotechnology; to organize and conduct experiments using knowledge and skills of working with animals and humans.
7	**General physiolo gy**	4	Biotech-nology raw ma-terials	Biotech-nology in animal protec-tion	**Aim.** Formation of the ability to analyze and use the principles and laws of the human body, which provide adaptation, homeostasis of the body and the preservation of its health**.** **Contents.** During the course study, the following content of the discipline is revealed: general physiology; physiology of excitable tissues; mechanisms regulating body functions; the internal environment of the body; system of internal organs and their regulation; blood system; physiology of the heart,

					blood vessels; regulation of respiration; physiology of the immune system; digestive physiology; bienergy; osmoregulation, discharge; reproductive system; biotechnological methods of regulation of lactogenesis, lactopoiesis. **Expected results:** students should know: basic anatomical and physiological concepts and terms; the morphofunctional organization of a person; basic mechanisms of regulation of functions of biological systems of organism; the basic mechanisms of adaptation and protection of a healthy body when exposed to environmental factors; be able to: the specific reactions and their analytical effects; violations of basic functional parameters of human life; the most important indicators of human activity at rest and during exercise; possess: skills of working with specialized laboratory equipment and devices for solving practical problems, including the skills of measuring the basic functional characteristics of human activity (pulse, blood pressure).
8	**Fundamentals of Genetic Engineering**	3	General and Molecular Genetics	Biochemistry	**Aim.** To give the future specialist theoretical knowledge and practical skills in the analysis of General and molecular genetic processes and phenomena in microorganisms, plants and animals and to reveal their importance in the modern biotechnological process. **Contents.** During the course study, the following content of the discipline is revealed: the structure, properties of the DNA molecule; enzymes in genetic engineering; vector systems; gene extraction methods; rDNA molecule design; transformation of rDNA molecules into cells; genetic engineering in the structure of chromosomes, genome; cell engineering; plant genetic engineering; transgenic animals; cloning; the use of genetic engineering methods in obtaining biologically active substances. **Expected results:** students should know the methods of gene isolation and genetic engineering, objects of genetic engineering in various fields: biotechnology, medicine, agriculture, etc.; be able to apply this knowledge to develop strategies to solve specific technological problems; to use the basic laws of heredity and variability, features of genetic material, fundamentals of genetic analysis, chromosomal theory of heredity, types and causes of variability of organisms in solving practical problems in the field of genetic engineering, for biotechnological processes.
8	**Basics of Molecular Biotechnology**	3	Genetics with the basics of breeding	Biochemistry	**Aim.** Formation of ideas about the current state of the methodology of molecular biotechnology. **Contents.** During the course study, the following content of the discipline is revealed: general principles, methods of bioengineering; achieving increased production of proteins encoded by genes cloned in Escherichia coli cells; expression of cloned eukaryotic genes in Escherichia coli cells; protein engineering; genetic engineering system of gram-positive bacteria of the genus Bacillus; genetic engineering of cultured mammalian cells; vector systems based on animal viruses. **Expected results:** students should know the basic methodological principles and approaches of molecular biotechnology; be able to: use the knowledge to improve theoretical training, as well as learn how to apply them in practice; use the basic laws of heredity and variability, features of genetic material, the basics of genetic analysis, in solving practical problems for biotechnological processes; be competent: - in the ability to professionally use the skills of experimental research in standard and changing situations in future professional activities.
9	**Biotechnology of microorganisms**	5	Microbiology and virology	Fermentation biotechnology	**Aim.** To form ideas about the principles and features of microbiological processes used in biotechnology, as well as about products - requirements for microorganisms and raw materials, methods of cultivation of microorganisms, methods of isolation and purification of necessary products, specific industrial products based on microbiological synthesis and transformation. **Contents.** During the course study, the following content of the discipline is revealed: the basis of microbiological biotechnology; modern methods of creating industrial strains of microorganisms; biotechnological production based on microbial biomass production; production of microbial protein, organic acids, neutral products; alcohol, acetobutyl fermentation; receiving vaccines; biotechnology of metals, environment, medicinal, prophylactic agents, antibiotics; microbiological production of food and beverages. **Expected results:** students need to know: the basics of growing microorganisms, products of microbiological synthesis and biomass collection

					technology; requirements for final products and raw materials; be able to determine the species composition of microorganisms of the desired object of the food industry; develop the composition of microorganisms and additives and its introduction into production; to possess skills of application in practical activity specialized knowledge of fundamental sections of Microbiology and skills of performance of researches, for development of the microbiological processes occurring at production of foodstuff.
9	**Industrial Microbiology**	5	General Microbiology	Technical Microbiology	**Aim.** Formation of system knowledge and skills for the development of products of microbiological synthesis, familiarization with the main achievements and promising areas of industrial Microbiology. **Contents.** During the course study, the following content of the discipline is revealed: history, promising directions of industrial microbiology; cultivation of microorganisms; the use of fermentation and other metabolic processes; obtaining biologically active substances and individual components of microbial cells; production based on microbial biomass production; technological bioenergy; biotechnological use of cell energy processes; phototrophic microorganisms, the prospects for their use in biotechnology. **Expected results:** the student should know: the theoretical basis for obtaining products of microbial synthesis; laws of kinetics of growth of microorganisms and the formation of metabolic products; methods of cultivation of microorganisms; be able to: work with pure cultures of microorganisms; lead the process of cultivation of microorganisms in flasks; apply in practice specialized knowledge of the fundamental sections of Microbiology and skills of research for the development of microbiological processes occurring in the production of various products; evaluate the quantitative characteristics of the growth of microorganisms; own: methods of work with microorganisms; rules of safe work in the microbiological laboratory.
10	**Plant Biotechnology**	5	Plant physiology	Final State Attestation	**Aim.** Formation of ideas about the current state of knowledge about the biology of cultivated plant cells as an object of plant biotechnology and all major areas of biotechnology. **Contents.** During the course study, the following content of the discipline is revealed: cultivated plant cells as an object of biotechnology; production and cultivation of callus; cell technologies in the biosynthetic industry; clonal micropropagation and plant health; overcoming in vitro progamous and postgamous incompatibility; haploid technology; cell selection; cell engineering; plant genetic engineering; preservation of in vitro gene pool. **Expected results:** the student should know about: methods of cultivation of cells, tissues and organs of plants in vitro; processes of dedifferentiation, leading to the formation of callus; ways of morphogenesis in vitro and factors that regulate plant regeneration; theoretical and methodological principles of the use of cultured cells to obtain important metabolites for clonal micropropagation and plant health, to overcome incompatibility with distant hybridization; be able to: work with plant cultures; control plant growth; have skills: work in sterile conditions with isolated cells, tissues, callus mass; isolation of Explant from plant object; calculation of nutrient solution concentrations; preparation of nutrient solutions; cultivation of plant tissue cultures; skills of working with specialized laboratory equipment and devices for solving practical problems.
10	**Biotechnology in plant protection**	5	Anatomy and morphology of plants	Final State Attestation	**Aim.** Familiarization with the General issues and theoretical foundations of agricultural biotechnology, to form the necessary theoretical knowledge and practical skills for the use of biotechnology in plant protection. **Contents.** During the course study, the following content of the discipline is revealed: genetic engineering in plant protection; technology of obtaining plants resistant to pests; biotechnology biopreparations for plant protection; biopesticides; entomopathogenic bacterial biopreparations; biotechnology for obtaining antibiotics and their use in plant protection; biotechnological methods for the diagnosis of phytopathogens; cell cultures, tissues and organs in plant protection. **Expected results:** student must know: basic laws of natural Sciences in professional activities, current status of biotechnology in the field of plant protection and production technologies and biopreparations for plant protection and their application; to be able: to justify the use of biotechnological preparations for plant protection, use of biotechnological

					techniques in an integrated system of plant protection; to have the skills and /or experience to carry out microbiological examination of samples of plants and biological products for plant protection; skills of working with specialized laboratory equipment and devices for solving practical problems.
11	**Basics of food biotechnology**	5	Fundamentals of Biotechnology	Biotechnology of plant and animal products	**Aim.** Students acquire theoretical knowledge and develop skills in the field of modern food biotechnology**.** **Contents.** During the course study, the following content of the discipline is revealed: food biotechnology based on fermentation processes and other metabolic reactions; yeast production; alcohol production; brewing; winemaking; bakery production; milk processing production; microbial food based biotechnology; food safety and sanitary control; nutritional supplements; problems of biosafety of products of modern biotechnological production. **Expected results:** students should know: the latest achievements in the field of biotechnology in the food industry; traditional biotechnological processes used in the food industry; microbiological processes in the preparation of food; the effect of enzymes, food additives, biologically active substances on the quality and properties of biological raw materials and food products based on it; General technology of food production; methods of research indicators of food quality; be able to: use the knowledge to analyze experimental data relating to the selection, characteristics and improvement of objects of biotechnology, as well as their use in a variety of technological processes of food production; use the knowledge of technologies and factors that affect the speed of biochemical processes in food production; own: technique of determining the quality of bacterial, yeast and enzyme preparations, food additives, biologically active substances, finished foods; technique of selection of raw materials, assortment and technology of food production, which are produced by the food industry.
11	**Isolation and purification of biotechnology products**	5	Fundamentals of Biotechnology	Biopreparations technology	**Aim.** Mastering students ' knowledge and skills of isolation and purification of biologically active substances obtained by biotechnology. **Contents.** During the course study, the following content of the discipline is revealed: technical and technological characteristics of biotechnology products; isolation of proteins, enzymes; biotechnology of amino acid synthesis, their purification; isolation, purification of hormonal drugs; obtaining nucleotides, nucleic acids; sources of lipids, the main methods of their selection; production of fermentation products; obtaining sugars, polysaccharides; getting vitamins; principles of obtaining antibiotics, alkaloids, vaccines. **Expected results:** students should know the main groups of biotechnology products and their most important characteristics, basic concepts and principles of methods of isolation purification of biotechnology products, methods of chemical, biochemical identification and determination of biotechnology products; be able to: use the basic laws of biochemistry, molecular biology in the development of technologies for isolation and purification of biologically active substances; use quantitative and qualitative methods for the analysis of biotechnology products; manage the technological process of isolation and purification of finished products.
12	**Animal Biotechnology**	5	Human and animal physiology	Modern methods in biotechnology	**Aim.** To form an idea about the possibilities of genetic and cellular engineering of animals, about the ways and methods of using animal cells in biotechnology**.** **Content**. During the course of study, the following content of the discipline is revealed: the general biological basis of animal biotechnology; animal biotechnology methods; reproduction biotechnology; artificial insemination and embryo transfer; mammalian chimera; animal cloning; genetic transformation; cryopreservation of gametes and embryos; applied aspects of cellular and embryogenetic engineering; obtaining transgenic animals. **Expected results:** students should: know: General biological bases of animal biotechnology, experimental approaches to cell and embryological engineering, principles of cloning of genetic transformation of somatic and germ cells of animals; on the application of biotechnological methods in science and practice of animal husbandry and medicine; be able to: use theoretical knowledge for implementation in science and practice; acquire: practical skills of handling microscopic equipment and specialized laboratory equipment and

					devices for solving practical problems.
12	**Biotech-nology in animal protec-tion**	5	General physiolo gy	Modern methods in biotechn ology	**Aim.** Familiarization with the General issues and theoretical foundations of agricultural biotechnology, to form the necessary theoretical knowledge and practical skills for the use of biotechnology in animal protection.. **Contents.** During the course study, the following content of the discipline is revealed: the classification of crops and the peculiarities of their use in animal husbandry systems in various soil and climatic conditions; agroclimatic and agricultural zoning; organization of animal protection work at an agricultural enterprise; the possibility of using biological objects for the protection of animals, methods of biotechnology in the protection of animals. **Expected results:** the student should know: information about the organization of works on animal protection in the agricultural enterprise; the possibility of using biological objects for animal protection, biotechnology methods in animal protection; be able to apply biological objects for animal protection; have the skills of organizing and conducting experiments, using the knowledge and skills of working with various objects of biotechnology.
13	**Basics of physical and chemical analysis**	5	Bio-chemis-try	Toxico-logical analysis of food products	**Aim.** Getting students knowledge about the methods of chemical and physico-chemical analysis, their theoretical foundations, as well as the acquisition of skills and abilities to make theoretical conclusions based on the observed phenomena. **Contents.** During the course study, the following content of the discipline is revealed: the laws of thermodynamics; the first, second and third laws of thermodynamics; thermodynamic potentials; chemical equilibrium; phase equilibrium; solutions; disperse systems; thermodynamics of surface phenomena; adsorption; electrical properties of dispersed systems, stability and coagulation; electrochemistry; electrolysis; chemical kinetics and catalysis. **Expected results:** student must know: theoretical bases of physical-chemical analysis; be able to: use concepts and methods physico-chemical analysis and physical, chemical and mathematical laws to solve practical problems, to make the scheme of the analysis, conduct the selection method to achieve a specific goal; to possess: basic techniques of the chemistry of definitions and analysis of objects; theoretical basics of physical-chemical chemistry.
13	**Physical and Col-loid Chemis-try**	5	Bio-chemis-try	Food chemis-try	**Aim.** Familiarization with the General issues and theoretical foundations of physical and coloid chemistry, the formation of the necessary theoretical knowledge and practical skills for the use of physical and coloid chemistry in biotechnology. **Concepts**. During the course study, the following content of the discipline is revealed: balance; solutions; chemical equilibrium thermodynamics; the law of the masses; electrochemistry; chemical kinetics, catalysis; dispersed systems, thermodynamics of surface phenomena; adsorption; adsorption theory; electrical properties of dispersed systems, stability, coagulation; HMWC solutions, their properties, gels and jellies; electrical properties of HMWC solutions; molecular kinetic properties of solutions of high molecular compounds. **Expected results:** students should know: the purpose and objectives of physical and colloidal chemistry, ways to solve them, the basic laws of physics and chemistry, physical and chemical phenomena and patterns used in physical and colloidal chemistry; safety rules in the chemical laboratory and physical equipment; solutions and processes occurring in aqueous solutions; be able to: use the basic techniques and methods of physical and chemical measurements; work with the main types of devices used in physical and colloidal chemistry; make calculations on the studied issues; carry out elementary statistical processing of experimental data in physical and chemical experiments; own: methods of statistical processing of experimental results of physical and chemical studies; technique of basic physical and chemical experiments.
14	**Fermen-tation biotech-nology**	4	Biotech-nology of microor-ganisms	Engineer ing Enzymol ogy	**Aim.** The study of the theoretical foundations of biotechnology fermentation and practical application of the knowledge in practice. **Concepts**. During the course study, the following content of the discipline is revealed: the main raw material of the fermentation industry and its; sugar-containing and starch-containing raw materials; malt production; production of bakery yeast and enzyme preparations; mold fungi and methods of their

					cultivation; yeast production operations; production of enzyme preparations for the brewing industry. **Expected results:** the student should know: the basics of biotechnology and technology and technology of fermentation, technical requirements for raw materials, materials and finished products; possess: the skills of using research methods and instruments for research, as well as skills of laboratory research; be able to: apply in practice specialized knowledge of the fundamental sections of Microbiology and skills of research for the development of microbiological processes of fermentation production.
14	**Technical Microbiology**	4	Industrial Microbiology	Chemical Technology Basics	**Aim.** Mastering the technical foundations of Microbiology, which Orient the future specialist to the need for careful compliance with sanitary standards in the production, prevention of losses and manufacture of high-quality products. **Concepts**. During the course of study, the following content of the discipline is revealed: the subject and tasks of technical microbiology; systematics, morphology, physiology of microorganisms; the conversion of carbon compounds by microorganisms; types of fermentation; cellulose degradation; the conversion of nitrogen compounds by microorganisms; production of vitamins, hormones, amino acids, feed, protein, lipids; microbiological processes during ensiling and haying; the use of microorganisms in the organization of biological farming. **Expected results: s**tudents should: know: the basic laws of life of microorganisms; the role of individual groups of microorganisms in the processes occurring in the biosphere and the possibility of their use in practice; be able to: apply in practice specialized knowledge of the fundamental sections of Microbiology and skills of research for the development of microbiological processes occurring in the production of food, biologically active substances and secondary metabolites, as well as to assess the results obtained; to master the skills: to determine the belonging of microorganisms to a certain morphological or ecological group, their physiological state.
15	**Engineering Enzymology**	5	Fermentation biotechnology	Biotechnology of biological active substances	**Aim.** To form ideas about the development of engineering industries using biological objects to solve economic problems. **Concepts**. During the course study, the following content of the discipline is revealed: engineering enzymology as a science, industrial processes using immobilized enzymes, enzymatic conversion of cellulose into sugar, the use of enzymes in electrochemical systems; basic engineering enzymology methods, biotechnology of primary and secondary metabolites, immobilized enzymes in the food industry, immobilized enzymes in medicine, microanalysis. **Expected results:** the student should know the directions, achievements and prospects of development of engineering Enzymology; scientific basis of Biocatalysis for the synthesis and modification of organic compounds, the use of imobilized enzymes and proteins in medicine to create new drugs; be able to control the technological process of obtaining biotechnological products based on various raw materials and processes of isolation and purification of finished products.
15	**Chemical Technology Basics**	5	Technical Microbiology	Basics of isolation and purification of bioproducts	**Aim.** Familiarization with the General laws of chemical technology, the most typical chemical-technological processes, reactors and chemical-technological systems (CTS), as well as with the basics of chemical technology of a number of industries. **Concepts**. During the course study, the following content of the discipline is revealed: technology, classification of chemical technology; priority directions of development of modern chemical technology; theoretical foundations of chemical technology; chemical production, chemical process; general laws of chemical processes; main types of chemical processes; chemical reactors, their classification; chemical process systems (CPS); raw material and energy subsystem of CPC; most important industrial chemical production. **Expected results**: students should know: the principles and methods of assessing the efficiency of production; General laws of chemical processes; be able to: calculate the main characteristics of the chemical process; manage the technological process of obtaining biotechnological products based on various raw materials and processes of isolation and purification of finished products; possess: skills of performing basic laboratory analyses to determine the quality of the technological product.

16	**Fundamentals of environmental biotechnology**	6	Modern methods in biotechnology	Final State Attestation	**Aim.** To acquaint students with the main environmental problems of the environment, the basic principles of biotechnology, types of bioreactors used to clean the environment, as well as other objects and methods of cleaning and improvement of the environment. **Concepts**. During the course study, the following content of the discipline is revealed: the subject and tasks of environmental biotechnology; interconnection of microorganisms in ecosystems; wastewater characteristics; operations in wastewater treatment plants; aerobic and anaerobic wastewater treatment; industrial apparatus for wastewater treatment; metal biosorption; biological processing and cleaning of industrial wastes of various industries; soil bioremidation; forecast ecology. **Expected results**: the student should know: the main characteristics of wastewater; the importance of microorganisms in preserving the natural balance, new technologies of bioremediation based on the use of biocatalysts of a new generation-immobilized enzymes and whole microbial cells; be able to: apply this knowledge to develop strategies to solve specific environmental problems; argue the importance of living organisms in bioremediation, bioremediation technology and the use of bioreactors to clean the environment; to possess skills of statement of experimental experiments in laboratory conditions.
16	**Biotechnology for cleaning soils and ponds**	6	Modern methods in biotechnology	Final State Attestation	**Aim.** Formation of a complex of knowledge in the field of modern biotechnological methods of soil and water purification from pollutants. **Concepts**. During the course study, the following content of the discipline is revealed: the composition of the soil, water, sludge; soil formation process; soil, aquatic biota; the use of biotechnology to clean contaminated soils and water bodies; soil bioremidation; species composition of plants, microorganisms used in the purification of soil and water from pollution; microbiological preparations used in cleaning soil and water; biodegradation of oil pollution. **Expected results**: student must know: the types of microorganisms that can break down the substances – pollutants; biological treatment of soils and surface water; mechnaism accumulation of pollutants in biological objects; be able to comply with the legal requirements in achieving the desired results of the bioremediation of soils and waters; to argue the importance of living organisms in bioremediation technologies bioremediation; to possess: approaches to the choice of the methods of biological objects and equipment for the bioremediation of soil and water bodies from pollutants; information about the ways of intensification of processes of bioremediation; skills of drawing up of the technological scheme of processes of bioremediation of soils and reservoirs from polluting substances on the basis of results of scientific developments.
MAIN DISCIPLINES					
Elective courses (EC)					
1	**Biotechnology of plant and animal products**	6	Basics of food biotechnology	Food microbiology and sanitary hygiene	**Aim.** To study the modern achievements of food biotechnology in the production of plant and animal products. **Contents.** During the course study, the following content of the discipline is revealed: classification of food by raw materials; secondary resources, prospects for their use; types of plant and animal raw materials, especially the use of food; the processes occurring in the raw material during its processing into intermediate and final products and storage; factors affecting the biotechnological processes of food. **Expected results:** students should be aware of new achievements and methods in biotechnology of the food industry for the production of plant and animal products; be able to make schemes of production of the desired product; manage the technological process of obtaining biotechnological products based on various raw materials and processes of isolation and purification of finished products.
1	**Bioprepparations technology**	6	Isolation and purification of biotechnol-	Biotechnological safety of raw materials	**Aim.** Formation of system knowledge on technological bases of biotechnology and quality control of biological products in various dosage forms on the basis of microbiological processing of plant raw materials and other raw materials. **Contents**. During the course study, the following of the discipline is revealed:

			ogy products	and biotechnological production	basic principles of industrial technology of biological products; principles of fermentation of pure cultures of microorganisms; raw material base, environmental problems of technology of biological products; technology of biosynthesis of water-soluble, fat-soluble vitamin compounds with coenzyme catalytic functions; technology of biosynthesis of L – amino acids; technology of industrial biosynthesis of biological products of antibiotics; technology of production of protein biologics; technology of microbial lipids. **Expected results:** the student must: know: the algorithm of production of biopreparations based on modern technology in compliance with international requirements and standards; principles of modern biological products based on vegetable raw materials and microbiological material; about the basic normative documents concerning the manufacture, quality control, storage and use of biological products; to be able: to use rules and norms of sanitary-hygienic regime rules provide aseptic conditions for production of biopreparations in accordance with NTD; to control the technological process of obtaining biotechnological products based on various raw materials and processes of isolation and purification of finished products; to have an idea: about optimization of technology of biological products based on rational microbiological processing of plant raw materials; about trends in the development of microbiological technologies using new strains of microorganisms.
2	**Food Processing Equipment Technology**	5	Industrial Biotechnology	Basics of biotechnology production design	**Aim.** Obtaining knowledge in the field of design and operation of biotechnological machines and devices that future specialists will be able to apply in their professional activities. **Contents.** During the course study, the following content of the discipline is revealed: machine-hardware schemes; transport, auxiliary equipment in biotechnology; equipment for sterilization, extraction, pressing, filtration, flotation, cultivation of microorganisms in solid nutrient media; fermenters; equipment for separation of liquid heterogeneous systems, for purification and concentration, for drying products of microbiological production, for grinding, standardization, granulation and microcapsulation. **Expected results: s**tudents should know the basic laws of the course; understand the essence of the basic methods used in the operation of biotechnological machines; have an idea about the current problems of operation of biotechnological machines; be able to operate modern professional biotechnological equipment and devices, as well as organize, plan and manage existing biotechnological processes and production.
2	**Processes and devices in biotechnology**	5	Industrial Biotechnology	Industrial ecology	**Aim.** Mastering by students of theoretical and practical knowledge and skills in the field of device design and operation of biotechnological equipment. **Contents.** During the course study, the following content of the discipline is revealed: hardware equipment of microbiological productions; theory of biotechnology processes; thermal processes and apparatus; thermal processes in enzymes; devices, processes of isolation of microbial synthesis products; mass transfer processes with a fixed phase contact surface; membrane processes in biotechnology; hardware equipment of phytobiotechnological, zoobiotechnological productions; bioreactors for growing plants. **Expected results:** the student must know the basic concepts, stages of biotechnological processes, basic methods of chemical identification of substances; be able to choose the equipment, type of producers and conditions of a particular biotechnological process; operate modern professional biotechnological equipment and devices, as well as organize, plan and manage existing biotechnological processes and production.
3	**Food microbiology and sanitary hygiene**	5	Biotechnology of plant and animal products	Standardization and certification of biotechnology products	**Aim.** Obtaining knowledge and skills with the subject area of the food industry specialist. **Contents.** During the course study, the following content of the discipline is revealed: microflora of food, their sanitary and hygienic control; groups of microbiological criteria for food safety; microflora of milk, dairy products, fish, fish products, meat products, eggs, egg products; determination of microflora products; sanitary and microbiological control of food production, the environment; sanitary hygiene; food infections, food poisoning. **Expected results:** znet t principles for the development of i technological schemes, technological o and technical documentation; criteria n for the selection and calculation of the main and auxiliary equipment; The f methods of heat and material bal-

					ances o of biotechnological and chemical industriesr the Expected results of the study: the student must know the basic concepts and terms of food Microbiology, the main types of microorganisms dangerous to humans, possible sources of microbiological contamination in food production, the conditions of their development, sanitary and technological requirements for premises, equipment, inventory, clothing; be able to carry out microbiological control of food, to determine the main groups of microorganisms; possess the skills to work with basic laboratory equipment.sis work.
3	**Biotechnological safety of raw materials and biotechnological production**	5	Biopreparations technology	Quality management in the organization of biotechnological production	**Aim.** To form theoretical knowledge on biological and biotechnological safety of raw materials and biotechnology of production of products and acquisition of practical skills on control of indicators of safety of food. **Contents.** During the course study, the following content of the discipline is revealed: problems of pollution of raw materials and biotechnological production; regulatory and legislative basis of food safety in Kazakhstan; factors and control of biological contamination of raw materials and biotechnological production of microorganisms, their metabolites, toxic elements, helminths, compounds used in crop and livestock production, radioactive elements; control of food additives, GMOs. **Expected results:** students should know the state laws, regulations, ensuring the biological safety of raw materials and biotechnology production; modern research methods of biological safety of raw materials and biotechnology production; research methodology; be able to: monitor and evaluate compliance with environmental, chemical (Toxicological analysis) and biological safety of food raw materials, food ingredients and finished products in laboratories; possess the skills: quality management of food products; determination of the main types of contamination of food raw materials and biotechnological production; control of biological safety of raw materials and biotechnological production.
4	**Toxicological analysis of food products**	6	Basics of physical and chemical analysis	Final State Attestation	**Aim.** To form ideas about toxic pollutants of food products and methods of their determination. **Contents.** During the course study, the following content of the discipline is revealed: the quality of food products, ensuring its control; classification of toxic, potent substances in Toxicological chemistry; contamination of food raw materials, food xenobiotics of chemical, biological origin; food Toxicological and genetic evaluation; the concept of "poison", poisoning; isolation, detection and determination of substances after their treatment from biological material. **Expected results:** students should know the theoretical foundations of food toxicology; be able to determine the content of harmful substances in food products; monitor and assess compliance with environmental, chemical (Toxicological analysis) safety of food raw materials, food ingredients and finished products; possess the skills to determine toxic substances in food products.
4	**Food chemistry**	6	Physical and Colloid Chemistry	Final State Attestation	**Aim.** The study of the conceptual apparatus of the discipline, the basic theoretical principles and methods, instilling skills of applying theoretical knowledge to solve practical problems. **Contents.** During the course study, the following content of the discipline is revealed: food chemistry and human nutrition; food raw materials as a biological object; protein substances; carbohydrates; dietary fibers; lipids; minerals, vitamins; enzymes; water in food; food, dietary supplements; food safety; basics of nutrition; nutraceuticals, probiotics, prebiotics. **Expected results:** student must know: - the chemical composition of raw materials, intermediates and finished food products; methods of evaluation of nutritive values of food; General regularities of chemical, biochemical and microbiological processes during storage of raw materials; the transformation and interaction of the main chemical components of raw materials in the technological process in the production of food and the impact of regimes on the composition, properties, basic nutrients, food and biological value of raw materials and finished products; be able to: - determine the chemical qualitative and quantitative composition of the object under study, reasoned to choose a test method for specific tasks; possess: skills of the experiment with the relevant calculations and conclusions; basic chemical and physico-chemical methods of analysis to determine the properties and technological parameters of the materials used and finished products.

5	**Basics of biotechnology production design**	5	Food Processing Equipment Technology	Final State Attestation	**Aim.** The formation of foundations for technological thinking skills engineering analysis and design of biotechnological production, education needs and ability to constantly improve its knowledge, development of students ' creative thinking and finding the optimal approach to the solution of practical issues, the General issues of designing of the food enterprises, the choice and substantiation of technological schemes, the implementation of the layout of the shops and industrial buildings. **Contents.** During the course study, the following content of the discipline is revealed: product calculations; design of the technological part; selection and calculation of technological equipment; schedules of equipment; architectural and construction part; calculation of areas of production workshops, laboratories and ancillary facilities; design of production facilities and layout of the plant; the basic regulations used in the design of enterprises of biotechnological production. **Expected results:** student must know: main principles of designing of food plants; norms of technological design of enterprises of food industry; basic principles of biotechnological production methods of evaluating the efficiency of production; the concept of biotechnological production; the selection criteria and the equipment stages of cultivation, extraction and purification products of biosynthesis; the most important constructive elements of machines and apparatus; methods and apparatus for transporting solid, liquid and gaseous media; control and measuring equipment and automatic control systems of biotechnological processes; standards of safety and labor protection; be able to: draw up a scheme of biotechnological production, possessing knowledge of the most important structural elements of machines and devices and norms of technological design of food industry enterprises.
5	**Industrial ecology**	5	Processes and devices in biotechnology	Final State Attestation	**Aim.** Formation of knowledge in the field of industrial ecology, allowing in the process of production activities to identify sources of environmental pollution at production facilities, to determine the concentration of pollutants, to assess existing and propose new means of reducing pollution, to assess the environmental effect of environmental measures. **Contents.** During the course study, the following content of the discipline is revealed: environmental justification of design decisions in the placement of economic objects engaged in biotechnology activities; environmental control and supervision; types of environmental pollution; pollution of the atmosphere, natural waters, soil; methods of purification of gas emissions and wastewater enterprises of biotechnological industries; protection of subsoil, land, plant and animal resource. **Expected results:** the student must: know: the specifics and mechanism of toxic effects of harmful substances, energy effects and combined effects of factors; legal, regulatory, technical and organizational bases of environmental safety; means and methods to improve the safety and environmental friendliness of technical means and processes; be able to: identify the main hazards of the human environment, processes and equipment to assess the effectiveness of various methods and devices to protect the environment from pollutants and develop recommendations to reduce pollution of the environment; use the basic means of quality control of the environment; operate modern professional biotechnological equipment; to possess skills of application of methods of instrumental control of parameters and levels of negative impacts of environmental pollution on personnel, the population and the natural environment.
6	**Biotechnology of biological active substances**	5	Engineering Enzymology	Final State Attestation	**Aim.** To provide students with knowledge of biotechnological methods of production of biologically active substances (BAS) using biological objects. **Contents.** During the course study, the following content of the discipline is revealed: preparatory stage, cultivation of microorganisms; obtaining of biologically active substances, their use in biology and medicine; cultivation of microalgae; biotechnology of biologically active substances enriched in trace elements on the basis of microbial biomass; technology autolysis of yeast; improving the efficiency of some biotechnological stages of beer production; integrated processing of the biomass of industrial microorganisms. **Expected results:** students should know: the basic laws of biotechnology BAS; be able to: use theoretical knowledge in the field of biotechnology BAS, as well as the main sections of Microbiology for the development of microbiological processes occurring in the production of biologically active substances

					and secondary metabolites; possess: the theoretical foundations of biotechnology of biological active substances.
6	**Basics of the isolation and purification of bioproducts**	5	Chemical Technology Basics	Final State Attestation	**Aim.** Mastering students ' knowledge and skills of isolation and purification of biological products. **Contents.** During the course study, the following content of the discipline is revealed: technical and technological characteristics of biotechnology products; isolation, purification of proteins, enzymes, hormonal drugs; biotechnology synthesis of amino acids, their purification; obtaining nucleotides, nucleic acids; obtaining lipids, methods of their allocation; obtaining fermentation products, sugars, polysaccharides, their use; obtaining fat-and water-soluble vitamins, antibiotics, alkaloids, vaccines. **Expected results:** the student should know: the main groups of biotechnology products and their most important characteristics; the basic concepts and principles of methods of isolation purification of biotechnology products; methods of chemical, biochemical identification and determination of biotechnology products; be able to: use the basic laws of biochemistry, molecular biology in the development of technologies for isolation and purification of bioproducts; use quantitative and qualitative methods for the analysis of biotechnology products; to possess skills of technological process control of obtaining biotechnological products on the basis of various raw materials and processes of separation and purification of finished products.
7	**Standardization and certification of biotechnology products**	6	Food microbiology and sanitary hygiene	Final State Attestation	**Aim.** Training of students with in-depth study of theoretical and practical bases on standardization and certification of biotechnological products. **Contents.** During the course study, the following content of the discipline is revealed: concepts, definitions in the field of standardization, quality management, certification; regulatory and technical documentation of biotechnological products in biotechnological production; methods of standardization; types of standards; sign of compliance with state standards; procedure for the development of standards; systems of standards; technical regulations; product quality, consumer protection; application of certification; rules, procedure for certification. **Expected results:** the student should be able to: apply regulatory requirements to the main types of products and processes; to apply the documentation of quality system; use measuring tools; demonstrate knowledge in the field of standardization and certification and the ability to work with normative and technical documentation; to know the basic concepts and definitions of standardization and certification; the main provisions of the systems (complexes) of technical and organizational methods of standards; technical regulations; product quality; scope of certification; rules and procedure of certification.
7	**Quality management in the organization of biotechnological production**	6	Biotechnological safety of raw materials and biotechnological production	Final State Attestation	**Aim.** Formation of competencies that allow to develop quality management systems of biotechnological products in accordance with the requirements of Kazakhstan and international quality standards. **Contents.** During the course study, the following content of the discipline is revealed: the concept of "product quality"; the system of indicators of quality of biotechnological products; the main mechanisms of quality management system; quality management system: definition, requirements; development of quality management system in the enterprise; mechanisms of product quality management; features of quality management of biotechnological products; safety and quality of biotechnological products; preparation of technical documentation. **Expected results:** student must know: the standards systems of quality management of biotechnological production; guidelines on quality control of products; requirements for the organization of work with personnel; be able to: harnessed instrumentation in the production of biotechnological products; use basic principles of organization of metrological support of production; production; demonstrate knowledge in the field of standardization and certification and the ability to work with normative and technical documentation; possess: methods in the field of quality management system of biotechnological production; skills of operational control at all stages of the production process for compliance with quality standards and specifications.

Note: * - means that the discipline of study for all educational trajectories

LIST

of components for your choice for the educational program
6B05121 "Biotechnology"
Duration of studies: 4 years. Form of study: full - time

Name of the discipline	Code of discipline	Credits	Semester
1. General educational disciplines			
Component of choice 1			
Module of economic and legal knowledge		5	
Basics of a Market Economy and Entrepreneurship	*BMEE1111*	3	2
Fundamentais of law and anti-corruption	*FLAC1112*	2	
Module of economic and natural knowledge		5	
Basics of a Market Economy and Entrepreneurship	*BMEE1111*	3	2
Basics of life safely and ecology	*FLAC1112*	2	
2. Basic disciplines			
Component of choice 1			2
Cytology and Histology	CH1211	3	
Cell and tissue biology	CTB1211	3	
Component of choice 2			3
Phyto and zoological resources in biotechnology	PZRB2212	6	
Biotechnology raw materials	RMB2212	6	
Component of choice 3			3
Microbiology and virology	MV2213	6	
General Microbiology	GM2213	6	
Component of choice 4			3
Cell biotechnology	CB2214	5	
Cell selection of plants	CSP2214	5	
Component of choice 5			3
General and Molecular Genetics	GMG2215	5	
Genetics with the basics of breeding	GWBB2215	5	
Component of choice 6			4
Plant physiology	PP2216	4	
Anatomy and morphology of plants	AMP2216	4	
Component of choice 7			4
Human and animal physiology	HAP2217	4	
General physiology	GP2217	4	
Component of choice 8			4
Fundamentals of Genetic Engineering	FGE2218	3	
Basics of Molecular Biotechnology	BMB2218	3	
Component of choice 9			5
Biotechnology of microorganisms	BM3219	5	
Industrial Microbiology	IM3219	5	
Component of choice 10			5
Plant Biotechnology	PB3220	5	
Biotechnology in plant protection	BPP3220	5	
Component of choice 11			5
Basics of food biotechnology	BFB3221	5	
Isolation and purification of biotechnology products	IPBP3221	5	
Component of choice 12			5
Animal Biotechnology	AB3222	5	
Biotechnology in animal protection	BAP3222	5	
Component of choice 13			6

Basics of physical and chemical analysis	BPCA3223	5	
Physical and Colloid Chemistry	PCC3223	5	
Component of choice 14			
Fermentation biotechnology	FB3224	4	6
Technical Microbiology	TM3224	4	
Component of choice 15			
Engineering Enzymology	EE4225	5	7
Chemical Technology Basics	CTB4225	5	
Component of choice 16			
Fundamentals of environmental biotechnology	FEB4226	6	7
Biotechnology for cleaning soils and ponds	BCSP4226	6	
3. Profiling disciplines			
Component of choice 1			
Biotechnology of plant and animal products	BPAPO3306	6	6
Biopreparations technology	BT3306	6	
Component of choice 2			
Food Processing Equipment Technology	FPET3307	5	6
Processes and devices in biotechnology	PDB3307	5	
Component of choice 3			
Food microbiology and sanitary hygiene	FMSH4308	5	7
Biotechnological safety of raw materials and biotechnological production	BSRMBP4308	5	
Component of choice 4			
Toxicological analysis of food products	TAFP4309	6	7
Food chemistry	FC4309	6	
Component of choice 5			
Basics of biotechnology production design	BBPD4310	5	7
Industrial ecology	IE4310	5	
Component of choice 6			
Biotechnology of biological active substances	BBAS4311	5	8
Basics of isolation and purification of bioproducts	BIPB4311	5	
Component of choice 7			
Standardization and certification of biotechnology products	SCBP4312	6	8
Quality management in the organization of biotechnological production	QMOBP4312	6	