«Alikhan Bokeikhan University»
Department of Information and Technology and Economics
Economy and Management Department

6B05121 - BIOTECHNOLOGY
THE CATALOGUE OF ELECTIVE SUBJECTS

Year of entrance - 2024

Semey, 2024 y.

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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
BASIC DISCIPLINES					
Elective courses (EC)					
1	**Phyto resources in biotechnology**	6	Objects of biotechnology	Plant biotechnology	**Aim.** To equip the future biotechnologist with knowledge about the species composition, classification, brief description and use of representatives of the kingdoms of plants, fungi as raw materials or objects of research in biotechnological processes. **Content.** During the course, the following content of disciplines is revealed: representatives of the plant world as phytoresources in human life; species composition and ecological characteristics of plants of the Earth, the Republic of Kazakhstan considers biotechnologies and prospects for use; branches of biotechnology in which biological objects are used. **Expected results** of the study: To apply in practice the skills of working with specialized laboratory equipment and devices with various objects of biotechnology to solve practical problems and research activities in the field of biotechnology;
1	**Animal resources in biotechnology**	6	Objects of biotechnology	Plant biotechnology	**Aim.** To equip the future biotechnologist with knowledge about the species composition, classification, brief description and use of representatives of the animal kingdoms as raw materials or objects of research in biotechnological processes. **Content.** During the course, the following content of disciplines is revealed: representatives of the plant world as animal resources in human life; species composition and ecological characteristics of animals of the Earth, the Republic of Kazakhstan considers biotechnologies and prospects for use; branches of biotechnology, which include biological objects. **Expected results** of the study: To apply in practice the skills of working with specialized laboratory equipment and devices with various objects of biotechnology to solve practical problems and research activities in the field of biotechnology;
2	**Cell biotechnology**	5	Cytology and Histology	Fundamentals of Biotechnology	**Aim.** To equip the future biotechnologist with modern ideas about the most promising areas of development of cellular biotechnology in the world, to show its relationship with achievements in the field of molecular biology, cellular and molecular biophysics, bio-chemistry, molecular genetics, microbiology, molecular immunology and bioinformatics. **Content**. During the course, the following content of the discipline is revealed: brief history, stages of development of cellular biotechnology; theoretical foundations of cellular biotechnology; genomics, proteomics, bioinformatics; objects of cellular biotechnology; cells and subcellular macromolecular structures, their use; somatic hybridization; cellular biotechnology of microbiological systems; application of cellular biotechnology in eukaryotic systems; cellular biotechnology in

					medicine; commercialization of cellular biotechnology. **Expected results** of the study: the student should know about: the subject, the tasks of the history of development, objects, methods of cellular biotechnology, the trends in the development of cellular bio-technology in the modern world and its most promising areas, cellular biotechnology of microbiological systems, genetic engineering of plants and animals, achievements of cellular biotechnology in medicine, environmental aspects biotechnologies; be able to: critically analyze scientific experiments; have the skills to work with specialized laboratory equipment and devices for solving practical problems..
2	**Cell selection of plants**	5	Cytology and Histology	Fundamentals of Biotechtechnology	**Aim.** The purpose of studying the discipline is to gain knowledge and skills for the development and application of cell selection methods to improve and create new plant varieties with specified properties. **Contents.** During the course, the following content of the discipline is revealed: cell and tissue culture in vitro, the concept of cell and tissue culture; possibilities and prospects of plant cell and tissue culture methods; experimental morphogenesis; induced morphogenesis in cell and tissue culture; principles of cellular engineering; methods of non-traditional breeding for crop production; embryoculture; somaclonal variability; creation of plants with useful features using biotechnology: cellular engineering and solving the problem of nitrogen fixation: clonal micropropagation and improvement of growing material: preservation of the gene pool of higher plants in collections and cryobanks. The importance of genetic engineering for solving practical problems of crop production, medicine and industry. **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.
3	**Plant physiology**	4	School biology course	Biotechtechnology of plant and animal products	**Aim.** The purpose of studying the discipline is the study of plant physiology, which is aimed at a comprehensive understanding of the functions and processes of plants for their effective use and conservation. **Contents.** During the course, the following content of the discipline is revealed: functional types of plants and ecocenotic strategies; cellular foundations of plant organization and functioning; plant bioenergetics (photosynthesis and respiration); physiology of water metabolism; physiology of mineral nutrition; plant growth and development; adaptation of plants to environmental conditions; plant resistance to effects of stressors; interaction of plants with components of biocenoses; ecological and physiological strategies of plants; plant physiology and problems of global ecology. **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.
3	**Human and animal physiology**	4	School biology course	Biotechnology of plant and animal products	**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.
4	**Environmental protection and monitoring**	4	Fundamentals of scientific and environmental knowledge	Fundamentals of ecological biotechnology	**Aim.** is to provide special knowledge about the state of the environment and to form students' systematic ecological thinking, which will provide an integrated approach to solving ecological and economic problems of modern nature management. **Content:** Protection of monitoring and water resources. Protection and monitoring of soils. Protection and monitoring of atmospheric air. Protection of the ozone layer. Regulatory framework for the protection of biological resources in the Republic of Kazakhstan. The Red Book of the Republic of Kazakhstan. Biodiversity. Protection of forests and other plant complexes. Wildlife and its protection. Landscape protection.

					Biological monitoring: general grounds and concepts. Theoretical foundations of biomonitoring. **The expected results** of the study students should know: – theoretical foundations, purpose, tasks and functions of monitoring; – origin, types, sources of environmental pollution; – methods and tools for conducting observations and research in various monitoring systems and types; – features of the development of ecological systems; – conceptual framework for classification of environmental monitoring; – features of creation, development and organizational structure of the National Environmental Monitoring System of the Republic of Kazakhstan; – types of environmental monitoring of the Republic of Kazakhstan; – interaction of the National Environmental Monitoring System with the system of monitoring and forecasting of natural and man-made emergencies and the system of social and hygienic monitoring in the Republic of Kazakhstan; – a network of observation points, research facilities, controlled indicators for monitoring the quality of the state of the environment in the territory of the Republic of Kazakhstan; – regulatory legal support for the activities of various systems and types of environmental monitoring; be able to: – conduct ecological and economic analysis of environmental problems arising from different types and scales of the impact of natural and anthropogenic factors on the environment and the intensity of the use of natural resources; – determine the regulations of observations, the composition of environmental information, the procedure for obtaining and providing it to consumers of various levels; apply the knowledge and skills to improve scientific and practical activities in order to ensure the development of an integrated approach to the analysis of environmental problems and the solution of environmental management issues; – use information and analytical materials and information technologies in the field of environmental monitoring to determine the strategy of rational use of natural resources; possess: an understanding of the mechanisms of operation of the National Environmental Monitoring System in the context of rational nature management and environmental protection; – skills of practical work using information analytical materials and information technologies in the field of environmental monitoring; – skills of planning the main stages of environmental monitoring.
4	**Rational use of natural resources**	4	Fun-damen-tals of life safety	Funda mentals of ecologi cal	**Aim.** familiarization of students with theoretical knowledge and practical skills to understand the importance of preserving the quality of the environment, rational use of natural resources **Contents:** Ecological and geographical foundations of nature management. Natural systems as objects of human impact. Rational use of natural resources. Protection of nature and the

			and ecology	biotech nology	human environment. Improving the properties of natural and natural-anthropogenic geosystems. Environmental management and the state of geosystems **Expected results:** must have knowledge of the fundamentals of the economic system to master the basic concepts and categories of the economy of natural resource use. Be able to analyze the causes and mechanism of environmental quality, predict the impact on the natural environment and human society. Be able to find an integrated approach to the study of economic problems. Be able to find an integrated approach in the study of environmental problems. Be able to work effectively in a team, have the skills to work independently. Study legislative and regulatory documents.
5	**Ecology of microorganisms**	5	General Microbiology and Biotechnology	Fundamentals of environmental biotechnology	**Aim.** The purpose of studying the discipline is to acquire knowledge about the interactions of microorganisms with the environment, their role in ecosystems and the application of this knowledge to solve environmental and biotechnological problems. **Contents:** During the course, the following content of the discipline is revealed: the interaction of microorganisms with the environment; other living organisms; physico-chemical factors in ecosystems. Within the framework of this discipline, students explore how microorganisms affect environmental processes such as the cycles of substances and energy, the distribution and biodiversity of organisms in various environments, as well as their adaptation to changing environmental conditions. They also study how human activity affects microbial communities and what consequences this may have for human health and the environment. **Expected results** of the study: Students acquire knowledge about the interactions of microorganisms with the environment, their role in ecosystems and processes of biogeochemical cycles. **Be able to** analyze the ecosystem functions of microorganisms, conduct research on their interactions with the environment and assess their impact on biogeochemical processes.; **acquire skills** in working with microbiological research methods, analyzing microbial communities and applying environmental principles to study the role of microorganisms in the environment.
5	**Microbiomes**	5	General Microbiology and Biotechnology	Fundamentals of environmental biotechnology	**Aim.** The purpose of mastering the discipline is to acquire knowledge about the composition, functions and interactions of microbiomes in various ecosystems and organisms, as well as the application of this knowledge to improve health, agriculture and ecology. **Contents.** During the course, the following content of the discipline is revealed: microbial communities; their structure, functions and relationships with the environment in various ecosystems; the role of microorganisms in biological and geochemical processes; the impact on the health of plants, animals and humans, as well as their importance for ecosystem balance and sustainability. Within the framework of this discipline, students study methods of microbiome analysis, their

					impact on the environment, as well as the possibilities of applying their knowledge in various fields, including medicine, agriculture, ecology and biotechnology. **To know** about methods of cultivation of cells, tissues and organs of plants in vitro; processes of dedifferentiation leading to the formation of callus; pathways of morphogenesis in vitro and factors regulating plant regeneration; theoretical and methodological principles of using cultured cells to obtain important metabolites, for clonal micropropagation and plant health improvement, to overcome incompatibility with distant hybridization; **Be able to**: put into practice the skills of working with plant crops; control plant growth; Possess the skills of: working in sterile conditions with isolated cells, tissues, callus mass; isolation of explant from a plant object; calculation of nutrient solution concentrations; preparation of nutrient solutions; cultivation of plant tissue cultures; skills in working with specialized laboratory equipment and devices for solving practical problems.
6	**Plant Biotechnology**	5	Photo resources in biotechnology	Agricultural biotech technology	**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, the content of the discipline is revealed: cultured plant cells as an object of biotechnology; obtaining and cultivating callus; cell technologies in the biosynthetic industry; clonal micro-reproduction and plant health improvement; overcoming in vitro progamous and postgamous incompatibility; haploid technology; cell selection; cell engineering; plant genetic engineering; preservation of the 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.
6	**Biotechnology in plant protection**	5	Photo resources in biotechnology	Agricultural biotech technology	**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.
7	**Animal Biotechnology**	5	General and molecular genetics	Modern methods in biotech technology	**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.
7	**Biotechnology in animal protection**	5	General and molecular genetics	Modern methods in biotech technology	**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.
8	**Basics of food biotechnology**	5	fundamentals of biotechnology	Standardization and certification of biotechnological 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.
8	**Isolation and purification of biotechnology products**	5	fundamentals of biotechnology	Standardization and certification of biotechnological products	**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.
9	**Basics of physico-chemical analysis of food products**	4	Inorganic and analytical chemistry s	Toxicological analysis of food product	**Aim.** Students gain knowledge about the methods of chemical and physico-chemical analysis, their theoretical foundations, as well as the acquisition of skills and abilities to draw theoretical conclusions based on observed phenomena. **Content.** During the course, the following disciplines are revealed: the study of quality issues of products and finished products: product properties, quality indicators; types and methods of quality control; identification and falsification; organization of food quality control: food quality control; semi-finished products and finished products; value and classification of measurement methods of control; documentation of the quality of products, semi-finished products and finished products; physico-chemical methods of analysis of products, semi-finished products and finished food **Expected results** of the study: the student should know: the theoretical foundations of physico-chemical analysis; be able to: use the concepts and methods of physico-chemical analysis and apply physical, chemical and mathematical laws to solve practical problems, draw up analysis schemes, select a method to achieve a specific goal; possess: basic techniques of chemistry definitions and analysis objects; theoretical foundations of physical and chemical chemistry.
9	**Physical and colloid chemistry**	4	Inorganic and analytical chemistry s	Toxicological analysis of food product	**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**. In the course of studying the course, the following content of the disci-pline is revealed: balance; solutions; thermodynamics of chemical equilibrium; law of acting masses; electrochemistry; chemical kinetics, catalysis; dispersed systems, thermodynamics of surface phenomena; adsorption; adsorption theory; electrical properties of disperse systems, stability, coagulation; IUD solutions, their properties, gels and jellies; electrical properties of IUD solutions; molecular-kinetic properties of HMS solutions. **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.
10	**Engineering**	3	Biochemis-	Final certifi-	**Aim.** To form ideas about the development of engineering industries using biological objects to solve economic problems.

	enzy-mology		try	cation	**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.
10	**Chemi-cal technol-ogy ba-sics**	3	Bio-chemis-try	Final certifi-cation	**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.
11	**Funda-mentals of envi-ronmen-tal bio-technol-ogy**	6	Environ ron-mental protec-tion and moni-toring	Final state certifi-cation	**Aim.** The purpose of studying the discipline is the application of biotechnological methods and processes aimed at solving environmental problems and the sustainable use of natural resources.. **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. All these topics are considered taking into account the principles of circular economy, cyclicity, sustainable development and world experience. **Expected results**: the student should know: the main characteris-

					tics 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.
11	**Biotechnology for cleaning soils and ponds**	6	Environ ron-mental protection and monitoring	Final state certification	**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.
12	**Agricultural Biotechnology**	5	Plant biotechnology	Final State certification	**Aim.** is to form future specialists of technological training in modern areas of biology, knowledge of basic biotechnological processes and industries, the basics of genetic and cellular engineering and the possibility of further implementation of their own knowledge in innovative areas of natural sciences. **Content:** During the course, the content of the disciplines is revealed: the content of agricultural biotechnology; genetics and genetic engineering in plant biotechnology; methods of clonal micro-reproduction; renewable resistant forms of plants to adverse environmental diseases; phytohormones and synthetic regulators of plant growth and development in biotechnology and crop production; application of in vitro methods in plant breeding; biotechnology in animal husbandry; embryo transplantation; cloning, production of chimeric and transgenic animals; biotechnology and biosafety. **Expected results** of the study: the student should know: the ability of a creative approach to the production technology of modern bioproducts for agriculture in the study of

					biotechnological processes and productions; to give knowledge about the conditions and factors of the development and creation of finished biotechnological products, the basic laws and methodological approaches used in the creation of new bioproducts needed in various sectors of agriculture.
12	**Medical and Veterinary Biotechnology**	5	Plant biotechnology	Final State certification	**Aim.** mastering the theoretical foundations of biotechnology and acquiring knowledge, skills and abilities in the design, production and control of biological products. **Content:** During the course, the specific content of the disciplines is revealed: the content of medical and veterinary biotechnology; biological objects as a means of producing medicinal, preventive and diagnostic products for humans and animals; approaches to biotechnological pharmaceutical and veterinary drugs; the use of recombinant DNA methods in medical and veterinary biotechnology (genetic engineering microbiological production); biotechnology of immunogens and vaccines; the use of monoclonal antibodies for therapeutic purposes; nanobiotechnology in medical and veterinary biotechnology; a unified GLP, GCP and GMP system for the introduction into practice and production of medicines. Expected results of the study: the student should know: the possibilities of modern specialized equipment, solutions of general professional tasks; be able to apply modern technologies and research methods in professional interpretation of the results obtained
13	**Basics of programming in Python**	3	Information and communication technologies	Modern methods in biotechnology	**Aim.** formation of basic concepts of structural programming; formation of programming skills in Python. **Content:** Python language. Data types, operations, operators. Features of input/output. Built-in Object Types: Numbers Strings Tuples Lists Dictionaries Sets. File I/O. Reading strings using file iterators. Working with binary files. Data processing. Arrays and vector densities. Plotting and data visualization. Numpy library for implementing mathematical objects and calculations. Creating applications with a graphical interface. Overview of graphic libraries: Tkinter, PyQt. Classes in Python. Registration of data, methods, operations. Inheritance. Multiple study. Composition when developing classes. **Expected results** of the study: the student should know: the basic methods of data collection and processing in Python; be able to: • find the data necessary to work in the programming language; possess: • programming skills in Python; • skills to work with different formats of data files.
13	**Mathematical modeling in biology**	3	Information and communication technologies	Modern methods in biotechnology	**Aim.**. mastering modern methods and programs for analyzing research results and statistical processing using personal computers in various areas of scientific work **Content**: The concept of the model, the rationale for the construction of the model. Types of models and their cognitive capabilities. the study of the problem of life Principle as a phenomenon. Basic research of models of biological systems. Mathematical methods for the study of biological systems. Examples of models of biological systems **Expected results** of the study: the student should know: the

					main methods of scientific research; be able to: identify and systematize the main ideas in scientific texts; critically evaluate any incoming information regardless of the source; avoid automatic application of standard formulas and techniques in solving problems; possess the skills of collection, processing, analysis and systematization information on the research topic; skills in choosing methods and means of solving research problems
MAIN DISCIPLINES					
Elective courses (EC)					
1	**Biotechnology of plant and animal products**	6	Plant physiology	Biological safety of food products	**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	**Biopreparations technology**	6	Plant physiology	Biological safety of food products	**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 content of the discipline is revealed: 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 ra-

					tional microbiological processing of plant raw materials; about trends in the development of microbiological technologies using new strains of microorganisms.
2	**Technological equipment of the food industry**	5	Industrial Biotechnology	Fundamentals of biotechnological 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.** In the course of studying the course, the following content of the discipline is revealed: machine-hardware circuits; transport, auxiliary equipment in biotechnology; equipment for sterilization, extraction, pressing, filtering, flotation, cultivation of microorganisms on solid nutrient media; fermenters; equipment for separating liquid heterogeneous systems, for purification and concentration, for drying microbiological products, for grinding, standardization, granulation and microencapsulation.. **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	**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 founda-

					tions 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.
3	**Chemistry food products**	6	Basics of physical and chemical analysis	Final State Attestation	**Aim.**. The study of the conceptual apparatus of the discipline, the main theoretical provisions and methods, instilling the skills of applying theoretical knowledge to solve practical problems. **Content.** During the course, the content of the disciplines 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, biologically active additives; food safety; fundamentals of ecological nutrition; nutraceuticals, probiotics, prebiotics. **Expected results** of the study: the student should know: - chemical composition of raw materials, intermediates and finished food products; methods for assessing the nutritional value of food; general regularities of chemical, biochemical and microbiological processes occurring during storage of raw materials; transformations and interaction of the main chemical components of raw materials during processing in the production of products nutrition and the influence of its regimes on the composition, properties of the main nutrients, nutritional and biological value of raw materials and finished products; be able to: - determine the chemical qualitative and quantitative composition of the object under study, reasonably choose a test method for specific tasks; possess: the skills of conducting an experiment with appropriate calculations and formulation of conclusions; basic chemical and physico-chemical methods of analysis to determine the properties and technological indicators of the materials used and finished products.
4	**Biological safety of food products**	5	Biotech technology of plant and animal products	Final state certification	**Aim**.: formation of necessary theoretical knowledge and practical skills about the concept of biological safety as the absence of unacceptable risk or damage to the health and life of people when consumed in generally accepted quantities of products of animal origin; hygienic characteristics of the main components of raw materials and products of biological origin; basic laws of the Republic of Kazakhstan regulating the safety of raw materials and food for humans and the environment; contamination of raw materials and products; ways to reduce harmful effects on humans and the environment; waste disposal. **Content:** During the course, the following disciplines are revealed: regulatory documents regulating the requirements for the quality and safety of food products, control over their quality and safety; basic quality management studies; the International HACCP and ISSO system; the ways of food products in the trophological chain; toxicological and hygienic characteristics of toxins, pesticides, detection of metals, radioactive poisoning, antibiotics and hormonal drugs, mycotoxins; microbiological indicators of food safety; antialimentary nutrition factors; technochemical control of food production. **Expected results** of the study: the student should know general

					basic information on chemistry be able to: analyze the physico-chemical analysis data to organize and plan the quality of raw materials and finished products; possess: methods for determining organoleptic, chemical and physical indicators of microbiological quality of raw materials and finished products
4	**Biological safety of biotechnological production**	5	Biotechnology of plant and animal products	Final state certification	**Aim**: to form theoretical knowledge on the biological and biotech safety of food production biotechnology and to acquire practical skills in monitoring food safety indicators. **Content:** During the course of the course, special disciplines are revealed: the regulatory and legislative framework for ensuring the biosafety of biotechnological productions; the safety system in the field of genetic engineering; possible aspects of biological hazard and environmental risks of genetically modified organs; modern microbial biohazard factors associated with biotechnological processes; Biosafety products for the production of diagnostic and immunobiological drugs; biosafety problems on an industrial scale the safety of working with collection, production and test strains requires observation in biotechnological processes; environmental aspects of biotechnological productions. **Expected results** of the study: the student should know the methods of controlling the quality and safety of biotechnological products; be able to: prepare micro-preparations of microbial cells; conduct microscopy of biological objects (cells, tissues and their parts); possess: skills of working with micro-preparations; - methods of selecting optimal modes for growing microbial cultures; methods of analyzing the safety of biotechnological products.
5	**Basics of biotechnology production design**	5	Technological equipment of the food industry	Industrial practice III	**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	Technological equipment of the food industry	Industrial practice III	**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	**Radiobiology**	5	Ecology of microorganisms	Environmental biotechnology	**Aim**: The purpose of studying the discipline is to understand the effects of ionizing radiation on living organisms and to develop methods for the protection and application of radiation in science. **Contents:**During the course, the following content of the discipline is revealed:fundamentals of radiobiology; types of ionizing radiation; physical foundations of radiation exposure; radiobiological effects at the level of tissues and organs; radiobiology and human protection;radioecology; effects of radiation on the environment and ecosystems. This course provides fundamental knowledge about the nature of radiation exposure, its mechanisms of action and methods of protection, as well as the use of radiation in various fields. **Expected results** of the study: students acquire knowledge about the mechanisms of ionizing radiation effects on biological systems, including molecular, cellular and tissue levels, as well as the principles of radiation protection.

					Be able to assess the radiation effects on biological objects, conduct experiments with ionizing radiation and develop radiation protection measures. They acquire skills in working with radiometric devices, analyzing radiation damage at the cellular level and developing scientifically based measures to protect against radiation.
6	**Radioecology**	5	Ecology of microorganisms	Environmental biotechnology	**Aim**: The purpose of the discipline is to study the behavior of radionuclides in the environment, their interaction with biotic and abiotic components of ecosystems and the development of measures to minimize radiation pollution of the environment. **Contents**: During the course, the following content of the discipline is revealed: fundamentals of radioecology; sources of radiation pollution; migration of radionuclides in the environment; biogeochemical cycles of radionuclides; the effect of radiation on ecosystems; Assessment of radiation risk to the environment; radioecological safety; modern problems and research in radioecology. This course provides comprehensive knowledge about the effects of radiation on natural systems and the necessary measures to protect the environment from radiation pollution. **Expected results** They acquire knowledge about the effects of radiation on ecosystems, the mechanisms of its spread in the environment and methods for assessing and minimizing radiation risk to nature and humans. Be able to assess radiation pollution in the environment, analyze its impact on ecosystems and develop measures to reduce radiation risk.; acquire skills in conducting radiation monitoring, analyzing data on radiation pollution and developing environmentally sound strategies to eliminate it
7	**Standardization and certification of biotechnology products**	6	Fundamentals of food biotechnology	Final state certification	**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	**Environ**	6	Funda	Final	**The aim** of studying the discipline is to master the theory and

	mental manage ment		mentals of food biotech nology	state certific ation	practice of environmental management in an organization, to obtain information, legal and methodological knowledge for students to develop plans and implement environmental management systems, rational use of natural resources, ensuring environmental safety of manufactured goods and services provided.. **Content.** During the course, the following disciplines are revealed: general "product quality"; the system of quality indicators of biotechnological products; the main mechanisms of the quality management system; quality management system: definition, requirements; development of a quality management system at the enterprise; mechanisms of product quality management; features of quality management of biotechnological products; safety and quality of biotechnological products; preparation of technical documentation documentation.. **Expected results** of the study: students should know: the laws of the development of nature and society in the light of the emergence and formation of environmental management; methodology of planning and implementation of environmental management system in the organization; be able to: professionally conduct managerial, marketing, commercial, advertising work related to the environmental activities of the organization; develop management decisions and justify the choice of optimal, based on the criteria of a scientifically sound combination of socio-economic efficiency and environmental safety of economic activity; possess: terminology in the field of environmental management; methods of organization and implementation of environmental management system,

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	Amount of credits	Semester
1. Basic disciplines			
Component of choice 1			2
Phytoresources in biotechnology	PhB2214	6	
Animal Resources in biotechnology	ARB2214	6	
Component of choice 2			3
Cellular Biotechnology	CB2215	5	
Cellular plant breeding	CPB2215	5	
Component of choice 3			5
Plant Physiology	PP3216	4	
Human and Animal Physiology	HAPhyZ3216	4	
Component of choice 4			4
Environmental protection and monitoring	EPM2217	4	
Rational use of natural resources	RNR2217	4	
Component of choice 5			4
Basics of Python Programming	BPP2218	3	
Mathematical modeling in biology	MMB2218	3	
Component of choice 6			4
Ecology of microorganisms	EM2219	5	
Microbiomes	Mbi 2219	5	
Component of choice 7			5
Plant biotechnology	PB3220	5	
Biotechnology in plant protection	BPP3220	5	
Component of choice 8			5
Basics of food biotechnology	BFB3221	5	
Isolation and purification of biotechnology products	IPBP3221	5	
Component of choice 9			5
Animal biotechnology	AB3222	5	
Biotechnology in animal protection	BAP3222	5	
Component of choice 10			6
Basics of physico-chemical analysis of food products	BPCAP3223	4	
Physical and colloidal chemistry	PCC3223	4	
Component of choice 11			7
Engineering Enzymology	EE 4224	3	
Basics of Chemical Technology	BCT4224	3	
Component of choice 12			7
Agricultural Biotechnology	AB4225	5	
Medical and Veterinary Biotechnology	MVB4225	5	
Component of choice 13			7
Basics of environmental biotechnology	BEB4226	6	

Biotechnology of soil and water purification	BSWP4226	6	
2. Profiling disciplines			
Component of choice 1			6
Biotechnology of plant and animal products	BPAP3306	6	
Biopreparations technology	BT3306	6	
Component of choice 2			6
Food Processing Equipment Technology	FPET3307	5	
Processes and devices in biotechnology	PDB3307	5	
Component of choice 3			7
Biological safety of food products	BSFP4308	5	
Biotechnological safety of biotechnological production	PDB4308	5	
Component of choice 4			7
Toxicological analysis of food products	TAFP4309	6	
Food chemistry	FE4309	6	
Component of choice 5			7
Basics of biotechnology production design	BBPD4310	5	
Industrial ecology	IE4310	5	
Component of choice 6			8
Radiobiology	RB 4311	5	
Radioecology	RE 4311	5	
Component of choice 7			8
Standardization and certification of biotechnology products	SCBP4312	6	
Environmental management	EM4312	6	