MINISTRY OF AGRICULTURE OF THE REPUBLIC OF KAZAKHSTAN
"NJSC "S. SEIFULLIN KAZAKH AGROTECHNICAL UNIVERSITY"

Approve
NJSC "Saken Seifullin Kazakh
Deputy Chairman of the Management
Board Academic Activity-Rector
_____ A.M Abdyrov.
«_____» _____ 2021.

CATALOG OF ELECTIVE COURSES

For students in groups of educational programs

6B05103 Biology

Nur-Sultan, 2021

MINISTRY OF AGRICULTURE OF THE REPUBLIC OF KAZAKHSTAN
"NJSC "S. SEIFULLIN KAZAKH AGROTECHNICAL UNIVERSITY"

Brief description of elective disciplines of the educational program

Ecology and sustainable

1	Name of course	Professionally-oriented Foreign Language
2	Code of course	POIYa 3221
3	Cycle of course	cycle of basic disciplines
4	Amount of credits	6
5	Level of preparation	Undergraduate
6	Department	Department of Microbiology and Biotechnology
7	Year	
8	Prerequisites	“Foreign language” in undergraduate
9	Postrequisites	Disciplines in a specialty in a foreign language
10	Course summarytd>	It is aimed at mastering the future masters' language for professional and academic purposes at an advanced level, which will allow you to freely operate the scientific and conceptual apparatus of the specialty, expand the scientific and information base, master the skills of interpreting scientific information, argumentation, persuasion, scientific debate, academic writing.
11	Learning outcomes	To own skills: oral communication in the specialty in the forms of monologue, dialogue / polylogue (report, message, discussion, debate, debate, round-table discussion); preparation of written forms for the presentation of information material in the specialty of communication, poster report, annotation); work with lexicographic sources in a foreign language (traditional and on-line); extract the necessary information from academic texts; understand the main idea of academic texts and texts in the specialty; the use of modern approaches to the study of a foreign language (national corps of foreign languages).

1	Name of course	English for special purposes
2	Code of course	AYaDSC 4229
3	Cycle of course	cycle of basic disciplines
4	Amount of credits	4
5	Level of preparation	Undergraduate
6	Department	Department of Microbiology and Biotechnology
7	Year	
8	Prerequisites	“Foreign language” in undergraduate level B1-B2
9	Postrequisites	Disciplines in a specialty in a foreign language
10	Course summarytd>	In-depth study of a foreign language and carry out foreign language interpersonal and intercultural communication with native speakers.
11	Learning outcomes	According to the results of mastering the program, the student, depending on the level of training, the student at the time of completion of the course reaches the level of B1- (IELTS 4.0-5.0) or B2- (IELTS5.5-6.0) and the formed skills for solving tasks of professional, interpersonal and intercultural interaction.

1	Name of course	Inorganic and organic chemistry
2	Code of course	NOH 1216
3	Cycle of course	cycle of basic disciplines
4	Amount of credits	5
5	Level of preparation	Undergraduate studies
6	Department	Department of Microbiology and Biotechnology
7	Year	1
8	Prerequisites	Basic school knowledge of biology, chemistry
9	Postrequisites	To study basic and core disciplines.
10	Course summarytd>	Theoretical foundations, basic laws and concepts of chemistry. The structure of the atom, substance. State of aggregation. Chemical bond. The basic laws of a chemical reaction. Reactions in the aquatic environment. Complex compounds. Redox process. Chemistry of bioactive elements. Fundamentals of Organic Chemistry. The relationship between the structure and property of substances. Methods of preparation, properties and use of organic substances.
11	Learning outcomes	To be able to use the experience of theoretical, experimental research and safe work with chemicals, solve design problems. Know the natural sources of organic raw materials; classification and principles of the nomenclature of organic compounds; know the methods of preparation and chemical properties of the main classes of organic compounds; The use of certain classes of organic compounds as indicators; methods for the isolation and purification of organic compounds (extraction, recrystallization, distillation, sublimation); construct the structural formula of an organic compound by its name and vice versa.

1	Name of course	Higher mathematics

2	Code of course	VM 1217
3	Cycle of course	cycle of basic disciplines
4	Amount of credits	5
5	Level of preparation	Undergraduate studies
6	Department	Department of Microbiology and Biotechnology
7	Year	1
8	Prerequisites	School course of mathematics
9	Postrequisites	Information and communication technologies, entrepreneurial activity
10	Course summarytd>	Elements of linear algebra and analytic geometry; The limit, derivative and integral of a function of one variable; Functions of several variables; Numeric series. Theory of Probability and Mathematical Statistics.
11	Learning outcomes	To own the technique of solving various types of calculation problems, analyze theoretical data, be able to apply the knowledge gained in solving applied problems in the study of biology, biotechnology, veterinary medicine and medicine; in the formalization of tasks, the construction of mathematical models and the selection of the most acceptable methods of solution; acquire skills in the implementation of algorithms in relation to specific tasks; in solving practical problems, in using the achievements of fundamental science for the successful study of general theoretical and special disciplines of the specialty, the development of mathematical thinking and logic for use in mathematical modeling.

1	Name of course	Analytical and physical and colloid chemistry
2	Code of course	AFH 1230
3	Cycle of course	cycle of basic disciplines
4	Amount of credits	5

5	Level of preparation	Undergraduate studies
6	Department	Department of Microbiology and Biotechnology
7	Year	1
8	Prerequisites	Inorganic chemistry, organic chemistry, Physics, Mathematics.
9	Postrequisites	To study basic and core disciplines
10	Course summarytd>	Equilibrium in a homogeneous system. Stages of analytical processes: selection and preparation of samples for analysis, measurement steps, evaluation of measurement results. Buffer capacity. Chemical thermodynamics and equilibrium. Chemical kinetics and electrochemistry. Volumetric analysis. Two, three and multicomponent systems. Gravimetric analysis. Colloid chemistry. Dispersed systems. The structure of the micelle. Physico-chemical methods of analysis.
11	Learning outcomes	Know the main sections of analytical and physical colloid chemistry: the metrological basis of chemical analysis, the gravimetric method (weight) analysis, the titrimetric method (volumetric) analysis, physico-chemical methods of analysis, the basics of chemical thermodynamics, phase equilibrium, solutions, the basics of electrochemistry, chemical kinetics and catalysis. To be able to prepare and set the titer of solutions, determine the content of ions in the solution and their concentration, justify proposals for improving the ongoing technological operations.

1	Name of course	Basics of Biostatistics and Bioinformatics
2	Code of course	OBB 2220
3	Cycle of course	cycle of basic disciplines
4	Amount of credits	6
5	Level of preparation	Undergraduate studies
6	Department	Department of Microbiology and Biotechnology
7	Year	2
8	Prerequisites	Computer science, molecular biology, general and molecular genetics, microbiology and virology, immunology
9	Postrequisites	Microorganism biotechnology, animal biotechnology, plant biotechnology, ecological biotechnology, breeding of industrial microorganism strains

10	Course summarytd>	Biological information, statistical processing of measurement results in biological research. Sequencing technology. Microsoft Excel Excel package features. Main categories of statistical analysis in Microsoft Excel, Microsoft Access database. Processing the results of serological studies. Decoding the genetic code of electronic resources NCBI. Possibilities of using the BLAST program. Introducing the Galaxy Web Platform
11	Learning outcomes	To have skills in working with software used in the analysis of biological data; engage in research and biotechnological practice using methods of biostatistics and bioinformatics; be able to process and analyze the results of their own research in the implementation of term papers and dissertations. Know the methodological foundations of scientific knowledge; basic research methods used in the field of biological sciences; general guidelines for experimental research; the methodology of the final scientific processing of research materials

1	Name of course	General pharmacology
2	Code of course	OF 2223
3	Cycle of course	cycle of basic disciplines
4	Amount of credits	5
5	Level of preparation	Undergraduate studies
6	Department	Department of Microbiology and Biotechnology
7	Year	2
8	Prerequisites	Organic and Inorganic Chemistry, Biochemistry, Physiology, Biology
9	Postrequisites	Pharmaceutical biotechnology, animal biotechnology, veterinary biotechnology, medical biotechnology
10	Course summarytd>	General pharmacology. General recipe. Means that affect afferent innervation, efferent innervation, central nervous system, metabolic processes and homeostasis.

11	Learning outcomes	To Be able to: choose dosage forms, methods of using drugs; analyze the effect of drugs on the totality of their pharmacological properties; Recognize undesirable effects of drugs, prevent them and eliminate them in case of occurrence; choose medicines for emergency care; navigate the arsenal of new drugs, know their most common synonyms. Skills: prescriptions for essential essential drugs; search and processing of data on medicines for information of clinical and pharmacy workers; preparation of applications for medicines, taking into account their pharmacological properties.

1	Name of course	Medical Biotechnology
2	Code of course	MB 3222
3	Cycle of course	cycle of basic disciplines
4	Amount of credits	6
5	Level of preparation	Undergraduate studies
6	Department	Department of Microbiology and Biotechnology
7	Year	3
8	Prerequisites	Microbiology and virology, immunology molecular biology, molecular genetics and genetic engineering, biotechnology of microorganisms
9	Postrequisites	Microbiological basis in the production of biotechnological products, pharmaceutical biotechnology
10	Course summarytd>	The importance of biotechnology in solving the problems of medicine and health. The use of human cells in biotechnology, fibroblasts, stem cells. IVF - problems and prospects. The technology for obtaining, fertilizing cells, replanting and storing invitro embryos. Requirements for sperm and egg donors. Banks of gametes and human embryos. The technology for producing antigens and hyperimmune serums for medicine. Production of diagnosticums of common diseases based on hybridoma technology and monoclonal antibodies.
11	Learning outcomes	To know: the basics of biosafety; features of the manufacturing technology of medicines, methods for their control, standardization and certification; genetic engineering methods used to create new generation diagnostic kits and vaccines. To be able to: carry out hyperimmunization, receive antibodies and antigens, conduct a preclinical test. To have: skills in obtaining phyto- and biological products, operations of hybridoma technology, DNA isolation and purification.

1	Name of course	Biotechnology of microorganisms
2	Code of course	BM 3232
3	Cycle of course	cycle of basic disciplines
4	Amount of credits	7
5	Level of preparation	Undergraduate studies
6	Department	Department of Microbiology and Biotechnology
7	Year	3
8	Prerequisites	Morphology, physiology, biochemistry, molecular biology, molecular genetics and genetic engineering, microbiology and virology, the basics of biotechnology
9	Postrequisites	Microbiological control of biotechnological production, veterinary biotechnology, food biotechnology, environmental biotechnology, industrial biotechnology
10	Course summarytd>	Strains producing the target products and requirements for their storage. Principles and methods for producing producer strains and super-producers. Methods for the cultivation of microorganisms. The study of the growth of microorganisms and the effect on it of pH and temperature of cultivation. The characteristics of the producers and the technology for producing microbial protein, organic acids and neutral products, primary metabolites of microorganisms, biologically active substances by microbiological synthesis.
11	Learning outcomes	To know the safety measures when working with biological material, the basics of classification, morphology, physiology, genetics and properties of producer strains; methods and approaches for the preparation, isolation and purification of primary and secondary metabolites of microorganisms; To be able to produce microbiological preparations, cultivate microorganisms by surface and deep methods, isolate pure cultures and identify them, maintain and store industrial cultures of microorganisms. The ability to solve problems of economic efficiency and the feasibility of using a particular producer strain; analyze data, draw up a production protocol.

1	Name of course	General Immunology
2	Code of course	OI 3231
3	Cycle of course	cycle of basic disciplines
4	Amount of credits	6
5	Level of preparation	Undergraduate studies
6	Department	Department of Microbiology and Biotechnology
7	Year	3
8	Prerequisites	Morphology, physiology, biochemistry.
9	Postrequisites	Microbiology and virology, veterinary biotechnology, molecular genetics and genetic engineering, animal biotechnology.
10	Course summarytd>	The concept of natural resistance and species immunity, acquired immunity. Modern ideas about antigens, protective mechanisms of a macroorganism, regulation of the immune response and applied immunology. The functioning of the immune system is normal, laws and principles of functioning. Knowledge of immunological methods for the determination of T and B lymphocytes, as well as methods for the isolation and study of immunoglobulins.
11	Learning outcomes	Know: basic immunological concepts and terms; the structure of the immune system, the mechanisms of formation of the humoral and cellular immune response; molecular genetic basis of immunological reactions and their regulation; features of the formation of various types of non-infectious and infectious immunity; main pathologies of immunity. be able to: apply scientific knowledge in the field of immunology in educational and professional activities; search and analyze scientific information on relevant immunological issues; own: a wide range of methods and approaches of immunological studies. Practical skills in using immunological tests to detect antigens and antibodies.

1	Name of course	Business activities
2	Code of course	PD 4227
3	Cycle of course	cycle of basic disciplines
4	Amount of credits	5
5	Level of preparation	Undergraduate studies
6	Department	Department of Microbiology and Biotechnology
7	Year	4
8	Prerequisites	Fundamentals of Economics, Fundamentals of Agribusiness
9	Postrequisites	Organization of production, professional activity
10	Course summarytd>	Concept, essence, basic types and organizational forms. Rationing and remuneration. Costs and financial performance of the organization (company). Economic efficiency of the organization (company) and entrepreneurial projects. Marketing and organization management. State support for entrepreneurship and its infrastructure.
11	Learning outcomes	To own: skills in applying various techniques and tools in a business management system; personnel assessment methods; risk management methods; methods for assessing the effectiveness of entrepreneurial activity.

1	Name of course	Ecology and sustainable
2	Code of course	EUR 2229
3	Cycle of course	cycle of basic disciplines
4	Amount of credits	4
5	Level of preparation	Undergraduate studies
6	Department	Department of Microbiology and Biotechnology
7	Year	2
8	Prerequisites	School biology program
9	Postrequisites	Plant physiology, Human genetics, Radiobiology
10	Course summary	Introduction to ecology: steppe as an example model. Abiotic, biotic factors. Ecosystem vs agroecosystem. Population ecology. Ecology of communities, The concept of the biosphere and noosphere. Global environmental issues. The concept of sustainable development. Natural resources and their rational use as one of the aspects of sustainable development. Socio-ecological problems of the present and sustainable development.
11	Learning outcomes	know: - the environmental laws and principles of interaction of organisms with the environment; - the types and composition of anthropogenic impact on the biosphere; - to collect, process and interpret materials on environmental factors, on the state of ecosystems, on environmental pollution, to distinguish between the main laws of interaction of living organisms with the environment; - the essence of the current environmental crisis; - the requirements for professional responsibility for the preservation of the habitat; - The principles of state policy in the field of environmental protection. to be able to: - assess the state of ecosystems; - predict the consequences of their professional activities in terms of impact on biosphere processes; - choose the principles of environmental protection in accordance with environmental laws. To master: analyzing socially significant problems and processes taking place in society, to predict their possible development in the future.

1	Name of course	Python language and data analysis
2	Code of course	YaPAD 2220

3	Cycle of course	cycle of basic disciplines
4	Amount of credits	1
5	Level of preparation	Undergraduate studies
6	Department	Department of Microbiology and Biotechnology
7	Year	2
8	Prerequisites	Higher mathematics, ICT
9	Postrequisites	Course and diploma design, future professional activity
10	Course summary	Python Programming. An introduction to Numpy and SQL. Programming environment. Python programming language. The concept of the type and value of a variable, simple types. Expressions and instructions. Data structures: strings, lists, tables, files. Functions. Conditional statements. Cycles. Editing and managing Python source code. Dictionaries. Dictionary methods. Iteration and Recursion. Indexed loops. Conditional loops. Introduction to sorting. Sorting algorithms: sort by selection, sort by insert, bubble sort. Complexity of algorithms. Search and sorting. Efficient sorting methods: binary or dichotomous studies, merge sort, quicksort. Classic programming paradigms, the Numpy library for solving linear algebra problems, algorithms and methods based on specific examples in the main specialty. Numpy.linalg module. Methods for solving systems of linear equations. Databases: relational model, storage concept, indexing. An introduction to SQL queries and Web database applications.
11	Learning outcomes	Know programming in the Python language. Be able to create programs in Python, connect libraries for writing programs, edit and manage source code. Be proficient in the Python programming language

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Veterinary virology

1	Name of course	Python language and data analysis
2	Code of course	YaPAD 2239
3	Cycle of course	cycle of basic disciplines
4	Amount of credits	2
5	Level of preparation	Undergraduate studies
6	Department	Department of Microbiology and Biotechnology
7	Year	2
8	Prerequisites	Higher mathematics, ICT
9	Postrequisites	Course and diploma design, future professional activity
10	Course summary	Python Programming. An introduction to Numpy and SQL. Programming environment. Python programming language. The concept of the type and value of a variable, simple types. Expressions and instructions. Data structures: strings, lists, tables, files. Functions. Conditional statements. Cycles. Editing and managing Python source code. Dictionaries. Dictionary methods. Iteration and Recursion. Indexed loops. Conditional loops. Introduction to sorting. Sorting algorithms: sort by selection, sort by insert, bubble sort. Complexity of algorithms. Search and sorting. Efficient sorting methods: binary or dichotomous studies, merge sort, quicksort. Classic programming paradigms, the Numpy library for solving linear algebra problems, algorithms and methods based on specific examples in the main specialty. Numpy.linalg module. Methods for solving systems of linear equations. Databases: relational model, storage concept, indexing. An introduction to SQL queries and Web database applications.
11	Learning outcomes	Know programming in the Python language. Be able to create programs in Python, connect libraries for writing programs, edit and manage source code. Be proficient in the Python programming language

1	Name of course	Statistical analysis and data visualization
2	Code of course	SAVD 3231
3	Cycle of course	cycle of basic disciplines
4	Amount of credits	2
5	Level of preparation	Undergraduate studies
6	Department	Department of Microbiology and Biotechnology
7	Year	3
8	Prerequisites	Higher mathematics, ICT, Python language and data analysis
9	Postrequisites	Course and diploma design, future professional activity
10	Course summary	Data processing with Pandas and Cartopy. Introduction to R and Scilab. Working with databases using the Pandas data analysis library and the Cartopy package for data processing in the field of agriculture and bioresources. Pandas implements a number of operations on heterogeneous types and missing data. Cartopy is a Python package for processing geospatial data for mapping and analyzing geospatial data.
11	Learning outcomes	Know the basics of working with Pandas and Cartopy databases. Be able to use the Pandas and Cartopy libraries and the R and Python programming languages. Be proficient in the R programming language for statistical computing, a package for processing geospatial data and using Scilab for numerical analysis, as well as using these tools to solve specific problems in the field of agriculture and bioresources.

1	Name of course	Statistical analysis and data visualization
2	Code of course	SAVD 3240
3	Cycle of course	cycle of basic disciplines
4	Amount of credits	1
5	Level of preparation	Undergraduate studies
6	Department	Department of Microbiology and Biotechnology
7	Year	3
8	Prerequisites	Higher mathematics, ICT, Python language and data analysis
9	Postrequisites	Course and diploma design, future professional activity
10	Course summary	Data processing with Pandas and Cartopy. Introduction to R and Scilab. Working with databases using the Pandas data analysis library and the Cartopy package for data processing in the field of agriculture and bioresources. Pandas implements a number of operations on heterogeneous types and missing data. Cartopy is a Python package for processing geospatial data for mapping and analyzing geospatial data.
11	Learning outcomes	Know the basics of working with Pandas and Cartopy databases. Be able to use the Pandas and Cartopy libraries and the R and Python programming languages. Be proficient in the R programming language for statistical computing, a package for processing geospatial data and using Scilab for numerical analysis, as well as using these tools to solve specific problems in the field of agriculture and bioresources.

1	Name of course	Radiobiology

2	Code of course	Rad 2236
3	Cycle of course	cycle of basic disciplines
4	Amount of credits	5
5	Level of preparation	Undergraduate studies
6	Department	Department of Microbiology and Biotechnology
7	Year	2
8	Prerequisites	Biophysics, biochemistry, human and animal physiology
9	Postrequisites	Cell biology, biotechnology, human genetics, genomics
10	Course summary	Radiobiology studies the effect of ionizing radiation on biological objects (biomolecules, cells, tissues, organisms, populations). The methods of protecting the body from the effects of radiation, ways of recovery from damage based on the general laws of the biological response to ionizing effects are considered.
11	Learning outcomes	As a result of mastering the discipline, the student must: Know and understand: (Descriptor A) - basic concepts of radiobiology; –the physical nature of the action of ionizing radiation; - mechanisms of biological action of ionizing radiation; - reactions of cells, tissues and organisms to the action of ionizing radiation; formation of distant radiation-induced effects; - mechanisms of development of radiation-induced carcinogenesis and hereditary effects; - features of the behavior of radionuclides in the surrounding environment; Be able and have an idea:(Descriptor B) - apply the acquired knowledge in practice, namely – - apply the acquired knowledge in practice; - plan and conduct radiobiological studies; - work with devices, equipment, as well as with biological objects when performing radiobiological studies; - to present the material in oral, written and graphic form for various contingents of listeners; Possess: Descriptor C, D, E) - skills of independent work with literary sources, skills of preparing reports and multimedia presentations; - skills of conducting scientific discussions; - have experience in the field of experimental radiobiological research

1	Name of course	Plants physiology
2	Code of course	FR 3235
3	Cycle of course	cycle of basic disciplines
4	Amount of credits	5

5	Level of preparation	Undergraduate studies
6	Department	Department of Microbiology and Biotechnology
7	Year	3
8	Prerequisites	School biology program
9	Postrequisites	Biochemistry, molecular genetics
10	Course summary	The value of water for the life of a plant. Osmotic water absorption. Plant cell as an osmotic system. Water current paths and motors. Root pressure. Crying plants. Guttation. Transpiration. Temporary, residual and long-term water deficit. Critical periods in plant ontogeny in relation to moisture in cereals and other plants. The essence and significance of photosynthesis. Types of carbon nutrition. Structural organization of photosynthesis. Chloroplast structure and formation. Chloroplast pigments and their optical properties. Methods for studying the chemistry of photosynthesis. Photosynthetic units and their composition. Light and dark phases of photosynthesis. Cyclic and non-cyclic photophosphorylation. Calvin cycle (C3 - carbon pathway in photosynthesis). Hatch-Slack cycle. Cooperation of the C3 and C4 pathways of photosynthesis. Acid metabolism (CAM) of bastards. Plant growth and development. Phytohormones. Mineral nutrition of plants. Adaptation of plants to unfavorable environmental conditions.
11	Learning outcomes	Know and understand: the basics of the physiology of plant life, the mechanisms that ensure the interaction of individual parts of the organism and the organism as a whole with the external environment; Be able to analyze and explain the mechanisms of physiological processes Possess: apply the obtained theoretical knowledge and skills in practical and research activities

1	Name of course	Human genetics
2	Code of course	GCh 4233
3	Cycle of course	cycle of basic disciplines
4	Amount of credits	6
5	Level of preparation	Undergraduate studies
6	Department	Department of Microbiology and Biotechnology
7	Year	4
8	Prerequisites	Biochemistry, general biology
9	Postrequisites	Molecular genetics

10	Course summary	The subject and tasks of human genetics. Regularities of inheritance and variability of traits in humans. Traits inherited with sex. Anthropogenetics and Medical Genetics. Genealogical, clinical and genealogical methods. The siblings method, the proband method. Criteria for autosomal dominant, autosomal recessive and sex-linked inheritance. Criteria for polygenic inheritance. Mutational variability. The relationship of human genetics with evolutionary theory. The genetics of embryonic development. Fundamentals of Population Genetics.
11	Learning outcomes	Know the basic laws of genetics, principles of heredity and variability, research methods in genetics. Be able to: apply the knowledge gained when solving problems. Possess methods for studying genetic inheritance and variability.

1	Name of course	Molecular genetics
2	Code of course	MG 4234
3	Cycle of course	cycle of basic disciplines
4	Amount of credits	8
5	Level of preparation	Undergraduate studies
6	Department	Department of Microbiology and Biotechnology
7	Year	4
8	Prerequisites	School biology program, inorganic and organic chemistry, biochemistry, physiology, morphology,
9	Postrequisites	Future professional activity
10	Course summary	Molecular genetics is a field of research at the intersection of molecular biology and classical genetics, which studies the chemical nature of the substance of heredity, the physicochemical prerequisites for storing information in a cell and accurately copying it for transmission over a number of generations. Molecular genetics employs a "research approach" to determine the structure and function of genes in an organism's genome, using genetic screening to link a gene sequence to a specific phenotype. Isolation of DNA and RNA; determination of the quantity and quality of nucleic acids in the sample by spectrophotometry and gel electrophoresis.

11	Learning outcomes	Know the differences in molecular genetic and cellular levels of life organization; structural and functional organization of hereditary material at the gene, chromosomal and genomic levels; basic principles of the application of molecular genetic methods in agriculture. To be able to apply research methods of molecular genetic processes to assess the factors of the formation of plant productivity and reproduction of animals; recognize normal and pathological karyotypes of plants and animals Possess the skills of working with the basic equipment of laboratories for molecular genetic research and know the principles of their work; isolate nucleic acids and study sequences.

1	Name of course	Microbiology and Virology
2	Code of course	MV 3232
3	Cycle of course	cycle of basic disciplines
4	Amount of credits	5
5	Level of preparation	Undergraduate studies
6	Department	Department of Microbiology and Biotechnology
7	Year	3
8	Prerequisites	School biology program,inorganic and organic chemistry, biochemistry.
9	Postrequisites	Molecular genetics, human genetics.Future professional activities
10	Course summary	Microbiology is the science of microorganisms, studies their systematics, structure, physiology, biochemistry, genetics and variability, distribution and role in nature, in human life, and also develops ways to control their vital activity, methods of their identification and recognition. Classification of microorganisms, the main signs of differentiation of prokaryotes, eukaryotes, viruses. Morphophysiological features of bacteria and viruses. Genetic apparatus of bacteria and viruses. Regularities of development and vital activity of all groups of microorganisms, as well as the role and importance of microbes in the processes of the circulation of substances in nature. The basic principles of the structure, reproduction of viruses, their interaction with the host cell, the origin and distribution of viruses in nature.
11	Learning outcomes	Know the principles of the cellular organization of bacteria; biophysical and biochemical processes occurring in a bacterial cell, the structure and cultural properties of viruses. Be able to: distinguish between membrane processes and molecular mechanisms of a bacterial cell Possess: the skills of preparing bacterial preparations, coloring preparations, as well as the skills of working with scientific literature.

1	Name of course	Methods of Mathematical Modeling
2	Code of course	MMM 3221
3	Cycle of course	cycle of basic disciplines
4	Amount of credits	2
5	Level of preparation	Undergraduate studies
6	Department	Department of Microbiology and Biotechnology
7	Year	3
8	Prerequisites	Higher mathematics, ICT
9	Postrequisites	Linear differential equations and Euclidean structures. Differential calculus of functions of several variables. Statistics.
10	Course summary	The discipline includes the following topics: power series, integration, application of power series to generalized functions, linear algebra, statistical methods, numerical algorithms in linear algebra, comparative analysis of methods. The course includes digital and practical applications: Euclidean structures and analysis of variance, partial differential equations and modeling. Linear differential equations of the second order. Structures on many decisions. Numerical methods of solution. The function of several variables. Differentiation and decomposition. Examples of partial differential equations. Functions of many variables: limits, continuity; properties of continuous functions; differential and partial derivatives of functions of many variables; partial derivatives of higher orders; extremum of the function of two variables. Examples of modeling problems in biology, agronomy, physics and chemistry
11	Learning outcomes	Know the basics of probability theory and mathematical statistics. To be able to apply in practice the foundations of probability theory, numerical, statistical, comparative methods for solving problems. Master the methods of mathematical statistics for data visualization and mathematical modeling in biology and agriculture

1	Name of course	Methods of Mathematical Modeling
2	Code of course	MMM 3242
3	Cycle of course	cycle of basic disciplines
4	Amount of credits	1
5	Level of preparation	Undergraduate studies
6	Department	Department of Microbiology and Biotechnology
7	Year	3
8	Prerequisites	Higher mathematics, ICT
9	Postrequisites	Linear differential equations and Euclidean structures. Differential calculus of functions of several variables. Statistics.
10	Course summary	The discipline includes the following topics: power series, integration, application of power series to generalized functions, linear algebra, statistical methods, numerical algorithms in linear algebra, comparative analysis of methods. The course includes digital and practical applications: Euclidean structures and analysis of variance, partial differential equations and modeling. Linear differential equations of the second order. Structures on many decisions. Numerical methods of solution. The function of several variables. Differentiation and decomposition. Examples of partial differential equations. Functions of many variables: limits, continuity; properties of continuous functions; differential and partial derivatives of functions of many variables; partial derivatives of higher orders; extremum of the function of two variables. Examples of modeling problems in biology, agronomy, physics and chemistry
11	Learning outcomes	Know the basics of probability theory and mathematical statistics. To be able to apply in practice the foundations of probability theory, numerical, statistical, comparative methods for solving problems. Master the methods of mathematical statistics for data visualization and mathematical modeling in biology and agriculture

1	Name of course	Methods of Mathematical Modeling
2	Code of course	MMM 3241
3	Cycle of course	Future professional activity
4	Amount of credits	2
5	Level of preparation	Undergraduate studies
6	Department	Department of Microbiology and Biotechnology
7	Year	3
8	Prerequisites	Higher mathematics, ICT
9	Postrequisites	Linear differential equations and Euclidean structures. Differential calculus of functions of several variables. Statistics.
10	Course summary	The discipline includes the following topics: power series, integration, application of power series to generalized functions, linear algebra, statistical methods, numerical algorithms in linear algebra, comparative analysis of methods. The course includes digital and practical applications: Euclidean structures and analysis of variance, partial differential equations and modeling. Linear differential equations of the second order. Structures on many decisions. Numerical methods of solution. The function of several variables. Differentiation and decomposition. Examples of partial differential equations. Functions of many variables: limits, continuity; properties of continuous functions; differential and partial derivatives of functions of many variables; partial derivatives of higher orders; extremum of the function of two variables. Examples of modeling problems in biology, agronomy, physics and chemistry
11	Learning outcomes	Know the basics of probability theory and mathematical statistics.To be able to apply in practice the foundations of probability theory, numerical, statistical, comparative methods for solving problems.Master the methods of mathematical statistics for data visualization and mathematical modeling in biology and agriculture

1	Name of course	Physical and chemical research methods
2	Code of course	FHMI 3226
3	Cycle of course	cycle of basic disciplines
4	Amount of credits	3
5	Level of preparation	Undergraduate studies
6	Department	Department of Microbiology and Biotechnology
7	Year	3
8	Prerequisites	Inorganic, organic, biochemistry
9	Postrequisites	Professional activity
10	Course summary	Classification of physical and chemical analysis methods. Electrochemical methods of analysis. General characteristics of the methods. The indicator electrode and the reference electrode. Equilibrium and non-equilibrium electrochemical systems. Electrogravimetric, conductometric, potentiometric, polarographic, coulometric methods. Chromatography in quantitative analysis. Classification of chromatographic methods. Ion exchange and sedimentary chromatography. Gas and liquid chromatography. Sensitivity and selectivity of physical and chemical analysis methods.
11	Learning outcomes	Know the physical and chemical methods of analysis, their theoretical foundations. To be able to apply in practice the methods of chromatography, as well as other methods for qualitative and quantitative analysis. To master in practice the methods of physical and chemical research for solving practical problems.

1	Name of course	Biophysics
2	Code of course	Bio 3227

3	Cycle of course	cycle of basic disciplines
4	Amount of credits	4
5	Level of preparation	Undergraduate studies
6	Department	Department of Microbiology and Biotechnology
7	Year	3
8	Prerequisites	School course in biology and chemistry
9	Postrequisites	Disciplines of magistracy. Professional activity
10	Course summary	The main regularities of biophysical phenomena, the laws of biophysics and biophysical properties of systems of biomolecules based on model concepts of biological systems. Kinetics of biological processes. Bioenergy. Thermodynamics of a biological system. Biological electrodynamics. Biomechanics. Biophysics of biological macromolecules. Physical properties, kinematics and dynamics of biological fluids. The theory of muscle contraction. Statistical and biological analysis of biological systems. General mechanical processes and mechanisms of energy processes. A brief history of the discovery and research of the phenomena of the bioelectric phenomenon. Direct and alternating currents in biological objects. Biological effects of electromagnetic fields. Photochemical reactions and photobiological processes. The influence of various physical factors on living organisms.
11	Learning outcomes	Know the theoretical foundations of biophysical phenomena; To be able to apply knowledge of thermodynamics and kinetics of biological processes in practice, for planning a scientific experiment. Master the basic methods of biophysical research of cells and vital systems of the body.