

AGREED
by General Director of the
RSE «Institute of Genetics and Physiology»



Zhanisova G.S.

«

2024

APPROVED
by Chairman of the Board - Rector
«International Information Technology
University» JSC



Khikmetov A.K.

«

2024

EDUCATIONAL PROGRAM

6B06114 “Biocomputing”

Code and classification of the field of education: 6B06 – Information and communication technologies

Code and classification of areas of training: 6B061 - Information and communication technologies

Group of educational programs: B057 – Information technologies

Level according to ISCE: 6

Level according to NQF: 6

Level according to SQF: 6

Duration of study: 4 years

Credits: 240

Almaty, 2024

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List of designations and abbreviations

BC	Basic Competence
BM	Basic Module
HE	Higher education
SCES	State Compulsory Educational Standard
EQF	European Qualifications Framework
ETF	European Training Foundation
KPS	knowledge, proficiencies, skills
NJC	National Job Classifier
NQF	National Qualifications Framework
NQS	National Qualifications System
GEM	General Educational Module
GM	General Module
EP	Educational Programme
GPM	General professional module
SQF	Sectoral Qualifications Framework
GEC	General Educational Competence
PS	Professional standard
PGE	Postgraduate education
PC	Professional Competences
PM	Professional Module
PG	Working group
RK	The Republic of Kazakhstan
SO	Study Outcome
SM	Special Module
QMS	Quality Management System
SEM	Socio-economic module
TPE	Technical and professional education
TPPE	Technical and professional education and post-secondary education
UNESCO	United Nations Educational, Scientific and Cultural Organization
Cedefop	European Centre for the Development of Vocational Training
DACUM	Developing Curriculum
ECVET	European Credit System for vocational education and training
EQAVET	European Quality Assurance in Vocational Education and Training
ENQA	European Association for Quality Assurance in Higher Education
ESG	Standards and Guidelines for Quality Assurance in the European Higher Education Area
FIBAA	International Agency for accreditation and examination of the quality of higher education
IQM-HE	Internal Quality Management in Higher Education
TACIS	Technical Assistance for the Commonwealth of Independent States
WSI	World Skills International

1. Description of the educational program

The educational program "Biocomputing" prepares elite highly motivated personnel for innovative and science-intensive sectors of the economy in the field of biology, who have theoretical and practical knowledge, skills and abilities necessary for their implementation in professional activities, meet the needs of the domestic and global intellectual labour market, and are ready to make a qualitative leap in biology and biotechnology. A specialist in biocomputing will use the tools of the software language in solving biological problems and perform data analysis, identify trends. Also, this educational program will allow you to improve programs for analysing genes and genomes, use other additional packages, such as Biopython, R, Bioconductor and Galaxy. The ability to interpret the results of a comprehensive analysis of biological processes, identify trends, and make a forecast is what a student of the educational program "Biocomputing" has in his baggage of knowledge.

Bioinformatics specialist also advises consumers on how to use its infrastructure components for research of biological objects and modernizing biotechnologies.

2. Objectives and tasks of the educational program

The objective of the educational program "Biocomputing" is to train elite highly motivated personnel for innovative and knowledge-intensive sectors of the economy in the field of biology, who have theoretical and practical knowledge, skills and abilities necessary for their implementation in professional activities, meet the needs of domestic and global intellectual labour markets, and are ready to make a qualitative leap in biology and biotechnology. The ultimate goal is to train a specialist in the field of biocomputing, to increase the efficiency of the industry and provide additional opportunities to consumers through the use of its technologies for processing, storing, exchanging and managing information.

The tasks of the educational program "Biocomputing" are:

- Getting students of good mathematical training.
- Getting students of good biological training.
- Formation of competences in various fields of programming and modern applied mathematics and computer science.
- Acquisition of the professional skills in solving applied and analytical problems in the field of biology with the use of modern tools and tools of information technology.
- Development of technological and infrastructure requirements for the system of analysis of biological objects, processes, and technologies.
- Training in work in the English-speaking environment, adaptation to the international education system

3. Requirements for the results of the development of the educational program

By the end of the educational program "Biocomputing", students will be able to:

- Argue the choice of basic standards, design principles and patterns, methods, tools and programming languages, including choosing methods and tools for constructing information protection systems of modern ICT;
- Apply mathematical models and methods of various processes;

- Create mathematical models using the methods of modern information technologies.
- To demonstrate sociability, initiative and psychological preparedness for work, including when working in a team and making management and technical decisions.
- Create and develop comprehensive software for biocomputing
- Have excellent programming skills.
- Be able to develop new algorithms.
- Apply machine learning and statistical modelling methods, select functions, and classify genetic data.
- Drug discovery modelling.
- Modelling of the protein-protein interaction.
- Work using biocomputing methods using Python or R languages.
- Develop and use biocomputing tools for protein modeling, sequence alignment, and quantification.

The following forms of exams are used as an assessment of learning results: computer testing, written exam (answers on sheets), oral exam, project (passing a course project), practical (open questions on a computer, solving problems on a computer, including in ACM format), complex (test/written/oral + others). According to Table 1 the following ratio of exam forms is recommended:

Table 1.

№	Examination form	Recommended percentage, %
1	Computer testing	20%
2	Written exam	10%
3	Oral exam	5%
4	Project	30%
5	Practical	30%
6	Complex	5%

The final certification ends with the defence of the diploma project.

4. Passport of the educational program

4.1 General Information

№	Field name	Note
1	Code and classification of the field of education	6B06 – Information and communication technologies
2	Code and classification of study areas	6B061 – Information and communication technologies
3	Educational programs group	057 – Information technologies
4	Наименование образовательной программы	«Biocomputing»
5	Brief description of the educational program	<p>The educational program "Biocomputing" prepares elite highly motivated personnel for innovative and science-intensive sectors of the economy in the field of biology, who have theoretical and practical knowledge, skills and abilities necessary for their implementation in professional activities, meet the needs of the domestic and global intellectual labour market, and are ready to make a qualitative leap in biology and biotechnology. A specialist in biocomputing will use the tools of the software language in solving biological problems and perform data analysis, identify trends. <i>Structure of EP:</i></p> <ul style="list-style-type: none"> • specialized knowledge in the field of biology. • data visualization. • Work with various programming languages, including R and Python; • Machine learning; • multivariate analysis and linear algebra. • Mathematical methods and computer modelling of the biological processes. • Bioengineering. • Bioinformatics. • Neurobiology. • Functional diagnostics.
6	Purpose of the EP	Training of elite highly motivated personnel for innovative and knowledge-intensive sectors of the economy in the field of biology, who have theoretical and practical knowledge, skills and abilities necessary for their implementation in professional activities, meet the needs of domestic and global intellectual labour markets and are ready to make a qualitative leap in biology and biotechnology.
7	Level according to ISCE	6
8	Level according to NQF	6
9	Level according to SQF	6
10	List of competences of the educational program:	

- GEC1: to know: social and ethical values based on public opinion, traditions, customs, social norms and focus on them in their professional activities; traditions and culture of the peoples of Kazakhstan; human and civil rights and freedoms; fundamentals of the legal system and legislation of Kazakhstan; social trends of society; fundamentals of physical culture and principles of a healthy lifestyle.
- GEC2: To have a well-formed national identity, civic unity, a sense of pride in their Fatherland, belonging to its history, which is the main core of Kazakhstan's patriotism.
- GEC3: Be able to independently analyse historical and modern sources in a comprehensive and critical manner, draw conclusions, and argue for them.
- GEC4: Have the ability to operate with special philosophical terminology and categorical and conceptual apparatus of philosophy.
- GEC5: Have communication skills in Kazakh and English, both in practice and in interpersonal communication. Have the skills and knowledge to translate, write scientific and technical documentation, prepare reports and other documentation.
- GEC6: Have the ability to translate scientific and technical documentation, prepare reports and other documentation; ability to interpersonal communication; be able to present projects, reports, essays in Kazakh, Russian and English.
- GEC7: Have basic knowledge and communication skills in areas related to the specialty "Biocomputing" in Kazakh and English in practical and research activities.
- BC1: Have the skills to use algorithms and programs for calculating the parameters of technological processes.
- BC2: Know the main directions of ICT development; the basics of using information resources for searching and storing information; the architecture and components of computer systems; the main goals and objectives of information security; the use of search engines and electronic resources for professional purposes.
- BC3: Ability to apply methods for solving differential and integral calculus of functions of several variables in applied problems; to be able to apply methods for solving differential equations in solving applied problems; to obtain approximate values of solutions using power series and Fourier series expansion with a given accuracy; to determine the optimal methods for solving practical problems.
- BC4: Know the methodological, regulatory and guidance materials related to the work performed; the main characteristics of natural and man-made environments.
- BC5: Be able to develop methodological and regulatory materials, technical documentation. As well as proposals and activities for the implementation of developed projects and programs.
- BC6: Have an understanding of the Python programming language for further work with genomic data.
- BC7: Have an understanding of scripting languages and methods for writing program code in them.
- BC8: Understand trends in data mining technologies, standards, and tools.
- BC9: Know: the main problems encountered in data analysis and ways to solve them; differences between Data Mining and classical statistical methods of analysis and OLAP systems; types of patterns and applications of Data Mining; types and methods of organizing data warehouses; classification of analytical systems; the composition of classes of software products that form a set of Business Intelligence.
- BC10: Ability to independently, comprehensively and critically analyze data in dynamics, taking into account ideological and methodological criteria for understanding the structure of genomics, proteomics and transcriptomics.
- BC11: Have an understanding of the principles, laws, structure, and relationships of processes and objects in organic and inorganic chemistry, General Chemistry, General Biology and Microbiology, biochemistry, and cell biology.

	<p>BC12: The ability to search for biomarkers to detect genetic diseases, including cancers, using computer technology (large-scale genetic and clinical biomarkers).</p> <p>PC1: Master the R programming language (statistical data analysis and plotting), as well as the python/pandas programming language and R packages for writing scripts necessary for the productive work of specialists in biocomputing, creating and maintaining a database and data analysis. Have the skills to develop new algorithms for solving problems in data analysis.</p> <p>PC2: Be able to create and develop complex software for biocomputing.</p> <p>PC3: Master the skills of molecular modelling; be able to apply the methods of machine learning and statistical modelling, sampling functions and classifications of genetic data, modelling of medicines (Drug discovery), and have the skills of modelling protein-protein interaction (Protein-protein interaction).</p> <p>PC4: Be able to develop new algorithms and write scripts in the R or Python programming languages for data processing and analysis and solve problems in data analysis.</p> <p>PC5: Ability to process large amounts of information.</p> <p>PC6: Ability to see the logical connection in the system of collected information; possession of advanced analytical tools.</p>	
11	<p>Learning outcomes of the educational program:</p> <p>SO1: Has an understanding of the principles and laws of the historical development of society, the historical periodization of Kazakhstan's history and place the history of Kazakhstan in world history and the history of Eurasia.</p> <p>SO 2: Can work in any operating system and with databases; apply methods and tools for information security; work with spreadsheets, perform data consolidation, and build charts.</p> <p>SO 3: Create mathematical models using modern information technology methods.</p> <p>SO 4: Able to describe the basic concepts of linear algebra and analytical geometry; the basic fundamental concepts of mathematical analysis; the theory of limits; the theory of continuous functions of one variable; the differential calculus of a function of one real variable.</p> <p>SO 5: Can use software language tools to solve biological problems and can perform data analysis and identify trends.</p> <p>SO 6: Has the skills to develop programs for analysing genes and genomes, using other additional packages such as Biopython, R, Bioconductor and Galaxy.</p> <p>SO 7: can interpret the results of complex analysis of biological processes, identify trends, and make forecasts.</p> <p>SO 8: Can explain the principles of regulating the functioning of living systems; use biological knowledge in professional activities.</p> <p>SO 9: is Able to find the necessary experimental and technological bases on which it is most effective and accurate to recreate the necessary properties of the bionic model.</p> <p>SO 10: Knows the basic laws of development and vital activity of the body based on the structural organization of cells, tissues and organs.</p> <p>SO 11: Knows the structural and functional organization of the human nervous system and model animals.</p> <p>SO 12: Has knowledge of the basic concepts of molecular biology; can adapt scientific knowledge and skills in molecular biology to the goals and objectives of chemical and biological education.</p> <p>SO 13: Can apply machine learning and statistical modelling methods to select functions and classify genetic data .</p>	
12	Mode of study	Full-time
13	Languages of study	English
14	Credits	240
15	Awarded academic degree	Bachelor of Information and Communication Technologies in the educational program «6B06114 – Biocomputing»

16	Developer(s) and authors:	JSC International Information Technology University, Department of Mathematical and computer modeling: <ul style="list-style-type: none"> - Uskenbayeva R.K., - Sharipov B.Zh., - Rysbaiuly B., - Ydyrys A.Zh. Institute of human and animal physiology: <ul style="list-style-type: none"> - Makashev E.K., - Tsitsurin V.I.
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4.2 The matrix of correlation of the learning outcomes of educational programs with competences formed

	SO 1	SO 2	SO 3	SO 4	SO 5	SO 6	SO 7	SO 8	SO 9	SO 10	SO 11	SO 12	SO 13
BC1			V	V		V							
BC 2		V			V								V
BC 3			V	V			V						
BC 4	V												
BC 5	V												
BC 6					V	V		V		V			V
BC 7			V		V						V		
BC 8					V	V	V		V				
BC 9							V						
BC 10						V			V		V	V	
BC 11										V	V	V	
BC 12						V			V			V	
PC1			V		V								
PC2					V	V							V
PC3													V
PC4		V			V					V	V	V	
PC5		V											
PC6				V		V							V

4.3 Information about the disciplines

№	Name of module / discipline	Brief description of discipline (30-50 words)	Number of credits	Formed competence (codes)	Prerequisites	Post requisites
Cycle of general educational disciplines						
University component / Optional component						
1.	Modern history of Kazakhstan	This course consists of studying the modern history of the country to understand the role and significance of current events in a historical context.	5	OK1, OK2	-	-
2.	Philosophy	This course consists of teaching philosophy to form a conscious attitude towards the environment	5	OK3, OK4	-	-
3.	Foreign language	This course consists of learning a foreign language in order to develop communication skills in a foreign language	10	OK5, OK6, OK7	-	
4.	Kazakh (Russian) language	This course consists of learning the Kazakh / Russian language to develop communication skills in the state and Russian languages.	10	OK5, OK6, OK7		
5.	Information and communication technologies	The course provides an overview in various areas of ICT, allowing students to gain basic knowledge of the use of modern ICT in their scientific and practical work, for self-study and other purposes	5	BC2		
6.	Political science	The course gives students knowledge about the political sphere of society, an idea of the relationship and interaction of politics and management	2	GEC1, GEC2		
7.	Sociology	This course consists of teaching sociology to understand society and social development.	2	GEC3		
8.	Psychology (of the Internet)	The course introduces various concepts, basic concepts, laws of management psychology	2	GEC3		
9.	Culturology	The course generates the necessary knowledge of culturology, develops an understanding of the originality of cultures of nations	2	GEC1		
10.	Physical culture	The course provides the solution to the main tasks of physical education students, provides for the delivery of control exercises and standards	8	GEC1		

11.	General Biology	The course includes knowledge about modern biological theory and concepts, the structure of biological objects, the essence of biological processes and phenomena, the basics of the structural organization and functioning of living systems, mechanisms for ensuring their homeostasis; features of manifestations of living at different levels of life organization;	5	GEC7	-	Molecular biology, Bionics
The cycle of basic disciplines University component						
12.	Mathematical Analysis	The purpose of the course is to acquaint students with important branches of calculus and its applications in computer science. During the learning process, students should be familiar with and be able to apply mathematical methods and tools to solve various applied problems. Moreover, they will study the fundamental methods of research of infinitely small variables using analysis, which is based on the theory of differential and integral calculations.	6	BC3	-	Differential Equations
13.	Bionics	The course will help you find the necessary experimental and technological bases on which you can most effectively and accurately recreate the necessary properties of the bionic model. The course consists of theoretical knowledge and practical experience of informal, "blurred" modeling of complex systems, which is of General scientific significance not only in biology and medicine, but also in solving important problems of optimal control, in a number of related natural Sciences, economic problems, problems of designing multi-stage branched communication systems, etc. the course will help to find the necessary experimental and technological bases, on which the necessary properties of the bionic model can be recreated more effectively and accurately. The course consists of theoretical knowledge and practical experience of informal, "blurred" modeling of	5	BC11, BC12	General Biology, Basics of bionics	Bioengineering with the basics of biophysics

		complex systems, which is of General scientific significance not only in biology and medicine, but also in solving important problems of optimal control, in a number of related natural Sciences, economic problems, problems of designing multi-stage branched communication systems, etc.				
14.	Mathematical methods and computer modelling of biological processes	The course will teach students how to apply machine learning and statistical modeling methods, function sampling, and classification of genetic data.	5	PC3, BC12, BC10	General Biology	Functional diagnostics
15.	Linear algebra and geometry	The course includes: Matrix theory, systems of linear equations, vector theory, analytical geometry, limit and differentiation of functions of one variable.	4	BC3	-	Numerical methods 1
16.	Differential equations	The course classifies differential equations and applies the necessary methods to solve these equations; teaches to solve linear differential equations of order n and systems of linear equations with constant coefficients; find the quiescent points of the autonomous system; solve boundary value problems for a linear homogeneous equation with constant coefficients; and use the mathematical apparatus for mastering the theoretical foundations and practical use of physical methods.	6	BC3	Mathematical analysis	DoC according CED
17.	Object-oriented programming	The course includes: Encapsulation, inheritance, polymorphism. Creating classes Create useful client applets and stand-alone applications based on actual requirements students receive from real customers or employers	6	BC7, BC1	Introduction to programming languages	Algorithms and data structure
18.	Numerical methods 1	The course includes: Fundamentals of the theory of errors, Systems of linear algebraic equations, Nonlinear equations and systems of nonlinear equations. Interpolation and best approximations. Differentiation and integration of	6	BC1, BC8, BC9	Linear algebra and geo	Numerical methods 2

		functions, Ordinary differential equations, Equations mathematical physics.			metry	
19.	Physics	The course covers such topics as: Kinematics; dynamics; circular motion and gravity; energy; pulse; simple harmonic oscillations; torque and rotational movement; electric charge and electric power; DC circuits; thermodynamics and mechanical waves, field and potential; electrical circuits; induction of magnetism and electromagnetism; geometrical and physical optics; and quantum, atomic and nuclear physics and sound	4	BC3	-	-
20.	Algorithms and Data Structures	The course is designed to study algorithms and development programs for solving various problems. To do this, the software structure, the principles for constructing algorithms and programs, methods for solving, algorithms, programming, debugging and implementing programs using a programming language are considered	6	BC1, BC7, BC9	Object-Oriented Programming	DoC according CED
21.	Introduction to programming languages	The course is intended for the formation of professional and educational competencies of future specialists in the field of computer security through familiarization with the general principles of construction and use of programming languages, as well as the development of design skills and implementation of practical algorithms tasks in the programming language, the use of assembly languages in modern computers.	6	BC7, BC9	-	Object-oriented programming
22.	Educational placement	The practice includes detailing the finishing blocks of a generalized scheme, select the necessary classes and methods, define sets of logically related data (data streams), introduce various additional tools to ensure visibility and enhance the service level of the projected program; develop a generalized algorithm scheme; develop and debug a program that implements the designed model	2	BC11	-	-

Cycle of basic disciplines Optional component						
23.	Numerical methods 2	The course covers the following sections: Basic problems of mathematical physics. Difference schemes for parabolic equations. Difference schemes for hyperbolic equations. Difference schemes for elliptic equations. Variational and variational-difference methods. Iterative and variational methods for solving nonlinear problems in mathematical physics. Monte Carlo Methods.	6	BC1, BC8, BC9	Numerical methods 1	DoC according CED
24.	Professional Kazakh (Russian) language	The course is dedicated to enhancing and deepening the knowledge and skills of the scientific Kazakh (Russian) language style, the formation of professional language competence	2	GEC5, GEC6, GEC7		
25.	Professionally-oriented foreign language	The course is dedicated to the analysis of professional topics: "Computers and Work", "Work in ICT", "Types of Computer Systems", "Basics of Computer Work", "Operating Systems and Graphic Interface", "Text Processing", "Cyberspace: security and crime", etc	4	GEC5, GEC6, GEC7		
26.	Probability Theory and Mathematical Statistics	The course is devoted to probability, as well as the relationship between mathematics and modeling, operating systems in an interdisciplinary training program, covering the section of mathematical analysis. Also the course is devoted to the statistics of any events, as well as the relationship between mathematics and modeling, operating systems in an interdisciplinary training program, covering the section of modern statistical methods and economic theory	6	BC3, BC8, BC12	-	DoC according CED
27.	Discrete mathematics and mathematical logic	Discrete mathematics is a part of mathematics devoted to the study of discrete objects (here discrete means, consisting of separate or unrelated elements). More generally, discrete mathematics is used whenever objects are counted, when relations between finite (or countable) sets are studied, and	6	BC3, BC8, BC12	-	DoC according CED

		when processes involving a finite number of steps are analyzed. The main reason for the growing importance of discrete mathematics is that information is stored and processed by computers in a discrete way.				
28.	Data analysis and visualization in Power BI	<p>An analyst is a specialist who studies and models a specific area. Power BI is an Analytics system that combines data from various information sources, converts it, and presents it in a visual form that is convenient for analysis. BI technologies allow you to process large unstructured amounts of data for decision-making.</p> <p>Power BI is a Suite of Microsoft software services that work together to turn unrelated company data sources into complete interactive reports.</p> <p>In this case, the source can be databases, Excel files, data from cloud sources and the Internet, text files, and so on. This tool helps you monitor the situation and get immediate answers to questions using detailed information panels available on each device.</p>	3	BC9	ICT	-
29.	3D Modeling and Design	The purpose of the course is to master the theoretical foundations and methods of computer 3D modeling used in mechanical engineering, to acquire skills in solving problems of designing cars and tractors with the use of applied programs for modeling and calculating mechanisms and components that allow solving applied problems both in the sphere of their professional activity and in carrying out course and practical work in following learning	7	PC2	-	-
30.	Programming on Python	The goal of the course is to develop programming skills in the Python language. As a result of mastering the discipline, the student must: know the basic constructs and idioms of the Python programming language and be able to put together in practice an uncomplicated program to perform the stated analytical task. Have skills in	3	BC6	-	MA chin e learn ing 1

		formalization and solving practical programming problems				
31.	Theory of Databases	The course explains what a database system is, and then proceeds to most of the training material for learning relational database systems - databases designed according to a relational (or tabular) model. Then the course moves from data abstraction to transaction management with additional materials to improve query performance. Finally, there are current trends in database system design that also define recent developments in the broader history of data storage technologies.	5	BC9	-	DoC according CED
32.	Machine learning 1	The course introduces students to the theoretical foundations and algorithms of machine learning, their possible practical implementations and applications in solving real problems. In this course, students should get an idea of the problems solved with the help of the theory in question, and the principles of constructing some of the main classifiers.	5	BC9, BC12	Programming on Python	Machine learning 2
33.	Functional diagnostics	Using methods of functional diagnostics, the state of other systems of the human body (digestive, endocrine, and hematopoietic organs) is also studied. The course describes the concepts of norm in healthy individuals and pathology in patients, as well as the results of research in the form of a functional diagnosis. The course contains a list of all methods of functional diagnostics, as well as a draft of approximate recommended standards of working time for individual groups of functional diagnostics studies.	5	BC10, BC11, BC12	-	-
Cycle of major University component						
34.	Industrial placement	The practice includes the study of the organizational structure and the complex of technical means of the information and analytical center (IAC) of the organization. Identification of the main tasks solved by the IAC. Study of the	4	PC6	-	-

		information support of the selected task (complex of tasks or subsystem). Studying the software of the selected task (complex of tasks or subsystem). Study of the software of the selected task (complex of tasks or subsystem). The study of the organizational and legal support of the selected task (a set of tasks or a subsystem). systematization and analysis of factual materials required for writing a term paper, a scientific report and a report on practical training				
35.	Industrial placement	The practice includes the study of the organizational structure and the complex of technical means of the information and analytical center (IAC) of the organization. Identification of the main tasks solved by the IAC. Study of the information support of the selected task (complex of tasks or subsystem). Studying the software of the selected task (complex of tasks or subsystem). Study of the software of the selected task (complex of tasks or subsystem). The study of the organizational and legal support of the selected task (a set of tasks or a subsystem). systematization and analysis of factual materials required for writing a term paper, a scientific report and a report on practical training	8	PC6	-	-
36.	Pre-diploma placement	The practice includes the consolidation of theoretical knowledge of the disciplines of the specialty; mastering practical skills, technology work in the specialty directly in the workplace using a PC, modern software and modern office equipment; the study and analysis of the real situation in the statics and dynamics of CAD in the short and long term with respect to the company - the base of internship; evaluation of the achieved commercial results of automation implementation in the	5	PC6	-	-

		short and long term, in relation to these specific enterprises; familiarity with the technology and technology of CAD development, procedures for making and implementing automation solutions at specific enterprises; collecting material for the graduation projects				
Cycle of major Component of choice						
37.	Machine learning 2	The purpose of this course is to learn the basics of machine learning theory, including discriminant, cluster and regression analysis, and to master the skills of practical solutions to data mining problems.	6	PC1, PC4, PC5	Mac hine learn ing 1	-
38.	Research methodology	The course is devoted to the study of activities aimed at developing students' ability to make independent theoretical and practical judgments and conclusions, the ability to objectively evaluate scientific information, freedom of scientific search and the desire to apply scientific knowledge in educational activities, including for the implementation of a diploma project (work).	2	BC4, BC5	-	-
39.	Molecular biology	The course contains a system of knowledge about the basic concepts of molecular biology; adapted scientific knowledge and skills in molecular biology to the goals and objectives of school chemical and biological education; as well as an understanding of information macromolecules and material carriers of life.	5	PC3, PC1	Gen eral Biol ogy	Neur obio logy
40.	Discipline of choice №3 (according CED)	Students are given a choice of elective courses.	5	BC10, BC11		
41.	Normal physiology	The course contains the basic laws of development and vital activity of the body based on the structural organization of cells, tissues and organs. Students will learn how to evaluate the parameters of the body's systems, as well as use educational, scientific, popular science literature, and the Internet to obtain up-to-date information on	4	PC3, PC6	-	-

		normal physiology for professional activities. As a result, they will have basic information conversion technologies: text, table editors, and Internet search.				
42.	Bioengineering with the basics of Biophysics	This course is designed to prepare students for the OP of Biocomputing. The course contains sections of Biophysics, genetics, and cell technologies. The course also includes work with human and animal stem cells using the latest cultural technologies, as well as the creation and reconstruction of new organs and tissues. The basic principles of bioengineering of damaged structures, including heart, nerve, bone and other tissues, are shown.	5	PC4	Bionics	-
43.	Neurobiology	The course will teach you to navigate in the relevant scientific literature. The student will get practical skills based on software modeling; learn the structural and functional organization of the human nervous system and model animals; ion mechanisms that mediate electrical signals of cells and synaptic signal transmission; localization of the receptor apparatus and biological effects of the main neurotransmitter systems of the body.	4	PC2	Molecular biology	-
44.	Basics of bioinformatics	The course will teach you how to work with a variety of data produced using new genomic sequencing technologies, their features, and ways to use them in solving both research and practical problems.	4	PC3	-	Bionics
45.	Discipline of choice №1 (according CED)	Students are given a choice of elective courses.	6	PC2, PC4		
46.	Discipline of choice №2 (according CED)	Students are given a choice of elective courses.	6	PC2, PC4		

4.4. List of modules and learning outcomes

Name of the educational program: «Biocomputing»

Qualification: Bachelor of Information and Communication Technologies in the educational program «6B06114 – Biocomputing»

Code of module/Module's name	Labour intensity of the module in credits	Learning outcomes	Criteria for evaluating learning outcomes	Disciplines that form the module Code / Name
GENERAL EDUCATION MODULES				
GEM01 Module of sociology and ethics	5	Have an understanding of the principles and laws of historical development of society, the historical periodization of Kazakhstan's history and place the history of Kazakhstan in world history and the history of Eurasia Able to independently comprehensively and critically analyze historical and modern sources, draw conclusions, argue them.	Oral interview, testing, report, boundary control, term papers	Modern history of Kazakhstan
	5	Has an idea of the subject, functions, main sections and directions of philosophy; the place and role of philosophy in the life of society and man; the main stages of development of world and Kazakh philosophical thought. Able to operate with special philosophical terminology and categorical and conceptual apparatus of philosophy; - creatively and critically work on original philosophical texts; - logically present their thoughts on the studied philosophical issues; - analyze the features of the Genesis and development of philosophical knowledge; - to form and argumentatively defend their own worldview.	Oral interview, testing, report, boundary control, term papers	Philosophy
	2	Has an understanding of the subject, functions, main sections and directions of sociology; consists in presenting key approaches in the sociology of organizations both at the level of theoretical concepts and models, and at the level of empirical research; in introducing students to the basic methods and techniques of research organizations Able to:	Oral interview, testing, report, boundary control, term papers	Sociology

		<p>– be able to navigate various sociological approaches to the analysis of organizations and literature on each approach;</p> <p>- get skills in critical analysis of these approaches (understand their advantages and limitations);</p> <p>- get basic analytical skills of sociological research of organizations;</p> <p>- have an understanding of the key research methods of organizations and their limitations.</p>		
2		<p>Have an idea of the subject, functions, main sections, must understand the basic concepts of politics and political science, the formation of the main political theories and concepts, to learn the contribution that various thinkers have made to the conceptual understanding of the most important problems of politics and society, the state and government</p> <p>Able to know the basics of scientific policy analysis at both theoretical and applied levels, the possibilities of political analysis and forecasting methods for making optimal management decisions.</p> <p>Apply theoretical knowledge in real political practice at the level of analysis, expertise, consulting, management;</p>	<p>Oral interview, testing, report, boundary control, term papers</p>	<p>Political science</p>
2		<p>Have an understanding of the subject, functions, main sections and directions of psychology; the place and role of psychology in society and human life;</p> <p>* Formation of fundamental knowledge, skills and competencies required in professional activities;</p> <p>* formation of environmental, physical, ethical, legal and thinking culture;</p> <p>* language training;</p> <p>* formation of universal and social and personal values;</p>	<p>Oral interview, testing, report, boundary control, term papers</p>	<p>Psychology</p>
2		<p>Have an idea of the subject of logically completed elements of the content of the discipline, provides a basis for determining the course topics to be submitted for verification. Structuring the content of this discipline is also a prerequisite for the functioning of the rating system. In addition, such structuring helps the student to form a General idea of the development of world culture and systematize their knowledge.</p> <p>Able to give students an idea of the main problems of cultural theory; identify objective patterns of world and national cultural processes;</p>	<p>Oral interview, testing, report, boundary control, term papers</p>	<p>Culturology</p>

GEM02 Language training	10	to find out the Genesis, functioning and development of culture as a specifically human way of life, which reveals itself historically as a process of cultural inheritance; consider the cultural aspects of various areas of public life; identify the features of cultural life in different regions of the world, historical epochs, cultural and historical types;	Oral interview, testing, report, boundary control, term papers	Foreign Language	
		Able to characterize-basic reading rules; word-formation models; contextual meanings of polysemous words; terms and lexical constructions of the sublanguage corresponding to the profile of the studied specialty; the most frequent specific grammatical phenomena. Understand statements in a foreign language features of the compositional and semantic organization of a scientific text; basic techniques for extracting the main information of the microtext.			
		10			Identify the language forms of expression of various types of information in a scientific text for solving problems of educational and professional communication; principles of writing texts of the main educational and scientific, scientific and professional genres.
		2			Identify the language forms of expression of various types of information in a scientific text for solving problems of educational and professional communication; principles of writing texts of the main educational and scientific, scientific and professional genres
		4			Able to characterize-basic reading rules; word-formation models; contextual meanings of polysemous words; terms and lexical constructions of the sublanguage corresponding to the profile of the studied specialty; the most frequent specific grammatical phenomena. Understand statements in a foreign language features of the compositional and semantic organization of a scientific text; basic techniques for extracting the main information of the microtext.
OOM03 Module of information technologies in science and industry	5	Know: – main directions of ICT development; – basics of using information resources for searching and storing information; – architecture and components of computer systems; – the main goals and objectives of information security.	Oral interview, testing, report, milestone	ICT	

		Can work in any operating system and with databases; apply methods and tools for information protection; work with spreadsheets, perform data consolidation, and build charts. Have the following skills: – processing of vector and bitmap images; – create multimedia presentations; – data visualization; – use of various forms of e-learning to expand professional knowledge; – working with e-technology cloud services.	control, calculation and graphic works	
	2	Have the ability to make independent theoretical and practical judgments and conclusions. Be able to objectively evaluate scientific information, freedom of scientific search and the desire to apply scientific knowledge in educational activities, including for the implementation of a diploma project (work).	Oral interview, testing, report, milestone control, calculation and graphic works	Research methodology
GEM04 A module of physical training	8	Knows the main tasks of physical education of students, Can pass control exercises and standards.	Offset	Physical Culture
BASIC MODULES				
BM01 Physics-Mathematical Module	6	Able to describe the basic concepts of linear algebra and analytical geometry; the basic fundamental concepts of mathematical analysis; the theory of limits; the theory of continuous functions of one variable; the differential calculus of a function of one real variable.	Oral interview, testing, report, milestone control, calculation and graphic works	Mathematical analysis
	4	Able to apply methods for solving differential and integral calculus of functions of several variables in applied problems; apply methods for solving differential equations in solving applied problems; obtain approximate values of solutions using power series and Fourier series expansion with a given accuracy; determine the optimal methods for solving practical problems.	Oral interview, testing, report, milestone control, calculation and graphic works	Linear algebra and geometry
	6	Know: probabilistic and statistical methods in science; basic concepts of mathematical statistics; basic methods for constructing estimates;	Oral interview, testing,	Discrete mathematics and mathematical logic

	methods for constructing confidence intervals; methods for building and testing statistical hypotheses.	report, milestone control, calculation and graphic works	Theory of Probability and Mathematical Statistics
6	<p>Know: basic principles, methods and results of modern probability theory and mathematical statistics.</p> <p>Be able to: calculate probabilities of random events and probabilistic characteristics</p> <p>process statistical data; construct adequate probability-theoretic and statistical data</p> <p>models of real processes and phenomena, carry out their mathematical analysis; evaluate the quality of obtained solutions to applied problems.</p> <p>Possess: methods of classical probability theory; skill in mathematical formalization of applied problems, analysis and interpretation of solutions of the corresponding mathematical models.</p> <p>al analysis; assessment of the quality of the obtained solutions to applied problems.</p> <p>Possess: methods of classical probability theory; skills of mathematical formalization of applied problems, analysis and interpretation of solutions of the corresponding mathematical models.</p>	Oral interview, testing, report, milestone control, calculation and graphic works	
6	<p>Know: basic concepts of the theory of differential equations, types and standard forms of writing basic differential equations, methods for solving basic differential equations.</p> <p>Be able to: apply differential equations for modeling physical processes, use differential equation tools for processing, analyzing and systematizing information on the research topic, and use mathematical literature if necessary.</p>	Oral interview, testing, report, milestone control, calculation and graphic works	Differential equations
4	<p>Knows and understands kinematics; dynamics; circular motion and gravity; energy; momentum; simple harmonic vibrations; torque and rotational motion; electric charge and electric force; DC Circuits; thermodynamics and mechanical waves, field and potential; electrical circuits; induction of magnetism and electromagnetism; geometric and physical optics; and quantum, atomic and nuclear physics and sound.</p>	Oral interview, testing, report, milestone control, calculation and graphic works	Physics

BM02 Module of mathematical modelling	6, 6	Knows and uses in modeling the Basics of error theory, systems of linear algebraic equations, Nonlinear equations and systems of nonlinear equations, Interpolation and best approximations, Differentiation and integration of functions, Ordinary differential equations, Equations of mathematical physics.	Oral interview, testing, report, milestone control, calculation and graphic works	Numerical methods 1, 2
BM03 Module of computer modelling	6	Know: organize the necessary data structures depending on the requirements of the task; Be able to: develop block diagrams of various algorithms; Have skills: develop programs in C ++ using the language tools.	Oral interview, testing, report, milestone control, calculation and graphic works	Introduction to programming
	6	Be able to develop sorting algorithms such as bubble sorting, merge sorting, quick sorting, etc Have the basics of OOP concepts, theory, methods and technologies of C ++, data structures and algorithms; application of algorithms and modern trends in technologies of a large company	Oral interview, testing, report, milestone control, calculation and graphic works	Object-oriented programming
	6	Able to know: basic algorithms to solve biological processes of different nature; Can use software language tools to solve biological problems and be able to perform data analysis and identify trends. Have skills in: implementing algorithms and data structures, as well as using programming language functions using modern software tools	Oral interview, testing, report, milestone control, calculation and graphic works	Algorithms and Data structures
	3	Know: Python programming language for working with genomic data; Unix operating system and commands for working in this environment; scripting languages and methods for writing program codes on them. Have the skills to develop programs for analysis of genes and genomes, using other additional packages such as Biopython, R, Bioconductor	Oral interview, testing, report, milestone control, calculation and graphic works	Programming on Python

	7	Have an understanding of: critical analysis and evaluation of modern scientific achievements, generating new ideas in solving research and practical problems, including in interdisciplinary fields.	Oral interview, testing, report, milestone control, calculation and graphic works	3D modelling and design
	5	Know: basic methods of numerical research of biological processes of various nature. Be able to: interpret the results of numerical analysis of biological data, identify trends, make forecasts; Own: implementations of numerical methods using modern software tools.	Oral interview, testing, report, milestone control, calculation and graphic works	Theory of databases
	5, 6	Know the basics of machine learning theory, including discriminant, cluster and regression analysis, and master the skills of practical solutions to data mining problems.	Oral interview, testing, report, milestone control, calculation and graphic works	Machine learning 1, 2
	3	Have an idea: about comparative analysis in genomics of ideological and methodological criteria for understanding the structural subsections of the new science-structural genomics, proteomics and transcriptomics.	Project, graphic works	Analysis and data visualization on Power BI
Professional module				
PM01 module of elective disciplines	6	Have professional skills	Oral interview, testing, report, boundary control, calculation and graphic works	Discipline of choice №1 of CED
	6			Discipline of choice №2 of CED
	5			Discipline of choice №3 of CED
PM02 Biological module	5	Know: modern biological theories and concepts, the structure of biological objects, the essence of biological processes and phenomena, the basics of the structural organization and functioning of living systems, mechanisms for ensuring their homeostasis; features of manifestations of living at different levels of life organization;	Oral interview, testing, report, milestone	General Biology

		<p>Can explain the principles of regulating the functioning of living systems; use biological knowledge in professional activities. Have skills: skills of working with a biological microscope; conducting research of biological objects, skills of independent search for biological information in various sources (educational texts, reference books, popular science)</p>	control, calculation and graphic works	
5		<p>It is able to find the necessary experimental and technological bases on which the necessary properties of the bionic model can be recreated more effectively and accurately. Have: theoretical knowledge and understanding that the accumulated practical experience in bionics of "informal," "blurred", modeling of complex systems, is of General scientific significance not only in biology and medicine, but also in solving important problems of optimal control, in a number of related natural Sciences, economic problems, problems of designing multi-stage branched communication systems, etc</p>	Bionics	
5		<p>Able to study the state of the human body systems (digestive, endocrine, hematopoietic organs). Know the norms in healthy individuals and pathology in patients, as well as the result of research in the form of a functional diagnosis. Know the list of all methods of functional diagnostics, as well as the draft of approximate recommended standards of working time for individual groups of functional diagnostics studies.</p>	Functional diagnostics	
4		<p>Be able to work with a variety of data produced using new genomic sequencing technologies, their features, and ways to use them in solving both research and practical problems.</p>	Basics of bioinformatics	
4		<p>Be able to: navigate the relevant scientific literature; Have: practical skills based on software modeling; Knows the structural and functional organization of the human nervous system and model animals. - ion mechanisms that mediate cell electrical signals and synaptic signal transmission; - localization of the receptor apparatus and biological effects of the main neurotransmitter systems of the body;</p>	Neurobiology	
4		<p>To know: the basic laws of development and life activity of the body based on the structural organization of cells, tissues and organs. Be able to: evaluate the parameters of the activity of the body's systems. Use educational, scientific, popular science literature, the Internet to</p>	Normal physiology	

		obtain up-to-date information on normal physiology for professional activities. To possess the basic technologies of transformation of information: text, tabular editors, search in the Internet. Know the algorithms and data structures used to analyze large data sets that are obtained using modern biotechnological methods. Can use machine learning and statistical modeling methods to select functions and classify genetic data.	5	Bioengineering with the basics of Biophysics Mathematical methods and computer modelling of biological processes Molecular biology
			5	
			5	
			5	
PM03 Module of placements	2	Have knowledge of the basic concepts of molecular biology; is able to adapt scientific knowledge and skills in molecular biology to the goals and objectives of chemical and biological education. Have an idea about information macromolecules and material carriers of life. Knows the organizational structure and complex of technical means of the information and analytical center (IAC) of the organization. Can identify the main tasks solved by the IAC. Knows the mathematical support for the selected task (set of tasks or subsystem) and software for the selected task (set of tasks or subsystem), organizational and legal support for the selected task (set of tasks or subsystem). systematization and analysis of actual materials required for writing a course paper, scientific report, and internship report.	4, 8	Educational placement Industrial placement Pre-diploma placement
			5	
			Report	

5. The curriculum of the educational program

№	Code of module	Code of discipline	Name of the discipline (rus)	Name of the discipline (Kaz)	Name of the discipline	Total credits	Semester	Control form	Total volume of study load	Number of classroom hours				SRO		Prerequisites	
										Total of classroom hours	Lectures	Laboratory	Practical	Whole SRO	SROP		
1		2	3	4	5	6	7	8	9	10	1	1	1	1	14	15	
1 GED																	
1.1 RC																	
1 General education disciplines (GED) - 56 credits																	
1.1 Required component - 51 credits																	
GED 1	GEM 01	SIK 1101	Современная история Казахстана	Қазақстанның қазіргі тарихы	Modern history of Kazakhstan	5	1	SEC	150	45	15		30	105	15		-
GED 2	GEM 01	FIL 3102	Философия	Философия	Philosophy	5	5	Exam	150	45	15		30	105	15		-
GED 3	GEM 02	IYa 1103	Иностраннный язык	Шет тілі	Foreign language	1	1,2	Exam	300	90			90	210	30		-
GED 4	GEM 02	K(R) Ya 1104	Казахский (русский) язык	Қазақ (орыс) тілі	Kazakh (Russian) language	1	1,2	Exam	300	90			90	210	30		-
GED 5	GEM 03	IKT 1105	Информационно-коммуникационные технологии	Ақпараттық-коммуникациялық технологиялар	Information and communication technology	5	1	Exam	150	45	15	30		105	15		-
GED 6	GEM 01	Pol 1106	Политология	Саясаттану	Political science	2	2	Exam	60	30	15		15	30	10		-

GED 7	GEM 01	Soc 1107	Социология	Элеуметтану	Sociology	2	2	Exam	60	30	15	15	30	10	-	
GED 8	GEM 01	Psy 2108	Психология (интернета)	Психология	Psychology	2	5	Exam	60	30	15	15	30	10	-	
GED 9	GEM 01	Kul 2109	Культурология	Мәдениеттану	Culturology	2	5	Exam	60	30	15	15	30	10	-	
GED 10	GEM 04	Fiz 1110, Fiz 2111	Физическая культура	Дене шынықтыру	Physical Culture	8	1,2, 3,4	Offset	240	0				40	-	
			Итого:			5	1		1530	555	10	5	30	42	975	185
			Вузовский компонент - 5 кредитов													
GED 11	PM0 2	OB 1112	Общая биология	Жалпы биология	Biology	5	3	Exam	150	45	15	30	105	15	-	
			Итого:			5			150	45	15	0	30	105	25	
2 BC			2 Basic disciplines (BD) - 112 credits													
2.1 RC			2.1 University component - 56 credits													
BD 1	Bm0 1	MA 1 201	Математический анализ	Математикалық талдау	Mathematical analysis	6	2	Written	180	60	30		30	120	15	-
BM 2	BM0 1	AG 1202	Алгебра и геометрия	Алгебра және геометрия	Algebra and geometry	4	1	Written	120	45	15		30	75	15	-
BD 3	BM0 1	Fiz 1203	Физика	Физика	Physics	4	2	Exam	120	45	15		30	75	15	-
BD 4	PM0 3	Bion 3204	Бионика	Бионика	Bionics	5	6	Written	150	45	15		30	105	15	OB 1112
BD 5	BM0 3	VVP 1205	Введение в программирование	Бағдарламауға кіріспе	Introduction to programming	6	1	Exam	180	60	15	30	15	120	15	-
BD 6	PM0 2	UP 1206	Учебная практика	Оқу практикасы	Educational practice	2	2	Report	60	30			30	30	10	-
BD 7	BM0 3	OOP 2207	Объектно-ориентированное программирование	Объекті-бағдарланған программалау	Object-oriented programming	6	3	Exam	180	60	15	30	15	120	15	VVP 1205

BD 8	BM03	ASD 2208	Алгоритмы и структуры данных	Алгоритмдер және деректер құрылымы	Algorithms and data structures	6	4	Exam	180	60	15	30	15	120	15	OOP 2107
BD 9	BM01	DU 2209	Дифференциальные уравнения	Дифференциалдық тендеулер	Differential Equations	6	5	Written	180	60	30	30	15	120	15	MA2 1204
BD 10	BM02	ChM1 2210	Численные методы I	Сандық әдістер I	Numerical methods I	6	4	Written	180	60	15	30	15	120	15	AiG 1202
BD 11	PM02	MMKMB P 3211	Математические методы и компьютерное моделирование биологических процессов	Биологиялық процестерді моделдеудің математикалық әдістері	Mathematical methods modeling of biological processes	5	7	Written	150	45	15	15	105	105	15	OB 1112
			Total:			5	6		1680	585	180	150	255	1095	160	
2.2 OC-BD			2.2 Optional component - 56 credits													
BD 12	BM01	TVMS 2212	Теория вероятности и математическая статистика	Ықтималдық теориясы және математикалық статистика	Probability Theory and Mathematical Statistics	6	3	Written	180	60	30		30	120	15	-
BD 13	BM01	DMML 2213	Дискретная математика и математическая логика	Дискретті математика және математикалық логика	Discrete Mathematics and Mathematical Logic	6	3	Written	180	60	30		30	120	15	-
BD 14	BM03	PnP 2214	Программирование на Python	Python бағдарламалау	Programming in Python	3	4	Exam	90	30	15	15		60	15	VVP 1205
BD 15	PM02	FD 4215	Функциональная диагностика	Функционалдық диагностика	Functional diagnostics	5	7	Written	150	45	15		30	105	15	-

BD 16	GEM 02	POIYa 2216	Профессионально-ориентированный иностранный язык	Кәсіби-бағытталған шет тілі	Professionally-oriented foreign language	4	3	Exam	120	45	45	75	15	-
BD 17	PM01	BDKV3 3217	Дисциплина по выбору №3 из КЭД	Тандау бойынша пән ЭПК №3	Discipline of choice №3 of CED	5	8	Exam	150	15	45	105	15	-
BD 18	GEM 02	PKYa 3218	Профессиональный казахский язык	Кәсіби қазақ тілі	Professional Kazakh language	2	7	Exam	60	30	30	30	10	-
BD 19	BM 03	3DMD 3219	3D Моделирование и дизайн	3D модельдеу және дизайн	3D Modeling and Design	7	5	Written	210	75	75	135	15	-
BD 20	BM 02	ChM2 3220	Численные методы 2	Сандық әдістер 2	Numerical methods 2	6	5	Written	180	15	60	120	15	ChM 1 2210
BD 21	BM 03	TBD 3230	Теория базы данных	Деректер қоры теориясы	Database theory	5	6	Written	150	45	45	105	15	-
BD 22	BM 03	MO1 3223	Машинное обучение 1	Машиналық оқыту 1	Machine Learning 1	5	7	Exam	150	45	45	105	15	PnP 2214
BD 23	BM 03	AVDPBI 3224	Анализ и визуализация данных в Power BI	Power BI деректерді талдау және визуализациялау	Data analysis and visualization in Power BI	3	6	Exam	90	30	30	60	15	IKT 1105
			Total:			55			1650	630	195	1025	180	
3 MD			3. Main disciplines (MD) - 60 кредита											
3.1 RC			3.1 University component - 13 credits											
MD 1	PM03	PP 2301	Производственная практика	Өндірістік практика	Internship	4	4	Report	120	0		120	15	-
MD 2	PM03	PP 3302	Производственная практика	Өндірістік практика	Internship	8	6	Report	240	0		240	15	-

MD 3	PM0 3	PP 4303	Преддипломная практика	Диплом алдындағы тәжірибе	Undergrad uate practice	5	8	Report	150	0	150	15	-	
			Total:			1	7		510	0	0	0	45	
3.2 OC- MD			3.2 Optional component – 47 credits											
OC 1	PM0 1	PDKV1 2304	Дисциплина по выбору №1 из КЭД	Тандау бойынша пән ЭПК №1	Discipline of choice №1 of CED	6	4	Write n	180	60	15	30	15	15
MD 2	PM0 1	PDKV2 3305	Дисциплина по выбору №2 из КЭД	Тандау бойынша пән ЭПК №2	Discipline of choice №2 of CED	6	5	Write n	180	60	15	30	15	15
MD3	PM0 3	MO2 4306	Машинное обучение 2	Машиналық оқыту 2	Machine Learning 2	6	8	Write n	180	60	15	30	15	15
MD 4	PM0 2	MB 3307	Молекулярная биология	Молекулалық биология	Molecular biology	5	6	Write n	150	45	15	15	15	15
MD 5	PM0 2	OBi 2309	Основы биоинформатики	Биоинформат ика негіздері	Basics of bioinformat ics	4	3	Write n	120	45	15	30	15	15
MD 6	PM0 2	Neibi 4310	Нейробиология	Нейробиологи я	Neurobiolo gy	4	7	Write n	120	45	15	30	15	15
MD 7	PM0 2	NF 4311	Нормальная физиология	Қалыпты физиология	Normal physiology	4	7	Write n	120	45	15	30	15	15
MD 8	PM0 2	BOB 4312	Биоинженерия с основами биофизики	Биофизика негізіндегі биоинженерия	Bioenginee ring with the basics of Biophysics	5	6	Write n	150	45	15	30	15	15
MD 10	OO M03	MI 4113	Методология исследования	Зерттеу әдістемесі	Research methodolo gy	2	7	Write n	60	30	15	15	15	10
			Total:			4	7							

6. Additional educational program (Minor)

Name of the additional educational program (Minor) with indicating the list of disciplines of that Minor	The total number of credits/ number of credit hours in the discipline	Semesters of education	Documents on the results of the development of additional educational programs (Minor)
Data Science:	18		
- Programming on Python	3	4	Transcript
- Machine learning 1	5	7	Transcript
- Machine learning 2	6	8	Transcript
- Analysis and data visualization on Power BI	3	6	Transcript