

APPROVED

By the Chairman of the Board, Rector of the  
ISC «International Information  
Technology University»

A.K. Khikmetov

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## EDUCATIONAL PROGRAM

### 6B06114 “Biocomputing”

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

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

Group of educational programs: 057 – Information technologies

Level according to MCKO: 6

Level according to NQF: 6

Level according to SQF: 6

Duration of study: 4 years

Credits: 240

Almaty, 2023

**Рецензия**  
на образовательную программу «6B06114 Биокomпьютинг»

Образовательная программа разработана в соответствии с государственным общеобязательным стандартом высшего и послевузовского образования по направлению подготовки «6B061 Информационно-коммуникационные технологии» (форма обучения очная), утвержденного приказом Министра образования и науки Республики Казахстан от 31 октября 2018 года № 604.

Программа содержит разделы, включая описание общей характеристики, цели, задачи, срок освоения и трудоемкость. Представлены планируемые результаты освоения образовательной программы, включающие базовые, профессиональные компетенции в соответствии с ГОСО высшего и послевузовского образования по соответствующим блокам базовой и вариативной частей. Уровни формирования указанных компетенций приведены в соответствии с рабочими программами дисциплин, практики, итоговой аттестации.

Образовательная программа составлена в логической последовательности освоения всех ее разделов. Вариативная часть представлена дисциплинами, перечень которых отражает запрос работодателей, учитывает развитие технологий, науки, создает возможность для удовлетворения профессионального и научно-познавательного интереса обучающихся.

Содержание рабочих программ дисциплин, практики, дисциплин вариативной части и порядок освоения в образовательной программе в полной мере обеспечивают уровень подготовки бакалавров. В качестве сильных сторон программы следует отметить, что к ее реализации привлекается опытный профессорско-преподавательский состав.

Представленная образовательная программа призвана подготовить молодых специалистов, обладающих современным научным подходом и знаниями в области молекулярной механики, геномики, биохимии, биофизики и физиологии. Будущие специалисты по Биокomпьютингу будут востребованы не только в научно-исследовательских и медицинских учреждениях Казахстана, но и за рубежом, так как наблюдается устойчивая тенденция к расширению рынка труда для специалистов по Биокomпьютингу, геномным базам данных, биомедицинским информационным системам и технологиям.

Таким образом, образовательная программа высшего образования «6B06114 Биокomпьютинг» соответствует требованиям Государственного общеобязательного стандарта высшего и послевузовского образования по направлению подготовки «6B061 Информационно-коммуникационные технологии». Она отражает комплексный и целевой подход для качественной подготовки кадров в бакалавриате по направлению подготовки 6B061 - Информационно-коммуникационные технологии.

Рецензент:

Главный научный сотрудник лаб. экологической физиологии человека и животных

РГП на ПХВ «Институт генетики и физиологии» ИИ МНВО РК

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## List of designations and abbreviations

CD	Cycle of core disciplines
CC	Core competency
BM	Basic module
UC	University component
HE	Higher education
NMS	National Mandatory Standards of Higher and Post-Graduate Education
ATT	Additional types of training
EQF	European qualifications framework
EFE	European foundation for education
KSA	Knowledge, Skills and Abilities
FA	Final attestation
OC	Optional component
ISCED	International Standard Classification of Education
NQF	National qualifications framework
NQS	National qualifications system
GHM	General humanitarian module
RC	Required component
GEM	General education module
GED	Cycle of general education disciplines
AP	Academic program
GPM	General professional module
SQF	Sectoral qualifications framework
GEC	General education competence
M	Cycle of majors
PI	Professional internship
PS	Professional standard
PE	Postgraduate education
PC	Professional competence
PM	Professional module
LO	Learning outcome
QMS	Quality Management System



## 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, etc. 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. Purpose and objectives of the educational program

*The goal* 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 objectives* 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:

- Be able to work in any operating system and with databases; apply methods and means of information protection; work with spreadsheets, consolidate data, build diagrams;
- Develop mathematical models using the methods of modern information technologies;

- 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; differential calculus of a function of one real variable;
- Use software language tools to solve biological problems, interpret the results of a comprehensive analysis of biological processes, perform data analysis, identify trends, and make a forecast;
- Have the skills to develop programs to analyze genes and genomes, using additional packages such as Biopython, R, Bioconductor, and Galaxy;
- Apply suitable data structures and develop appropriate algorithms for solving various computational problems;
- Be able to explain the principles of regulation of the functioning of living systems; use biological knowledge in professional activities;
- Be able to find the necessary experimental and technological foundations on which the necessary properties of the bionic model can be recreated most effectively and accurately;
- To know the basic laws of the development and vital activity of the body on the basis of the structural organization of cells, tissues and organs;
- To know the structural and functional organization of the nervous system of humans and model animals;
- Possess knowledge of the basic concepts of molecular biology; be able to adapt scientific knowledge and skills in molecular biology to the goals and objectives of chemical and biological education;
- Be able to apply machine learning and statistical modeling methods for sampling functions and classifying genetic data;
- Analyze modern sources, draw conclusions, argue them and make decisions based on the information;
- Apply various tools for software development, user interface, storage and data processing systems, build a 3D model of an object or process;

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.</p> <p><i>Structure of EP:</i></p> <ul style="list-style-type: none"> <li>• specialized knowledge in the field of biology.</li> <li>• data visualization.</li> <li>• Work with various programming languages, including R and Python;</li> <li>• Machine learning;</li> <li>• multivariate analysis and linear algebra.</li> <li>• Mathematical methods and computer modelling of the biological processes.</li> <li>• Bioinformatics.</li> <li>• Neurobiology.</li> <li>• Functional diagnostics.</li> </ul>
6	Purpose of the EP	<p>Training of elite highly motivated personnel for innovative and knowledge-intensive sectors of the economy in the field of biology, possessing the theoretical and practical knowledge, skills necessary for their implementation in professional activities that meet the needs of the domestic and world markets of intellectual labor, 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 IT technologies for processing, storage, exchange and management of information.</p>
7	Level according to ISCE	6



8	Level according to NQF	6
9	Level according to SQF	6
10	<p>List of competences of the educational program:</p> <p>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.</p> <p>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.</p> <p>GEC3: Be able to independently analyse historical and modern sources in a comprehensive and critical manner, draw conclusions, and argue for them.</p> <p>GEC4: Have the ability to operate with special philosophical terminology and categorical and conceptual apparatus of philosophy.</p> <p>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.</p> <p>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.</p> <p>GEC7: Have basic knowledge and communication skills in areas related to the specialty "Biocomputing" in Kazakh and English in practical and research activities.</p> <p>BC1: Have the skills to use algorithms and programs for calculating the parameters of technological processes.</p> <p>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.</p> <p>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.</p> <p>BC4: Know the methodological, regulatory and guidance materials related to the work performed; the main characteristics of natural and man-made environments.</p> <p>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.</p> <p>BC6: Have an understanding of the Python programming language for further work with genomic data.</p> <p>BC7: Have an understanding of scripting languages and methods for writing program code in them.</p> <p>BC8: Understand trends in data mining technologies, standards, and tools.</p> <p>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.</p> <p>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.</p>	



	<p>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> <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>LO 1: Be able to work in any operating system and with databases; apply methods and means of information protection; work with spreadsheets, consolidate data, build diagrams.</p> <p>LO 2: Develop mathematical models using the methods of modern information technologies.</p> <p>LO 3: 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; differential calculus of a function of one real variable.</p> <p>LO 4: Use software language tools to solve biological problems, interpret the results of a comprehensive analysis of biological processes, perform data analysis, identify trends, and make a forecast.</p> <p>LO 5: Have the skills to develop programs to analyze genes and genomes, using additional packages such as Biopython, R, Bioconductor, and Galaxy.</p> <p>LO 6: Apply suitable data structures and develop appropriate algorithms for solving various computational problems.</p> <p>LO 7: Be able to explain the principles of regulation of the functioning of living systems; use biological knowledge in professional activities.</p> <p>LO 8: Be able to find the necessary experimental and technological foundations on which the necessary properties of the bionic model can be recreated most effectively and accurately.</p> <p>LO 9: To know the basic laws of the development and vital activity of the body on the basis of the structural organization of cells, tissues and organs.</p> <p>LO 10: To know the structural and functional organization of the nervous system of humans and model animals.</p> <p>LO 11: Possess knowledge of the basic concepts of molecular biology; be able to adapt scientific knowledge and skills in molecular biology to the goals and objectives of chemical and biological education.</p> <p>LO 12: Be able to apply machine learning and statistical modeling methods for sampling functions and classifying genetic data.</p> <p>LO 13: Analyze modern sources, draw conclusions, argue them and make decisions based on the information.</p> <p>LO 14: Apply various tools for software development, user interface, storage and data processing systems, build a 3D model of an object or process;</p>

	LO 15: Be able to apply the acquired knowledge according to the selected additional educational program; LO 16: Demonstrate the ability to conduct interdisciplinary scientific research using basic knowledge from the fields of economics and law, ecology and life safety. Apply entrepreneurial qualities to the tasks of calculating the profitability of scientific projects. To build personal and interpersonal relationships in compliance with the anti-corruption culture.	
12	Mode of study	Full-time
13	Languages of study	English, Russian
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: Rysbaiuly B., Ydyrys A.Zh., Tokmukhametova F.K. Institute of Genetics and Physiology: Makashev Y.K.

#### 4.2 The matrix of correlation of the learning outcomes of educational programs with competences formed

	LO 1	LO 2	LO 3	LO 4	LO 5	LO 6	LO 7	LO 8	LO 9	LO 10	LO 11	LO 12	LO 13	LO 14	LO 15	LO 16
BC1		V	V		V	V						V				
BC 2	V			V		V		V								
BC 3		V	V	V												
BC 4															V	V
BC 5									V			V				
BC 6				V	V		V			V						
BC 7		V		V												
BC 8				V	V			V								
BC 9				V								V				
BC 10					V			V		V	V			V		
BC 11									V	V	V					
BC 12					V			V			V					
PC1		V		V								V				
PC2				V	V							V				
PC3									V	V	V					
PC4	V			V												
PC5	V											V	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 competences (codes)	Prerequisites	Postrequisites
Cycle of general educational disciplines University component / Optional component						



1.	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	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		
<b>Cycle of General subjects (CGS)</b>						
<b>The university component (UC) and (or) the Component of choice (CC)</b>						
11.	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
12.	Elective course #1 (CGS)		5			
	Economic theory	The course provides an overview of the principles and patterns of economic relations.		GC6 BC2		
	Startups and entrepreneurship	The course is designed to help students develop IT competencies, entrepreneurial skills, Teamwork, Business Skills and Softskills.		GC3		
	Fundamentals of law and anti-corruption culture	During the course, students will get acquainted with such concepts as anti-corruption consciousness and anti-corruption culture, acquire knowledge		GC1 GC3		

		about corruption as a phenomenon of modern reality and its historical roots. The discipline forms the acquisition of skills to work with legislation in the field of anti-corruption, and develops a civic attitude to this phenomenon.				
	Fundamentals safety of life activity and ecology	This discipline is a higher school that studies ways of safe human interaction with the environment (industrial, household, urban, natural), the sustainable functioning of business facilities (organizations) in emergency situations, issues of protection from negative factors, prevention and elimination of consequences of natural and man-made emergencies and the use of modern means of destruction.		GC3		
	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 completion of a thesis project (work).		GC3 BC5	-	-
<b>The cycle of basic disciplines University component</b>						
13.	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
14.	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 complex systems, which is of General scientific significance not only in biology and medicine, but also in solving	5	BC11, BC12	General Biology, Basics of bioinformatics	Bioengineering with the basics of biophysics



		important problems of optimal control, in a number of related natural Sciences, economic problems, problems of designing multi-stage branched communication systems, etc.				
15.	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
16.	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
17.	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.	5	BC3	Mathematical analysis	DoC according CED
18.	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	7	BC7, BC1	Introduction to programming languages	Algorithms and data structure
19.	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 functions, Ordinary differential equations, Equations mathematical physics.	4	BC1, BC8, BC9	Linear algebra and geometry	Numerical methods 2
20.	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	-	-
21.	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



22.	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
23.	Teaching practice	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	-	-
<b>Cycle of basic disciplines</b> <b>Optional component</b>						
24.	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.	4	BC1, BC8, BC9	Numerical methods 1	DoC according CED
25.	Business correspondence in the state 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		
26.	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		
27.	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
28.	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	6	BC3, BC8, BC12	-	DoC according CED

		countable) sets are studied, and 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.				
29.	Data analysis and visualization in Power BI	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. Power BI is a Suite of Microsoft software services that work together to turn unrelated company data sources into complete interactive reports. 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.	3	BC9	ICT	-
30.	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	-	-
31.	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 formalization and solving practical programming problems	4	BC6	-	MAc hine learni ng 1
32.	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	-	DoCa ccord ing CED
33.	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,	5	BC9, BC12	Progr ammi ng on Pytho n	Mach ine learni ng 2



		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.				
34.	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	-	-
<b>Cycle of major University component</b>						
35.	Industrial practice	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	4	PC6	-	-
36.	Industrial internship	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	-	-
37.	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	5	PC6	-	-



		achieved commercial results of automation implementation in the 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				
<b>Cycle of major Component of choice</b>						
38.	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.	5	PC1, PC4, PC5	Mach ine learni ng 1	-
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	Gener al Biolo gy	Neur obiol ogy
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 normal physiology for professional activities. As a result, they will have basic information conversion technologies: .text, table editors, and Internet search.	4	PC3, PC6	-	-
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	Bioni cs	-
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	Mole cular biolo gy	-

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		
47.	Minor 1	Students choose from a list of minors of other EP.	5	PC8		
48.	Minor 2		5	PC8		
49.	Minor 3		5	PC8		



#### 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
<b>GENERAL EDUCATION MODULES</b>				
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	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;          - get skills in critical analysis of these approaches (understand their advantages and limitations);          - get basic analytical skills of sociological research of organizations;          - 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          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.          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;          * Formation of fundamental knowledge, skills and competencies required in professional activities;          * formation of environmental, physical, ethical, legal and thinking culture;          * language training;          * 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.          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>



		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;		
GEM02 Language training	10	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.	Oral interview, testing, report, boundary control, term papers	Foreign Language
	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.	Oral interview, testing, report, boundary control, term papers	Kazakh (Russian) language
	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	Oral interview, testing, report, boundary control, term papers	Business correspondence in the state language
	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.	Oral interview, testing, report, boundary control, term papers	Professionally – oriented foreign language
	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
OOM03 Module of information technologies in science and industry				

		<p>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.</p> <p>Have the following skills:</p> <ul style="list-style-type: none"> <li>- processing of vector and bitmap images;</li> <li>- create multimedia presentations;</li> <li>- data visualization;</li> <li>- use of various forms of e-learning to expand professional knowledge;</li> <li>- working with e-technology cloud services.</li> </ul>	control, calculation and graphic works	
GEM04 A module of physical training	8	<p>Knows the main tasks of physical education of students,</p> <p>Can pass control exercises and standards.</p>	Offset	Physical Culture
	5	Have an idea of the principles and laws of economic relations.	Oral interview, testing, report, milestone control, calculation and graphic works	Fundamentals of economic theory
	5	<p>Have the ability to make independent theoretical and practical judgments and conclusions.</p> <p>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).</p>	Oral interview, report, milestone control	Research methodology
	5	Have an understanding of the principles of law and anti-corruption culture	Oral interview, report, milestone control	Fundamentals of law and anti-corruption culture
	5	Have an idea of the principles and patterns of ecology and life safety	Oral interview, report, milestone control	Fundamentals safety of life activity and ecology
	5	Have an idea of IT competence, entrepreneurial skills	Oral interview, report, milestone control	Startups and entrepreneurship
<b>OOM05 Research and Entrepreneurship Module</b>				



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	Algebra and geometry
	6	Know: probabilistic and statistical methods in science; basic concepts of mathematical statistics; basic methods for constructing estimates; methods for constructing confidence intervals; methods for building and testing statistical hypotheses.	Oral interview, testing, report, milestone control, calculation and graphic works	Discrete mathematics and mathematical logic
	6	Know: basic principles, methods and results of modern probability theory and mathematical statistics. Be able to: calculate probabilities of random events and probabilistic characteristics process statistical data; construct adequate probability-theoretic and statistical data models of real processes and phenomena, carry out their mathematical analysis; evaluate the quality of obtained solutions to applied problems. Possess: methods of classical probability theory; skill in mathematical formalization of applied problems, analysis and interpretation of solutions of the corresponding mathematical models. al analysis; assessment of the quality of the obtained solutions to applied problems.	Oral interview, testing, report, milestone control, calculation and graphic works	Theory of Probability and Mathematical Statistics

			<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> <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>	<p>Oral interview, testing, report, milestone control, calculation and graphic works</p>	Differential equations
BM02 Module of mathematical modelling	6, 6		<p>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.</p>	<p>Oral interview, testing, report, milestone control, calculation and graphic works</p>	Numerical methods 1, 2
BM03 Computer simulation module	6		<p>Know: organize the necessary data structures depending on the requirements of the task;</p> <p>Be able to: develop block diagrams of various algorithms;</p> <p>Have skills: develop programs in C ++ using the language tools.</p>	<p>Oral interview, testing, report, milestone control, calculation and graphic works</p>	Introduction to programming
	6		<p>Be able to develop sorting algorithms such as bubble sorting, merge sorting, quick sorting, etc</p> <p>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</p>	<p>Oral interview, testing, report, milestone control</p>	Object-oriented programming
	6		<p>Able to know: basic algorithms to solve biological processes of different nature;</p> <p>Can use software language tools to solve biological problems and be able to perform data analysis and identify trends.</p>	<p>Oral interview, testing, report, milestone control, calculation and graphic works</p>	Algorithms and Data structures



	Have skills in: implementing algorithms and data structures, as well as using programming language functions using modern software tools		
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	Have professional skills	Oral interview, testing, report,	Discipline of choice №1 of CED

		Discipline of choice №2 of CED	Discipline of choice №3 of CED
PM02 Biological module	6	boundary control, calculation and graphic works	Biology
	5		
	5		<p>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;</p> <p>Can explain the principles of regulating the functioning of living systems; use biological knowledge in professional activities.</p> <p>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>
	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.</p> <p>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>
	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>
	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>
	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.</p>
			<p>Functional diagnostics</p>
			<p>Basics of bioinformatics</p>
			<p>Neurobiology</p>
			<p>Bionics</p>



	<p>- 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> <p>4</p> <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 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.</p> <p>5</p> <p>Know the algorithms and data structures used to analyze large data sets that are obtained using modern biotechnological methods.</p> <p>5</p> <p>Can use machine learning and statistical modeling methods to select functions and classify genetic data.</p> <p>5</p> <p>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.</p>		<p>Normal physiology</p> <p>Bioengineering with the basics of Biophysics</p> <p>Mathematical methods and computer modelling of biological processes</p> <p>Molecular biology</p>
PM03 Module of placements	<p>2</p> <p>4</p> <p>8</p> <p>5</p>	<p>Report</p>	<p>Educational placement</p> <p>Industrial practice</p> <p>Industrial internship</p> <p>Pre-diploma placement</p>

## 5. Curriculum of the educational program

№	Module code	Module name in three languages (kaz / rus / eng)	Discipline Code	Discipline name in three languages (kaz / rus / eng)	Cycles (GED, CD, M)	Components (RC, OC, UC)	Total number of credits (ECTS)	Total number of academic hours	Number of classroom hours				Number of SIS hours		Form of control (Midterm, End-of-term, examination, CP defense, differential test, DP defense)	Prerequisites (Discipline Code)	
									Total number of classroom hours	lectures	practical classes (sem.)	laboratory classes	Total number of SIS hours	Including TSIS			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
<b>1 year</b>																	
<b>I semester</b>																	
1	ООМ02	Тілдік дайындық / Языковая подготовка / Language training	LAN6001A	Шет тілі / Иностраный язык / Foreign language	CGS	RC	5	150	45	0	45	0	105	15	M, E, Exam	-	
2	ООМ03	Ақпараттық технологиялар модулі / Модуль информационных технологий / Information Technology Module	ICT6001	Ақпараттық-коммуникациялық технологиялар / Информационно-коммуникационные технологии / Information and Communication Technologies	CGS	RC	5	150	45	15	0	30	105	15	M, E, Exam	-	
3	БМ01	Физика - математикалық Модуль / Модуль Физико-математический / The Physics and Mathematics module	MAT6001	Алгебра және геометрия / Алгебра и геометрия / Algebra and Geometry	BD	UC	4	120	45	15	30	0	75	15	M, E, Exam	-	
4	БМ03	Компьютерлік модельдеу модулі / Модуль компьютерного моделирования / Computer simulation module	SFT6001	Бағдарламалауға кіріспе / Введение в программирование / Introduction to Programming	BD	UC	6	180	60	15	15	30	120	15	M, E, Exam	-	
5	БМ03	Компьютерлік модельдеу модулі / Модуль компьютерного моделирования / Computer simulation module	SFT6558	WEB технологиялары / WEB technology	BD	UC	6	180	60	15	15	30	120	15	M, E, Exam	-	
6	БМ01	Физика - математикалық Модуль / Модуль Физико-математический / The Physics and Mathematics module	MAT6509	Дискреттік математика және математикалық логика / Дискретная математика и математическая логика / Discrete Mathematics and Mathematical Logic	BD	CC	6	180	60	30	30	0	120	15	M, E, Exam	-	



		Total number for a 1 semester:													
		2 year													
		Тілдік дайындық / Языковая подготовка / Language training	Шет тілі / Иностранный язык / Foreign language	CGS	RC	32	960	315	90	13	90	645	90		
7	ООМ02	Модуль физическо-математической подготовки / Физика - математикалық модуль / The Physics and Mathematics module	LAN6002A	CGS	RC	5	150	45	0	45	0	105	15	M, E, Exam	-
8	ООМ04	Модуль физическо-математической подготовки / Физическая культура / Physical Culture	PHC6005	CGS	RC	4	120	45	0	45	0	75	15	M, E, dif.test	-
9	БМ01	Математикалық модуль / Математический анализ / Mathematical analysis	MAT6002	BD	UC	6	180	60	30	30	0	120	15	M, E, Exam	-
10	БМ03	Компьютерлік модельдеу модулі / Модуль компьютерного моделирования / Computer simulation module	SFT6519	BD	CC	7	210	75	0	75	0	135	15	M, E, Exam	-
11	ПМ03	Тәжірибе модулі / Модуль практик / The Practice module	PP6501	BD	UC	2	60	30	0	30	0	30	0	Dif.test	-
12	БМ03	Компьютерлік модельдеу модулі / Модуль компьютерного моделирования / Computer simulation module	SFT6516	BD	CC	4	120	45	15	0	30	75	15	M, E, Exam	-
		<b>Total number for a 2 semester:</b>				<b>28</b>	<b>840</b>	<b>300</b>	<b>45</b>	<b>22</b>	<b>30</b>	<b>540</b>	<b>75</b>		
		<b>TOTAL NUMBER FOR THE 1 YEAR:</b>				<b>60</b>	<b>180</b>	<b>615</b>	<b>13</b>	<b>36</b>	<b>12</b>	<b>118</b>	<b>165</b>		
							<b>0</b>		<b>5</b>	<b>0</b>	<b>0</b>	<b>5</b>			
		2 year													
		3 semester													
		Тілдік дайындық / Языковая подготовка / Language training	Қазақ (орыс) тілі / Казахский (русский) язык / Kazakh (Russian) language	CGS	RC	5 <th>150 <th>45 <th>0 <th>45 <th>0 <th>105 <th>15 <th>M, E, Exam</th> <th>- </th></th></th></th></th></th></th></th>	150 <th>45 <th>0 <th>45 <th>0 <th>105 <th>15 <th>M, E, Exam</th> <th>- </th></th></th></th></th></th></th>	45 <th>0 <th>45 <th>0 <th>105 <th>15 <th>M, E, Exam</th> <th>- </th></th></th></th></th></th>	0 <th>45 <th>0 <th>105 <th>15 <th>M, E, Exam</th> <th>- </th></th></th></th></th>	45 <th>0 <th>105 <th>15 <th>M, E, Exam</th> <th>- </th></th></th></th>	0 <th>105 <th>15 <th>M, E, Exam</th> <th>- </th></th></th>	105 <th>15 <th>M, E, Exam</th> <th>- </th></th>	15 <th>M, E, Exam</th> <th>- </th>	M, E, Exam	-
13	ООМ02	Модуль физическо-математической подготовки / Физическая культура / Physical Culture	LAN6001K	CGS	RC	5	150	45	0	45	0	105	15	M, E, Exam <td>-</td>	-
14	ООМ01	Әлеуметтану және этика / Социология и этики / Sociology and Ethics	HK6002	CGS	RC	5	150	45	15	30	0	105	15	M, E, Exam <td>-</td>	-
15	ООМ04	Модуль физическо-математической подготовки / Физическая культура / Physical Culture	PHC6006	CGS	RC	4	120	45	0	45	0	75	15	M, E, dif.test <td>-</td>	-
16	РМ02	Биологиялық модуль / Биологический модуль / Biological module	BIO6501	BD	UC	5	150	45	15	30	0	105	15	M, E, Exam <td>-</td>	-
17	БМ03	Компьютерлік модельдеу модулі / Модуль компьютерного моделирования / Computer simulation module	SFT6517	BD	UC	7	210	75	15	30	30	135	15	M, E, Exam <td>SFT 600 I</td>	SFT 600 I

18	БМ01	Физика - математикалық Модуль / Модуль Физико- математический / The Physics and Mathematics module	МАТ6531	Дифференциалдық теңдеулер / Дифференциальные уравнения / Differential Equations	BD	UC	5	150	45	15	30	0	105	15	M, E, Exam	MA T65 01							
<b>Total number for a 3 semester:</b>														<b>31</b>	<b>930</b>	<b>300</b>	<b>60</b>	<b>21</b>	<b>30</b>	<b>630</b>	<b>90</b>		
<b>4 semester</b>																							
19	ООМ02	Тілдік дайындық / Языковая подготовка / Language training	LAN6002K R	Қазақ (орыс) тілі / Казахский (русский) язык / Kazakh (Russian) language	CGS	RC	5	150	45	0	45	0	105	15	M, E, Exam	-							
20	ООМ01	Әлеуметтану және этика / Социологии и этики / Sociology and Ethics	SPS6003	Саясаттану / Политология / Political science	CGS	RC	2	60	30	15	15	0	30	15	M, E, Exam	-							
21	ООМ01	Әлеуметтану және этика / Социологии и этики / Sociology and Ethics	SPS6002	Әлеуметтану / Социология / Sociology	CGS	RC	2	60	30	15	15	0	30	15	M, E, Exam	-							
22	БМ03	Компьютерлік модельдеу модулі / Модуль компьютерного моделирования / Computer simulation module	SFT6501	Алгоритмдер және деректер құрылымы / Алгоритмы и структуры данных / Algorithms and data structures	BD	UC	6	180	60	15	15	30	120	15	M, E, Exam	SFT 651 7							
23	БМ02	Математикалық модельдеу модулі / Модуль математического моделирования / Module of mathematical modelling	МАТ6541	Сандық әдістер 1 / Численные методы 1 / Numerical methods 1	BD	UC	4	120	45	15	15	15	105	15	M, E, Exam	MA T65 31							
24	ПМ03	Тәжірибе модулі / Модуль практик / The Practice module	PP6502	Өндірістік практика / Производственная практика / Industrial practice	MD	UC	4	120	0	0	0	0	120	15	report	-							
25	БМ01	Физика - математикалық Модуль / Модуль Физико- математический / The Physics and Mathematics module	МАТ6004	Ықтималдықтар теориясы және математикалық статистика / Теория вероятностей и математическая статистика / Probability theory and mathematical statistics	BD	CC	6	180	60	30	30	0	120	15	M, E, Exam	MA T60 02							
<b>Total number for a 4 semester:</b>														<b>29</b>	<b>870</b>	<b>270</b>	<b>90</b>	<b>13</b>	<b>45</b>	<b>630</b>	<b>105</b>		
<b>TOTAL NUMBER FOR THE 2</b>														<b>с</b>	<b>180</b>	<b>570</b>	<b>15</b>	<b>34</b>	<b>75</b>	<b>126</b>	<b>195</b>		
<b>YEAR:</b>															<b>0</b>	<b>0</b>	<b>0</b>	<b>5</b>	<b>5</b>	<b>0</b>	<b>0</b>		
<b>3 year</b>																							
<b>5 semester</b>																							
26	ООМ01	Әлеуметтану және этика / Социологии и этики / Sociology and Ethics	SPS6005	Психология / Психология / Psychology	CGS	RC	2	60	30	15	15	0	30	15	M, E, Exam	-							
27	ООМ01	Әлеуметтану және этика / Социологии и этики / Sociology and Ethics	SPS6004	Мәдениеттану / Культурология / Cultural studies	CGS	RC	2	60	30	15	15	0	30	15	M, E, Exam	-							



28	ООМ02	Тідік дайындық / Языковая подготовка / Language training	LAN6002P A	Кәсіби бағытталған шет тілі / Профессионально-ориентированный иностранный язык / Professionally oriented foreign language	BD	CC	4	120	45	0	45	0	75	15	M, E, Exam	-
29	PM02	Биологиялық модуль / Биологический модуль / Biological module	BIO6502	Биоинформатика негіздері / Основы биоинформатики / Basics of bioinformatics	BD	CC	4	120	45	15	15	15	75	15	M, E, Exam	
30	БМ03	Компьютерлік модельдеу модулі / Модуль компьютерного моделирования / Computer simulation module	SFT6507	Деректер қоры теориясы / Теория базы данных / Database theory	BD	CC	5	150	45	15	15	15	105	15	M, E, Exam	SFT 650 I
31	ПМ04	Майнор пәндер модулі / Модуль Майнор дисциплин / The module of Minor disciplines	MIN601	Майнор 1 / Майнор 1 / Minor 1	MD	CC	5	150	45	15	15	15	105	15	M, E, Exam	-
				<b>Total number for a 5 semester:</b>			<b>22</b>	<b>660</b>	<b>240</b>	<b>75</b>	<b>12</b>	<b>45</b>	<b>420</b>	<b>90</b>		
<b>6 semester</b>																
32	ООМ01	Әлеуметтану және этика / Социология и этики / Sociology and Ethics	SPS6001	Философия / Философия / Philosophy	CGS	RC	5	150	45	15	30	0	105	15	M, E, Exam	-
33	PM02	Биологиялық модуль / Биологический модуль / Biological module	BIO6503	Бионика / Бионика / Bionics	BD	UC	5	150	45	15	30	0	105	15	M, E, Exam	
34	ПМ03	Тәжірибе модулі / Модуль практик / The Practice module	PP6505	Өндірістік тағылымдама / Производственная стажировка / Industrial internship	MD	UC	8	240	0	0	0	0	240	15	report	
35	БМ03	Компьютерлік модельдеу модулі / Модуль компьютерного моделирования / Computer simulation module	SFT6508 (1)	Машиналық оқыту 1 / Машинное обучение 1 / Machine Learning 1	BD	CC	5	150	45	15	0	30	105	15	M, E, Exam	
36	PM02	Биологиялық модуль / Биологический модуль / Biological module	BIO6504	Молекулалық биология / Молекулярная биология / Molecular Biology	MD	CC	5	150	45	15	30	0	105	15	M, E, Exam	
37	PM02	Биологиялық модуль / Биологический модуль / Biological module	BIO6505	Биофизика негіздері биоинженерия / Биоинженерия с основами биофизики / Bioengineering with the basics of Biophysics	MD	CC	5	150	45	15	30	0	105	15	M, E, Exam	
38	ПМ04	Майнор пәндер модулі / Модуль Майнор дисциплин / The module of Minor disciplines	MIN602	Майнор 2 / Майнор 2 / Minor 2	MD	CC	5	150	45	15	15	15	105	15	M, E, Exam	MI N60 I
				<b>Total number for a 6 semester:</b>			<b>38</b>	<b>114</b>	<b>270</b>	<b>90</b>	<b>13</b>	<b>45</b>	<b>870</b>	<b>105</b>		
				<b>TOTAL NUMBER FOR THE 3 YEAR:</b>			<b>60</b>	<b>180</b>	<b>510</b>	<b>16</b>	<b>25</b>	<b>90</b>	<b>129</b>	<b>195</b>		
								<b>0</b>	<b>5</b>	<b>5</b>	<b>5</b>	<b>0</b>	<b>0</b>			

4 year

7 semester																
39	ООМ02	Тілдік дайындық / Языковая подготовка / Language training	LAN6007K	Мемлекеттік тілде іс қағаздарын жүргізу / Делопроизводство на государственном языке / Business correspondence in the state language /	BD	UC	2	60	30	0	30	0	30	15	M, E, Exam	LA N60 02K R
40	PM02	Биологиялық модуль / Биологический модуль / Biological module	BIO6509	Нейробиология / Нейробиология / Neurobiology	MD	CC	4	120	45	15	30	0	75	15	M, E, Exam	
41	ООМ05	Зерттеу және кәсіпкерлік модулі / Модуль исследований и предпринимательства / Research and Entrepreneurship Module	RM6502	Зерттеу әдістемесі / Методология исследования / Research methodology	CGS	CC	5	150	45	15	30	0	105	15	M, E, Exam	-
			JUR 6507	Тіршілік қауіпсіздігінің және экологияның негіздері / Основы экологии и безопасности жизнедеятельности / Fundamentals safety of life activity and ecology												
			JUR 6470	Зан және сыйбайлас жемқорлыққа қарсы мәдениеттің негіздері / Основы права и антикоррупционной культуры / Fundamentals of law and anti-corruption culture												
			MGT6706	Стартаптар және кәсіпкерлік / Стартапы и предпринимательство / Startups and entrepreneurship												
42	БМ03	Компьютерлік модельдеу модулі / Модуль компьютерного моделирования / Computer simulation module	ECO6006	Экономикалық теория / Экономическая теория / Economic theory	MD	CC	5	150	45	15	15	15	105	15	M, E, Exam	SFT 650 8
			SFT6540	Машиналық оқыту 2 / Машинное обучение 2 / Machine learning 2												
43	ВМ02	Математикалық модельдеу модулі / Модуль математического моделирования / Module of mathematical modelling	MAT6543	Сандық әдістер 2 / Численные методы 2 / Numerical methods 2	BD	CC	4	120	45	15	15	15	75	15	M, E, Exam	
44	PM02	Биологиялық модуль / Биологический модуль / Biological module	BIO6507	Функционалдык диагностика / Функциональная диагностика / Functional diagnostics	BD	CC	5	150	45	15	30	0	105	15	M, E, Exam	
45	ПМ04	Майнор пәндер модулі / Модуль Майнор дисциплин / The module of Minor disciplines	MIN603	Майнор 3 / Майнор 3 / Minor 3	MD	CC	5	150	45	15	15	15	105	15	M, E, Exam	MI N60 2
46	PM02	Биологиялық модуль / Биологический модуль / Biological module	BIO6508	Қалыпты физиология / Нормальная физиология / Normal physiology	MD	CC	4	120	45	15	30	0	75	15		
							<b>34</b>	<b>1020</b>	<b>345</b>	<b>105</b>	<b>195</b>	<b>45</b>	<b>675</b>	<b>120</b>		
							<b>Total number for a 7 semester:</b>									



8 semester																
47	ПМ03	Тәжірибе модулі / Модуль практик / The Practice module	PP6504	Диплом алдыдағы практика / Преддипломная практика / Pregraduation practice	MD	UC	5	150	0	0	0	0	150	0	15	report
48	ПМ02	Деректерді талдау модулі / Модуль Анализа данных / Data Analysis Module	SFT6506	Power BI деректерді талдау және визуализациялау / Анализ и визуализация данных в Power BI / Data analysis and visualization in Power BI	BD	CC	3	90	30	0	30	0	60	15	15	M, E, Exam
49	ПМ01	Элективті пәндер модулі / Модуль элективных дисциплин / The module of elective disciplines	BIO6516 EGR6536	Биологиялық есептердегі Лаплас түрлендірулері / Преобразование Лапласа в биологических задачах / Laplace transformation in biological problems Бұрыс есептерді модельдеу / Моделирование некорректных задач / Simulation of ill-posed problems	MD	CC	5	150	45	15	15	15	105	15	15	M, E, Exam
50	PM02	Биологиялық модуль / Биологический модуль / Biological module	BIO6506	Биологиялық үдерістерді математикалық әдістер және компьютерлік модельдеу / Математические методы и компьютерное моделирование биологических процессов / Mathematical methods and computer modeling of biological processes	BD	UC	5	150	45	15	15	15	105	15	15	M, E, Exam
51				Дипломдық жұмысты, дипломдық жобаны жазу және қорғау немесе кешенді емтиханды дайындау және тапсыру / Написание и защита дипломной работы, дипломного проекта или подготовка и сдача комплексного экзамена / Writing and defending a diploma thesis, diploma project or preparation and passing of a comprehensive exam			8	240	0	0	0	0	240	15	15	DP Defense
				<b>Total number for a 8 semester:</b>			26	780	120	30	60	30	660	75	75	
				<b>TOTAL NUMBER FOR THE 4 YEAR:</b>			60	1800	465	135	255	75	1335	195	195	
				<b>TOTAL:</b>			240	7200	2205	570	1230	405	4995	720	720	

Summary table of indicators of the academic program's number of credits in the context of cycles of disciplines and semesters

Cycles of disciplines / Semester	1 sem.	2 sem.	3 sem.	4 sem.	5 sem.	6 sem.	7 sem.	8 sem.	Total number of credits ECTS	Note (AP structure according to the National Mandatory Standards of Higher and Post-Graduate Education)
<b>Cycle of general education disciplines (GED)</b>	<b>10</b>	<b>9</b>	<b>14</b>	<b>9</b>	<b>4</b>	<b>5</b>	<b>5</b>	<b>5</b>	<b>56</b>	* 56 cr.
- including the required component (GED RC)	10	9	14	9	4	5	5		51	* 51 cr.
- including optional component (GED OC)							5		5	* 5 cr.
<b>Cycle of core disciplines (CD)</b>	<b>22</b>	<b>19</b>	<b>17</b>	<b>16</b>	<b>13</b>	<b>10</b>	<b>11</b>	<b>8</b>	<b>116</b>	**
- including the university component (CD UC)	16	8	17	10	5	5	11	5	61	
- including optional component (CD OC)	6	11		6	13	5	3	3	55	
<b>Cycle of majors (M)</b>				<b>4</b>	<b>5</b>	<b>23</b>	<b>18</b>	<b>10</b>	<b>60</b>	**
- including the university component (M UC)				4	5	8	5	5	17	
- including optional component (M OC)					5	15	18	5	43	
<i>Professional internship (PI)</i>		2		4		8		5	19	
<b>Additional types of training</b>										
<b>Final attestation (FA)</b>										
<b>TOTAL number of credits for the academic program</b>	<b>32</b>	<b>28</b>	<b>31</b>	<b>29</b>	<b>22</b>	<b>38</b>	<b>34</b>	<b>26</b>	<b>240</b>	*Not less than 8 cr. Not less than 240 cr.

\*\*The cycle of core disciplines and majors (CD, M) is not less than 176 cr.






## 6. Additional educational program (Minor)

The name of the additional educational program (Minor) with an indication of the list of disciplines that form Minor	Total number of credits / number of credits by discipline	Semesters of study	Documents following the results of the development of additional educational programs (Minor)
<b>Web programmer</b>			
SFT6309 UX/UI development	5	5	Transcript
SFT6311 Front-end development	5	6	Transcript
SFT6314 Full Stack Development	5	7	Transcript
<b>Financial Engineering</b>			
FIN6701 Finance	5	5	Transcript
FIN6705 FIN6705	5	6	Transcript
FIN6702 Corporate Finance	5	7	Transcript
<b>Business &amp; Entrepreneurship</b>			
MGT6706 Startups and entrepreneurship	5	5	Transcript
(kv 5)MGT6714 International Business	5	6	Transcript
MGT6711 Production and Sales Management	5	7	Transcript
<b>Big Data Processing and Analysis</b>			
EPP 4106 Internet Entrepreneurship	5	5	Transcript
SFT6185 Data Analytics	5	6	Transcript
BDO 4310 Oracle NoSQL Databases	5	7	Transcript

**7. Approval sheet with developers**

Name of the educational program: 6B06114 «Biocomputing»

№	Position, academic or academic degree and Last Name I.O. of the developer of the educational program	Date	Signature	Note
1	Professor, Doctor of Physics and Mathematics Rysbaiuly B.			
2	Assistant professor, PhD Ydyrys A. Zh.			
3	Professor, Doctor of Biological Sciences, Institute of Genetics and Physiology, Makashev Y.K.			
4	Senior-lecturer, master Tokmukhamedova F.K.		