Appendix No 2 to Resolution No. 64/2026

THE PROGRAMME OF STUDY

The programme is effective from the academic year: 2026/2027

Field of study: BIOTECHNOLOGY

1. **ISCED Code: 0512**
2. **Form of study: full-time programme**
3. **Number of semesters: 6**
4. **Professional title awarded to graduates: licencjat [bachelor`s degree]**
5. **Educational profile: general academic**
6. **Field of science: natural sciences**
7. **Discipline of science**:
   - **leading discipline: biological sciences 71% (128 ECTS),**
   - **supplementary discipline: chemical sciences – 29% (52 ECTS).**
8. **Number of ECTS points necessary to complete studies: 180**
   1) the number of ECTS points that the student is obligated to obtain during classes conducted with the direct participation of academic teachers or other persons conducting classes: **114** - full-time programme of studies
   2) the number of ECTS points that the student is obligated to obtain as part of classes related to the conducted scientific activity in the discipline or disciplines to which the field of study is assigned in more than 50% of the total number of ECTS points): **95**
   3) the number of ECTS points that the student obtains by completing elective classes (at least 30%[1] of the total number of ECTS points) (including elective general education courses (classes)): **61**
   4) the number of ECTS points that the student is obligated to obtain as part of classes in the field of humanities or social sciences, not less than 5 ECTS points - in the case of fields of study assigned to disciplines within fields other than humanities or social sciences, respectively[2]: **5**
9. **Total number of hours of classes: 4620**
   - including the number of hours of classes conducted with the direct participation of academic teachers or other persons conducting classes: **2865**.
   - number of class hours conducted using distance learning methods and techniques: **0**.

[1] The percentage may differ if educational standards specify otherwise

[2] For degree programs classified under the humanities, the number of ECTS credits for courses in the social sciences is specified; for degree programs classified under the social sciences, the number of ECTS credits for courses in the humanities is specified

10. **The concept and goals of education** (including the description of the graduate):

The first-cycle programme of studies in the field of biotechnology at JKU (Jan Kochanowski University of Kielce) is conducted in accordance with the requirements of the Polish Qualifications Framework. After completing three-year first-cycle programme of studies, graduates of the field of biotechnology obtain a bachelor's degree. They have advanced knowledge in the field of mathematics, chemistry, biochemistry, physics, statistics, biophysics, plant and animal physiology, general genetics and general microbiology. The graduate's knowledge, both theoretically and practically, is consolidated by major courses (classes), including: environmental microbiology, molecular biology, bioprocess engineering, industrial biotechnology, or environmental engineering and technology. The first-cycle graduates in the field of biotechnology gain interdisciplinary education and the ability to combine knowledge from various disciplines. This enables them to cooperate with specialists from other fields and disciplines and to move efficiently at the interface between technology and experimental biology in biotechnology. The first-cycle programme of studies graduates are holders of a language proficiency certificate at the B2 level and are able to use a specialist language.

The first-cycle programme of studies graduates are prepared to:

- apply biotechnological methods in the industry using biotechnology and in related industries,
- take up work in analytical, control, diagnostic and research laboratories, including those performing work with the use of biological material,
- work in laboratories dealing with practical aspects of environmental protection and biotechnological processes in environmental engineering,
- operate research equipment,
- independently develop their own professional skills.

The obtained professional title gives them the opportunity to apply for admission to the second-cycle programme of studies in the field of Biotechnology or related fields, and to improve qualifications at postgraduate programmes of studies.

11. **LEARNING OUTCOMES:**

Symbol notation:

- BIOT – for marking the field of Biotechnology,
- 1A – for marking the cycle of study,
- symbol _ (underscore) – a separator,
- one of the letters W, U, K – for marking the category of outcomes (W-knowledge, U-abilities, K-social competence),
- outcome number within a given category, written in the form of two digits.

Learning outcomes symbols in the field of	After the completion a graduate:	Relate learning outcomes to: universal characteristics for a given level of the Polish Qualifications Framework (Act on ZSK- Integrated Qualifications System)	Relate learning outcomes to: second-level characteristics of learning outcomes for the qualifications at levels 6-7 of the Polish Qualifications Framework (Regulation of the Ministry of Science and Higher Education)
in the scope of **KNOWLEDGE:**			
BIOT1A_W01	knows and understands, at the advanced level, chemical and phyical issues allowing the explanation of biotechnological processes	P6U_W	P6S_WG
BIOT1A_W02	knows and understands, at the advanced level, genetic, biochemical, and physiological cellular processes	P6U_W	P6S_WG
BIOT1A_W03	knows and understands, at the advanced level, issues related to the genetic variability of organisms and processes occurring at the molecular level	P6U_W	P6S_WG
BIOT1A_W04	has advanced knowledge in the field of physiology and biochemistry of microorganisms for practical application	P6U_W	P6S_WG
BIOT1A_W05	knows and understands the methods in the field of mathematics, ststistics, and computer science used to describe and analyse biotechnological and natural processes	P6U_W	P6S_WG
BIOT1A_W06	knows and understands the most important threats to the natural environment at the level of population, biocenosis and ecosystem	P6U_W	P6S_WG
BIOT1A_W07	knows specialist terminology in polish and in a foreign language in the field of natural sciences and related sciences	P6U_W	P6S_WG
BIOT1A_W08	knows and understands the working of scientific and measuring equipment used in biotechnology and related sciences	P6U_W	P6S_WG
BIOT1A_W09	knows and understands the principles used in genetic engineering techniques, taking into account bioethical aspects	P6U_W	P6S_WG
BIOT1A_W10	knows and understands the principles of occupational health and safety and ergonomics	P6U_W	P6S_WK

BIOT1A_W11	has knowledge of intellectual property protection and copyright, and general principles of creating and developing forms of individual entrepreneurship in the scope of biotechnology	P6U_W	P6S_WK

in the scope of **ABILITIES:**

BIOT1A_U01	uses analytical techniques, breeding methods, and molecular tools used in biotechnology	P6U_U	P6S_UW
BIOT1A_U02	can find a solution to the problem in the scope of synthesis of chemical compounds and materials, determination of their physicochemical properties	P6U_U	P6S_UW
BIOT1A_U03	can select and apply research tools and methods typical of natural sciences used in biotechnology	P6U_U	P6S_UW
BIOT1A_U04	can properly select and apply statistical and bioinformatics methods in biotechnology research	P6U_U	P6S_UW
BIOT1A_U05	conducts, analyses, and records the results of biotechnology laboratory work	P6U_U	P6S_UW
BIOT1A_U06	can conduct biochemical tests and analyse morphological properties of organisms	P6U_U	P6S_UW
BIOT1A_U07	can synthesise data in the scope of biotechnology and natural sciences, critically evaluates their sources and draws conclusions	P6U_U	P6S_UW
BIOT1A_U08	can use the scientific language typical of biotechnology	P6U_U	P6S_UK
BIOT1A_U09	can use a foreigh language in accordance with the requirements specified for the level b2 of the common european framework of reference for languages of the council of europe	P6U_U	P6S_UK
BIOT1A_U10	can plan and organise his/her own work and that of a team to complete specific tasks	P6U_U	P6S_UO
BIOT1A_U11	can plan a path of personal and professional development	P6U_U	P6S_UU

in the scope of **SOCIAL COMPETENCE:**

BIOT1A_K01	is ready to critically evaluate his/her knowledge and the need to continuously develop his/her own competence	P6U_K	P6S_KK
BIOT1A_K02	is ready to initiate action for the benefit of the social environment, including the natural environment	P6U_K	P6S_KO
BIOT1A_K03	is ready to fulfil professional roles responsibly and to respect ethical principles	P6U_K	P6S_KR
BIOT1A_K04	is responsible for his/her own work and for the equipment entrusted	P6U_K	P6S_KR
BIOT1A_K05	is prepared to initiate public interest activities related to the promotion of biotechnology achievements.	P6U_K	P6S_KO

12. **CLASSES WITH ASSIGNED ECTS POINTS, LEARNING OUTCOMES, AND STUDY PROGRAMME CONTENT:**

Courses (classes)	Number of ECTS points	Study programme content	Reference to learning outcomes in the field of
GENERAL EDUCATION COURSES (CLASSES): (19 ECTS credits)			
1. Foreign language	9	**Lexical content:** Topics covered in widely available textbooks used in class at the B2 level (e.g., university, field of study, the importance of education and learning, work, media, technology, the environment, health, nutrition, sports, leisure, shopping, travel, society, culture, social phenomena). **Grammatical content**: In line with the characteristics of the level and the learning objectives defined by the Council of Europe's Common European Framework of Reference for Languages for level B2. **Language functions:** In line with the characteristics of the level and the learning objectives defined by the Council of Europe's Common European Framework of Reference for Languages for level B2.	BIOT1A_W07 BIOT1A_U09
2. Information and communication techniques	1	Effective and safe work organization in a digital environment using information and communication technologies. Utilizing the university's IT systems and digital tools for communication and work organization. Selecting and searching for reliable sources of information using academic databases. Editing text in accordance with the principles of proper document preparation. Creating structural formulas for organic and inorganic compounds, writing equations. Using a spreadsheet for basic calculations. Principles of creating presentations and effectively conveying content using visual aids. Principles of legal and ethical use of digital materials, including copyright and graphic resources.	BIOT1A_W05 BIOT1A_U04 BIOT1A_K01
3. Protection of industrial property and copyright	1	The concept of a creative work, copyrights and related rights. Fair use. Related rights. Inventions, biotechnological inventions, and patents. Trademarks and trademark protection rights. Industrial designs and utility models.	BIOT1A_W11
4. Entrepreneurship	1	The concept and types of entrepreneurial activity. Entrepreneur—concept, behaviors, and classifications. Internal and external determinants of entrepreneurial	BIOT1A_W11 BIOT1A_U11

			development. Entrepreneurship and the enterprise. Conditions, establishment, and operation of one's own business. Areas of entrepreneurial activity—family, women's, academic, social, and intellectual entrepreneurship.	BIOT1A_K03 BIOT1A_K05
5.	Elective courses (classes) in the field of humanities	3	Word culture / From Sumerians to polymers	BIOT1A_U10
6.	Elective courses (classes) in the field of humanities	2	Philosophy of nature / Copywriting	BIOT1A_U10
7.	An elective courses (classes) to support students in the learning process	2	Self-education techniques / Social communication	BIOT1A_U11 BIOT1A_K02 BIOT1A_K03

GENERAL / MAJOR COURSES (CLASSES): (103 ECTS credits)

1.	Mathematics	4	Complex numbers. Euler's formula. Power, polynomial, exponential, logarithmic and trigonometric functions. Vectors. Scalar product and vector product. The derivative of a function. Extremes of a function. Indefinite and definite integrals. Ordinary and partial differential equations. Operations on matrices. Calculating the inverse matrix. Systems of linear equations. The cubic equation. Fourier transformation.	BIOT1A_W05 BIOT1A_U03 BIOT1A_K01
2.	Physics	4	Fundamentals of physics. Knowledge and skills allowing students to solve selected physics problems. Quantities and laws in kinematics, dynamics, thermodynamics, electromagnetism, optics and nuclear physics. Interactions in the micro- and macroworld.	BIOT1A_W01 BIOT1A_U03 BIOT1A_U07 BIOT1A_K01 BIOT1A_K04
3.	General chemistry	8	Nucleons as components of the atomic nucleus. Isotopes. Natural and artificial nuclear transformations. Periodic table of elements and electron configurations of atoms. The main types of chemical bonds. Equilibria in electrolyte solutions. The concept of acid and base according to Arrhenius, Brönsted, Lewis. Application of the law of mass action to the dissociation of weak acids and bases. Calculations of the pH of solutions of strong and weak acids and bases. Salt hydrolysis according to Brönsted's theory. Buffer solutions. Oxidation and reduction reactions. Voltage series of metals. Metals and non-metals in biology and medicine. States of matter. Chemical thermodynamics. Phase equilibria. Chemical balance. Electrochemistry. Kinetics and catalysis: kinetics of complex reactions, chain reactions, biocatalysts. Colloids and surfactants: structure and stability, structure of	BIOT1A_W01 BIOT1A_W08 BIOT1A_W10 BIOT1A_U01 BIOT1A_U02 BIOT1A_U05 BIOT1A_U10 BIOT1A_K01 BIOT1A_K04

			micelles, electrical properties (double electrical layer), thermodynamics of surface layers.	
4.	Microscopy techniques	2	Historical outline of microscopy. Types of optical microscopes - their structure and principle of operation. Fluorescence, confocal microscopy. Autofluorescence phenomenon. Types of fluorochromes. Modern fluorescent techniques. Three-dimensional modelling of fluorescent images. Types of electron microscopes. Preparation of microscope slides for TEM. Practical application of appropriate microscopic techniques for biological observations.	BIOT1A_W02 BIOT1A_W08 BIOT1A_U05 BIOT1A_U06 BIOT1A_U10 BIOT1A_K01 BIOT1A_K04
5.	Databases	2	Database types and data formats. The concept of a relational database and terminology related to them. Designing and managing relational databases. Constructing queries in SQL. Getting acquainted with the biological database services available on the Internet: NCBI, EBI and the data formats used in them.	BIOT1A_W05 BIOT1A_U04 BIOT1A_U10 BIOT1A_K01
6.	Cell biology	4	Pro- and eukaryotic cell. Biological membranes - chemical composition, functions, transport through membranes. The cell nucleus. Structural organization of chromatin. Organization and function of the cytoplasm. The cytoskeleton. Mitochondria. Mitochondrial biogenesis. Mitochondriopathies. Ribosomes. The structure of the endoplasmic reticulum and its functions. Chemical structure and functions of the Golgi apparatus. Lysosomes - structure and functions. Microbodies, peroxisomes, glyoxysomes. Protein sorting. Intercellular signalling. Receptors. The cell cycle. Cell death. Ultrastructure of selected cells. Normal and neoplastic cells.	BIOT1A_W02 BIOT1A_W08 BIOT1A_U01 BIOT1A_U05 BIOT1A_U06 BIOT1A_U08 BIOT1A_K01 BIOT1A_K04
7.	Organic chemistry	4	Nomenclature, classification, structure of organic and bioorganic compounds. Isomerism of organic compounds. Physical and chemical properties of organic and bioorganic compounds. Functions of bioorganic compounds. Practical application of acquired knowledge in laboratory work.	BIOT1A_W01 BIOT1A_W07 BIOT1A_U02 BIOT1A_U03 BIOT1A_U05 BIOT1A_K01 BIOT1A_K03 BIOT1A_K04
8.	General microbiology	6	History of discoveries in the field of microbiology. Cell structure of gram-positive and gram-negative bacteria. Structure of the fungal cell wall. Selected pathogenic factors of gram-positive and gram-negative bacteria. Lytic and lysogenic cycle of bacteriophages. Conditions for the cultivation of bacterial cultures. Bacterial metabolism. Classification of antibiotics and mechanisms of action of antibiotics.	BIOT1A_W02 BIOT1A_W03 BIOT1A_W04 BIOT1A_U01 BIOT1A_U05

			Types of bacterial resistance to antibiotics. Bacteriocins and mutual interactions between microorganisms. Characteristics of selected serological and genetic methods used in microbiological diagnostics.	BIOT1A_U06 BIOT1A_K02 BIOT1A_K03 BIOT1A_K05
9.	General genetics	6	Basic genetic concepts. Classical genetics (Mendel's and Morgan's laws). Chromosomal theory of heredity. Inheritance of quantitative features. Inheritance of linked and sex-linked traits. Population genetics (population structure, heritability and kinship). Molecular bases of inheritance. Extrachromosomal inheritance. Gene structure and function. Genetic code. Genome. Regulation of gene expression. RNA interference. Mutagenesis, gene, chromosomal and genomic mutations, DNA damage repair systems. Molecular genetics (transcription and translation process, DNA methylation, selected epigenetic processes. Developing the ability to use theoretical knowledge in practice (analysis of genetic variation using the RFLP-PCR technique).	BIOT1A_W02 BIOT1A_W03 BIOT1A_W09 BIOT1A_U03 BIOT1A_U06 BIOT1A_K03 BIOT1A_K05
10.	Biochemistry	6	Structure and properties of basic classes of chemical compounds found in living organisms - proteins, carbohydrates, fats, nucleic acids. Principles of enzymatic catalysis and phenomena underlying the processes of capturing and converting energy in metabolic transformations - the basis of catabolic and anabolic processes in cells, integration of metabolism and regulation of metabolic processes. Metabolism of information molecules (nucleic acids and proteins). Metabolic pathways and cycles as a tool of biotechnology and examples of practical application of biochemical knowledge. Shaping the ability to use theoretical knowledge in laboratory practice.	BIOT1A_W02 BIOT1A_W03 BIOT1A_W04 BIOT1A_W08 BIOT1A_U01 BIOT1A_U03 BIOT1A_U05 BIOT1A_U06 BIOT1A_K01 BIOT1A_K03 BIOT1A_K04
11.	Fundamentals of statistics	4	Random variables: types of random variables, types of distributions of random variables. Density function, distribution function, quantiles. Statistical inference: sampling, point and interval estimation, statistical tests and their types. Selected methods of testing parametric and non-parametric hypotheses for one and two populations. Decomposition testing, compatibility and independence testing. Elements of correlation and regression analysis.	BIOT1A_W05 BIOT1A_W07 BIOT1A_U04 BIOT1A_K01

12.	Biophysics	3	Mechanisms of substance transport in biological systems. Membrane transport parameters. Molecular layers. Electrical conductivity of cells and tissues. Electrical model of the cell. Disadvantages of optical projections. Radiation effects in cells. Selected research methods: atomic force microscopy, surface plasmon resonance.	BIOT1A_W01 BIOT1A_W02 BIOT1A_W08 BIOT1A_U05 BIOT1A_U07 BIOT1A_K01 BIOT1A_K04
13.	Plant and animal physiology	4	Organisation of the nervous system, coding and transmission of nerve information, synaptic conduction. The essence of muscle contraction. The specificity of the myocardium. Composition and functions of blood and haematopoiesis. Functioning of the circulatory system and regulation of circulation. Regulation of the breathing process. Structure and functioning of the digestive system. Regulation of the functions of individual parts of the digestive system. Composition and regulation of the secretion of digestive juices. Structure, functions and regulation of liver function. Absorption of the products of digestion. Kidney physiology. Formation and excretion of urine. Tasks of plant physiology and basic research methods. Water management of plants and cells. Mineral economy. Basic plant metabolic processes. Physiology of plant growth and development, seed germination, vegetative and generative development, photoperiodism, vernalization, plant dormancy, biological role of phytohormones. Plant tissue cultures in vitro. Methods of determining the physiological state of plants.	BIOT1A_W02 BIOT1A_W07 BIOT1A_U03 BIOT1A_U05 BIOT1A_U06 BIOT1A_U07 BIOT1A_U10 BIOT1A_K01 BIOT1A_K04
14.	Fundamentals of immunology	4	Knows and is able to explain basic immunological concepts. Lists and describes the function of central and peripheral lymphatic organs. Can describe the basic mechanisms involved in the functioning of the immune system. Lists and describes the basic diseases of the immune system. Humoral and cellular response, characteristics of antibodies and their functions.	BIOT1A_W02 BIOT1A_W08 BIOT1A_W10 BIOT1A_U01 BIOT1A_U03 BIOT1A_U05 BIOT1A_U07 BIOT1A_U10 BIOT1A_K03 BIOT1A_K04

15.	Environmental microbiology	3	Microbiological characteristics of selected environments (water, soil, air). Methods of assessing pollution of the discussed environments. Biotechnological processes in wastewater treatment, bioremediation. The cycle of elements, i.e. nitrogen or sulphur, with an emphasis on processes in which microorganisms are involved (molecular nitrogen bound by bacteria, sulphate-reducing bacteria, methane bacteria). Bacteria of extreme environments (psychrophiles, thermophiles, alkaliphiles, acidophiles, hydrophiles). Application of enzymes isolated from environmental bacteria in biotechnology.	BIOT1A_W02 BIOT1A_W04 BIOT1A_W06 BIOT1A_U01 BIOT1A_U07 BIOT1A_K02 BIOT1A_K05
16.	Bacterial genetics	6	Organisation of genetic material in a prokaryotic cell. Domain structure of a nucleoid. Regulation of gene expression. Replication of genetic material. Recombination, mutation and DNA repair. Bacteriophages and the restriction and modification system. Methods of genetic material isolation on the example of prokaryotic organisms. Replication and identification of a selected DNA fragment by PCR. Restriction fragment polymorphism analysis. Electrophoresis and visualization of DNA. Horizontal gene transfer: transduction, conjugation and transformation. Determination of mutagen potency using the Ames test.	BIOT1A_W02 BIOT1A_W09 BIOT1A_U01 BIOT1A_U06 BIOT1A_K01 BIOT1A_K03 BIOT1A_K04
17.	Enzymology	3	Understanding the structure and properties of enzyme protein molecules. Catalytic and kinetic properties of enzymes. Nomenclature and classification of enzymes. Mechanisms of regulation of enzymatic reactions. Enzyme testing methods - isolation and purification, determination of enzymatic activity, detection of substrates and reaction products. Applications of enzymes in medicine (clinical diagnostics), industry (food, processing) and biotechnology (genetic engineering).	BIOT1A_W01 BIOT1A_W02 BIOT1A_W07 BIOT1A_U01 BIOT1A_U03 BIOT1A_U05 BIOT1A_U06 BIOT1A_K03 BIOT1A_K05
18.	Fundamentals of environmental protection for biotechnologists	1	Pollutants - definition, classification; Pollution emission sources; Characteristics of the atmosphere and processes affecting the transport of pollutants; Air pollution; Hydrosphere; Water pollution; Physical and chemical properties of the soil; Soil pollution; Mobility of elements and factors shaping it; Impact of pollution on living organisms.	BIOT1A_W01 BIOT1A_W06 BIOT1A_U07 BIOT1A_K02 BIOT1A_K05
19.	Introduction to spectroscopic techniques	3	The nature of electromagnetic radiation, absorption and emission of radiation, types of spectroscopy. Introduction to IR, UV-Vis, Raman and circular dichroism spectroscopy: spectrum formation, qualitative and quantitative analysis, parameters	BIOT1A_W01 BIOT1A_W07 BIOT1A_W08 BIOT1A_U01

			characterizing the absorption band. Emission spectroscopy, methods of nuclear magnetic resonance (1H, 13C) and mass spectrometry.	BIOT1A_U02 BIOT1A_U05 BIOT1A_K01 BIOT1A_K04
20.	Molecular biology	4	Nucleic acids and proteins - structure, properties and reactions of nucleic acids, structure of chromosomes. Analysis and interpretation of molecular mechanisms - transcription, translation, protein biosynthesis. Methods used in molecular biology - PCR, immunochemistry, cystometry.	BIOT1A_W02 BIOT1A_W03 BIOT1A_U03 BIOT1A_U06 BIOT1A_K01 BIOT1A_K03
21.	Genetically modified organisms - GMO	3	Genetics, gene, natural selection, artificial selection, human genome project, genetically modified organisms, plant modification targets, animal modification targets, plant transformation methods, animal transformation methods, modified food, marketing and control of GM food in Poland and Europe, in the world; producers of genetically modified food, labelling of GM food products, comprehensive product traceability system, cloning of organisms, reproductive cloning of plants and animals, use of stem cells, somatic cloning, DNA fingerprinting.	BIOT1A_W03 BIOT1A_W09 BIOT1A_U07 BIOT1A_U08 BIOT1A_K01 BIOT1A_K02 BIOT1A_K05
22.	Environmental engineering and technology	4	Determining the objectives of environmental engineering and technology and assessing the relationship between technology, natural resources, energy and the environment. Presentation of ways to minimize the negative impact of technology on the natural environment. Discussion of pro-ecological technologies and eco-innovations that are of the greatest importance in environmental protection: water treatment, wastewater and sewage sludge treatment, hazardous waste management, soil reclamation, gas purification and dedusting, and alternative energy sources. Getting acquainted in the field with technological processes of particular importance in environmental protection, including water intakes and their treatment, as well as sewage treatment plants.	BIOT1A_W06 BIOT1A_W07 BIOT1A_U07 BIOT1A_U10 BIOT1A_K02 BIOT1A_K05
23.	Bioinformatics	6	Bioinformatics techniques to describe data from DNA and cDNA sequencing experiments. Design of primers and probes for PCR and qPCR reactions. Basics of creating phylogenetic trees and assessment of biodiversity based on DNA and protein sequences. Methods of finding information in available databases and comparing them.	BIOT1A_W05 BIOT1A_W07 BIOT1A_U03 BIOT1A_U04 BIOT1A_U08 BIOT1A_K01 BIOT1A_K05

24.	Industrial biotechnology	3	Improving industrial microorganisms. Bacteria, yeasts and filamentous fungi used in industrial microbiology. Enzymes produced on an industrial scale by microorganisms. Application of enzymes in industrial processes. Microbial production of: alcoholic beverages, solvents, organic acids, amino acids, antibiotics, vitamins and provitamins. Pigments produced by microorganisms and their applications. Polymers produced by microorganisms and their applications. Immobilization of microorganisms in industrial processes.	BIOT1A_W05 BIOT1A_W06 BIOT1A_U06 BIOT1A_U10 BIOT1A_K02 BIOT1A_K02
25.	Bioprocess engineering	6	Biochemical basis of bioprocesses. Kinetics and growth models of microorganisms. Types of culture. Methods and kinetics of sterilization. Mass balancing - definitions and calculation tasks. Heat transfer processes. Classification of bioreactors. Transformation of bacterial cells with an expression vector containing a red fluorescent protein. Analysis of protein isolation efficiency from bacterial cells. Influence of microbial culture conditions on reporter gene expression. Analysis of the bioprocess in the bioreactor: aeration and mixing, mass and heat exchange, regulation and optimization of processes, principles of increasing the scale of the process. Stoichiometry and kinetics of microorganism growth in thermodynamic aspect.	BIOT1A_W02 BIOT1A_W04 BIOT1A_W08 BIOT1A_U01 BIOT1A_U07 BIOT1A_U08 BIOT1A_K01 BIOT1A_K02

COURSES (CLASSES) TO BE SELECTED: (54 ECTS credits)

1.	Courses (classes) within the scope of preparation and for submission of a diploma thesis	20	**Diploma seminar classes in the field of red, white, gray, and gold biotechnology, including respectively:** Papers of selected articles in the field of work issue. Searching for information. Translations of fragments of articles from a foreign language. Presentation of bachelor's theses. Discussing the main theses of bachelor's theses. Substantive and technical tips. The use of statistical methods. Reviews of bachelor's thesis. Substantive and editorial elements considered by reviewers. Presentation of bachelor's theses in PowerPoint. Discussion and correcting errors. Specifics and the course of the bachelor's exam. Discussion of the elements subject to the assessment. **Diploma workshop in the field of red, white, gray, and gold biotechnology, including respectively:** collecting materials, conducting an experiment, development of results and writing a thesis.	BIOT1A_W07 BIOT1A_W08 BIOT1A_W10 BIOT1A_W11 BIOT1A_U05 BIOT1A_U07 BIOT1A_U08 BIOT1A_U09 BIOT1A_U11 BIOT1A_K01 BIOT1A_K03 BIOT1A_K04
2.	Courses (classes) expanding the student's interests	34 from 46	Environmental Sample Analysis (4 ECTS) In vitro tissue cultures (4 ECTS) Mechanisms of animal development (3 ECTS)	BIOT1A_W01 BIOT1A_W02 BIOT1A_W03

			Good laboratory and hygiene practice (3 ECTS) Membrane technologies (2 ECTS) Biomedical polymers (2 ECTS) Fungus Biotechnology (3ECTS) Instrumental analysis in biotechnology (4 ECTS) Nanotechnologies (1 ECTS) Ecological and social aspects of biotechnology (2 ECTS) Patent law in biotechnology (2 ECTS) Plant biotechnology (3 ECTS) Regulation of gene expression (2 ECTS) Fundamentals of bioinorganic chemistry (4 ECTS) Fundamentals of molecular modeling (3 ECTS) Biofuel production (2 ECTS) Molecular ecology (1 ECTS) Environmental toxicology (2 ECTS) Instrumental Analysis of Microorganisms (2 ECTS)	BIOT1A_W04 BIOT1A_W05 BIOT1A_W06 BIOT1A_W07 BIOT1A_W08 BIOT1A_W09 BIOT1A_W10 BIOT1A_W11 BIOT1A_U01 BIOT1A_U02 BIOT1A_U03 BIOT1A_U04 BIOT1A_U05 BIOT1A_U06 BIOT1A_U07 BIOT1A_U08 BIOT1A_U10 BIOT1A_K01 BIOT1A_K02 BIOT1A_K03 BIOT1A_K04

INTERNSHIPS: : (4 ECTS credits)

INTERNSHIPS: 100 hours of student internship (4 weeks). Internships are held after the second year of studies	4	As part of the internships, the student should familiarise himself/herself with the functioning of the research laboratory in the workplace. The internship takes place in accordance with the individual internship plan agreed with the workplace. The internship is completed on the basis of the internship student book.	BIOT1A_W10 BIOT1A_U10 BIOT1A_U11 BIOT1A_K01 BIOT1A_K03 BIOT1A_K04

total	**180**

Students are required to complete 60 hours of physical education classes (semesters 3 and 4, ending with a pass with a grade)

Students are required to undergo a 4-hour training on safe and hygienic conditions of education (semester 1, ending with a pass).

Students are required to undergo a 2-hour library training (semester 1, ending with a pass).

Students are required to attend a 4-hour first aid course (semester 2, ending with a pass).

No ECTS credits are assigned to the classes mentioned above.

Foreign students are required to attend a Polish language course: 4 ECTS points

13. **Methods of verification and assessment of the learning outcomes achieved by the student during the entire educational cycle:**

- **phased works:** tests, reports on practical (laboratory) exercises, presentations, projects;
- written and oral **exams, credits**;
- **diploma process** (verification of the assumed learning outcomes) – the diploma thesis is assessed by the supervisor and the reviewer;
- **student internships** (completion of the concept of education and verification of effects in accordance with the regulations of internships);
- **tracing the graduates' careers** (information on the graduate's usefulness on the labour market);
- **survey of employers' opinions.**

The forms and methods of conducting classes as well as the assessment criteria and its components are specified in the detailed course description.
All forms of verification of the student's achievements obtained during classes in a given semester are recorded in the student`s periodic progress report.