Національний технічний університет України
«КИЇВСЬКИЙ ПОЛІТЕХНІЧНИЙ ІНСТИТУТ
імені ІГОРЯ СІКОРСЬКОГО»

Ecology and Technology of Plant Polymers

Biology

Working program of the discipline (Syllabus)

Details of the discipline	
Level of higher education	***First (bachelor's)***
Field of knowledge	*10 Natural sciences*
Speciality	*101 Ecology*
Educational program	*OPP Environmental Safety (EDEBO ID: 8256)*
Discipline status	*Regulatory*
Form (format) of training	*Full-time (full-time/remote/mixed)*
Year of preparation, semester	*1st year, fall semester*
Scope of discipline	*7 ECTS credits (210 hours)*
Semester control / control measures	*Exam*
Timetable	*6 hours per week (3 hours of lectures, 1 hour of practical and 2 hours of laboratory classes)*
Language of instruction	*Ukrainian*
Information about Course Leader / Instructors	Lecturer: *Ph.D., Senior Researcher, Valeriia Vember, vvember@gmail.com, @vvember* Practical / Seminar: *Ph.D., Senior Researcher, Vember Valeria Vladimirovna, vvember@gmail.com, @vvember* Laboratory: *https://eco-paper.kpi.ua/pro-kafedru/vykladachi/vizytky.html*
Course Placement	*https://do.ipo.kpi.ua/course/view.php?id=2157*

The program of the discipline

1. Description of the discipline, its purpose, subject of study and learning outcomes

The subject of the discipline "Biology" *is all manifestations of life: the structure and functions of living beings and their natural communities, their distribution, origin and development, connections with each other and with inanimate nature. The task of biology as a science is to study all biological laws and to reveal the essence of life and its manifestations in order to cognize and control them. For future environmental specialists, the study of biology is especially important, since modern theoretical ecology is one of the subdivisions of biological science and is necessary for future engineers to find ways of optimal development of mankind in the most distant future, to develop new methods for preserving the planet's biosphere. In general, the discipline "Biology" forms the conceptual and categorical, theoretical and methodological apparatus necessary for the study of ecology, environmental protection and disciplines related to environmental protection in various industries; organization of environmental protection measures at the level of institutions, departments, organizations, regions, the state and at the international level.*

Purpose and objectives of the discipline

The purpose of the discipline "Biology" is to form students' competencies:

- *PC 02 The ability to critically understand basic theories, methods and principles of natural sciences;*

- *PC 17 The ability to apply up-to-date methods and means of monitoring the state of atmospheric air, natural waters, soils and biota, to determine the level of contamination of natural and industrial materials with radioactive elements, to master methods for assessing the impact of adverse factors on living organisms, to determine the adaptive capabilities of the human body in environmental conditions.*

After mastering the discipline "Biology", students must demonstrate the following program learning outcomes:

- *PLO 02 To understand the basic environmental laws, rules and principles of environmental protection and nature management;*
- *PLO 03 To understand the basic concepts, theoretical and practical problems in the field of natural sciences that are necessary for analysis and decision-making in the field of ecology, environmental protection and optimal use of nature;*
- *PLO 06 To identify the factors that determine the formation of landscape and biological diversity;*
- *PLO 19 To raise the professional level by continuing education and self-education;*
- *PLO 26 To carry out laboratory researches with use of modern devices, to provide sufficient accuracy of measurement and reliability of results, to process the obtained results.*

2. Prerequisites and post-requisites of the discipline (place in the structural and logical scheme of training in the relevant educational program)

*The study of the discipline "**Biology**" is based on the principles of integration of various knowledge in biological disciplines acquired by students during school education. The discipline "**Biology**" is a fundamental basis that should ensure further study of the disciplines "General Ecology" and "Landscape Ecology".*

3. The content of the discipline

Chapter 1. Biology in the system of natural sciences

Topic 1. Biology – is a system of wildlife sciences
Topic 2. The Diversity of Life on Earth
Topic 3. Historical development of the organic world

Chapter 2. Botany with Fundamentals of Ecology and Phytocenology

Topic 4. Taxonomy of plants and their general characteristics
Topic 5. Adaptations of plants to survive in different habitats
Topic 6. Plant tissues and organs
Topic 7. Fundamentals of Phytocenology

Chapter 3. Zoology with Fundamentals of Ecology

Topic 8. Taxonomy of animals
Topic 9. Adaptations of animals to survive in different habitats
Topic 10. Animal tissues, organs and features of their functioning
Topic 11. Information Perception, Animal Sensory Systems

Chapter 4. Microbiology and its possibilities in solving environmental problems

Topic 12. General properties of microorganisms
Topic 13. Microorganisms in the Processes of Transformation of Natural and Synthetic Compounds
Topic 14. Microbial decomposition of natural substances and synthetic compounds. Microbial Biotechnology

Chapter 5. Cellular structure of organisms
Topic 15. Molecular level of organization of life
Topic 16. Cellular level of life organization
Topic 17. Reproduction and individual development of organisms

Chapter 6. Physiological, biochemical and genetic bases of life

Topic 18. Metabolism and energy conversion in the cell
Topic 19. Plastic metabolism
Topic 20. Heredity and variability

4. Training Materials & Resources

Basic

1. *Barna I.V.* Biology. – Ternopil: Textbooks and Manuals, 2020. – 560 p.
2. *Zholner L.G., Dekhtyarenko N.V., Linovytska V.M.* Cell Biology: Laboratory Practicum. – Kyiv: KPI them. Igor Sikorsky, 2020. – 50 pages.
3. *Ilyina Yu.Yu., Perelygina L.A., Prykhodko Yu.O.* Fundamentals of Human Biology: Textbook. – Kharkiv: A.M. Panov, 2019. – 279 p.
4. *Inshina N.M.* Fundamentals of Molecular Biology: Textbook. – Sumy: Sumy State University, 2019. – 120 p.
5. *Sobol V.I.* Biology. Handbook + Tests. – Kamianets-Podilskyi: Alphabet, 2021. – 796 p.

Auxiliary

6. *Bida O. A., Derii S. I., and Ilyukha L. M.* etc. Biology. Handbook for entrants and schoolchildren. – Kyiv: Litera LTD, 2009. – 652 p. (in Russian).
7. *Bogdanova D. K.* Handbook of pupil and student. Biology. Donetsk: BAO Ltd., 2004. – 592 p.
8. *Bohutska T. O.* Test tasks in biology. – Kamianets-Podilskyi: Alphabet-NOVA, 2003. – 112 p.
9. *Vasilyeva L.V. et al.* Biology : ucheb. posobie dlya studentov inostr. podgotov. f-t. – Kharkov: Izd. Tsentr. Kharkov. Nats. Un-ta, 2002. Ch. 1 – 120 p.
10. *Okolitenko N. I., Grodzinsky D. M.* Fundamentals of System Biology. manual. Kyiv, Lybid Publ., 2005. – 360 p.
11. *Pirog T. P.* General Microbiology. – K.: Nats. University of Food Technologies, 2004. – 471 p.
12. *Slyusarev A. O., Samsonov O. V., Mukhin V. M.* etc. Biology Kyiv: Vyshcha shkola, 2001. – 622 p.
13. *Reznichenko L. S., Vember V. V., Gruzina T. G., Nemiro S. A., and Ulberg Z. R.* Prospects of bacteria of the genera *Escherichia* and *Enterococcus* for the creation of a multicomponent probiotic // Bulletin of Problems of Biology and Medicine. – 2007. – Issue. 1, pp. 31–37.
14. *Vember V.V., Gomelya M.D., Petrichenko O.I.* Intensification of biological processes during the extraction of ammonium ions from water // Institute of the National Technical University of Ukraine "Kyiv Polytechnic Institute". Series "Chemical Engineering, Ecology and Resource Conservation". – 2017. – No 1 (16). – P. 53–58.

15. *Vember V. V., Lavrinenko O. M., Zagorniy M. M., Pavlenko O. Yu, Benatov D. E.* Study of the biological activity of nanoparticles of lanthanum, cerium and titanium oxides and their composites modified with silver // Bulletin of the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute", Series "Chemical Engineering, Ecology and Resource Saving". – 2022. – № 2 (21). – P. 79-87. DOI: 10.20535/2617-9741.2.2022.260354

Information resources on the Internet

16. *YouTube channel of the Ministry of Education and Science of Ukraine. Biology lessons. [Electronic resource]. – https://www.youtube.com/@MONUKRAINE/search?query=Biology*
17. *TeamLabBody – Online Application for the Study of Human Anatomy and Physiology – 3D Body Models – https://www.teamlabbody.com/en/index.html*
18. *The world's largest library of math and science simulations - https://www.explorelearning.com/*
19. *All biology in 1 lesson – https://www.youtube.com/watch?v=3HD-MRTKcpQ*
20. *V.I. Vernadsky Library – www.nbuv.gov.ua*

Educational content

5. Methods of mastering the discipline (educational component)

Lecture classes

Lectures are aimed at:

- ✓ *provision of modern and holistic knowledge in the discipline "Biology", the volume of which is determined by the target setting for each specific topic;*
- ✓ *determination of the level of development of the complex of biological sciences and the field of environmental protection; forecasting their development for the coming years;*
- ✓ *education of students' professional and business qualities and development of their independent creative thinking;*
- ✓ *involvement of students in the process of creative work together with the teacher: analysis of information and generation of ideas;*
- ✓ *use of methodological features of material processing for better understanding and perception (highlighting the main ideas and provisions, emphasizing conclusions, repeating them in different formulations);*
- ✓ *the use of visual elements for the perception of the material: a combination of a lecture with a demonstration of audiovisual materials, diagrams, tables and models;*
- ✓ *clarification of all newly introduced terms and concepts;*
- ✓ *accessibility of information for perception by this audience;*
- ✓ *formation of students' necessary motivation and interest in continuing their studies within the framework of independent work.*

No	Title of the lecture topic and list of main questions (list of didactic means, references to literature and tasks on the IWS)
1	**Biology is – a system of wildlife sciences** The concept of general biology. Structure of the Biological Sciences. Relationship of biology with other sciences. Biology as the foundation of theoretical ecology. Research Methods in Biology. History of the development of biology.

	Literature: [1] p. 10-51, [5] p. 8-21, [6] p. 4-5, [7] p. 5-17, [10] p. 15-19. *IWS:* Draw diagrams and make a table showing the various areas and subdivisions of biology, as well as its interaction with other sciences.
2	**The Diversity of Life on Earth** Biodiversity of the Earth and its ecological importance. Schemes for the classification of living organisms. Prokaryotes and eukaryotes. Bacteria and viruses. Mushroom Kingdom. Plant Kingdom. Animal World. Red and Green Books. *References*: [1] p. 11-24, [5] p. 18, 108, 249-254, 579-580, [6] pp. 13-144, [7] p. 6-7, 109-110, 174-175, 267-269, [12] pp. 22-29, 254-356, 476-577. *IWS:* To study the basic and secondary taxonomic ranks (categories) used to classify living organisms. Pay attention to the differences between individual groups of taxa for the Plant and Animal Kingdoms. Using the studied algorithm for determining taxonomic affiliation, give the biological classification of the species in the notebook *Homo sapiens* (*Homo sapiens*). Prepare for discussions on human impact on global biospheric processes and prospects for the conservation of animal and plant diversity in rapidly changing living conditions.
3	**Historical development of the organic world** The Synthetic Theory of Evolution and Its Basic Provisions. The role of natural selection. Modern views on the evolution of the organic world. Macro- and microevolution. Forms, directions and paths of macroevolution. *References*: [1] p. 482-498, 502-511, [5], [6] p. 88-602, [10] p. 96-140. *IWS:* Prepare for discussions on the following topics: 1) "Evolution of the biosphere" and 2) "V.I. Vernadsky's doctrine of the noosphere".
4	**Taxonomy of plants and their general characteristics** Fundamentals of Biological Classification of Living Organisms. Plant Kingdom. Main properties and economic value. Seaweed. Lichens. Mosses. Ferns, horsetails and lycopods. *References*: [1] p. 18-20, 71-99, [5] pp. 194-242, [6] p. 174-266, [7] p. 198-206. *IWS:* Work through the lecture material. Write down the characteristic features of the main systematic groups of plants. Describe and sketch the life forms of plants.
5	**Taxonomy of plants and their general characteristics** Seed plants. Gymnosperms and angiosperms. Comparative characteristics of terrestrial plants. Plant life forms. Features of their practical use. *References*: [1] p. 105-149, [5] p. 245-258, [6] p. 266-284, [7] p. 209-252. *IWS:* Work through the lecture material. Write down the characteristic features of the main systematic groups of plants. Describe and sketch the life forms of plants.

6	**Adaptations of plants to survive in different habitats** Main habitats. Characteristics of aquatic, soil and terrestrial-air environments. Features of anatomy, morphology and physiological and biochemical properties of plants that enable them to survive in different ecological zones. *References*: [1] p. 20-22, 27-30, 64-67, [5] pp. 141, [7] p. 101-104, [10] p. 234-237. *IWS:* Prepare a table that describes the advantages and disadvantages of living in aquatic, soil and terrestrial-air environments. Conduct an analysis and conclude on the presence of the most favorable environment for life.
7	**Plant tissues and organs** Separation of plant tissues into types. Creative fabrics. Basic fabrics. Conductive tissues – tracheas, tracheids, sieve tubes. Covering fabrics. Mechanical fabrics. The importance of different types of tissues for plant survival in different environments. *References*: [1] p. 483-485, [5] p. 175-180, [6] p. 204-207. *IWS:* Prepare for laboratory work: Write down the main types of plant tissues and their corresponding characteristics and signs.
8	**Fundamentals of Phytocenology** Plant communities. Their spatial structure, significance for the formation of landscapes and successional changes. *References*: [1] p. 239-242, 252-260, [7] p. 160-162, [8], [12] p. 272, 433-437, 545-546. *IWS:* Find information on the use of knowledge about ecological successions in practice. Prepare to discuss the types of terrestrial ecosystems and the distribution of major terrestrial communities. To systematize information on the features and composition of the main terrestrial biomes: tundra, taiga, coniferous forests, deciduous forests, steppe, savannah, tropical rain forests, deserts and semi-deserts.
9	**Taxonomy of animals** Fauna of the Earth. Principles of Animal Classification. Subkingdom *Unicellular.* Diversity of the subkingdom *Unicellular*. *References*: [1] p. 108-230, [5] p. 267-366, [6] p. 342-485. *IWS:* Work through the lecture material. Write down the characteristic features of the main taxonomic groups of animals. Prepare for the discussion of the following issues: 1) The importance of protozoa in the processes of purification and clarification of polluted water; 2) The simplest ones are indicator (indicative) organisms of the quality of activated sludge of treatment plants.

10	**Taxonomy of animals** Subkingdom *Multicellular.* Sponge type. Type *of intestinal cavities.* Type*: Flatworms*. Type*: Roundworms*. Phylum *Annelids.* Phylum *Mollusks.* Phylum *Arthropoda*. Classes *crustaceans, arachnids, insects*. Phylum *Echinoderms.* *References*: [1] p. 108-230, [5] p. 67-366, [6] p. 342-485. *IWS:* Work through the lecture material. Prepare for laboratory work: repeat the features of the morphological structure of protozoa.
11	**Taxonomy of animals** Phylum *Chordates.* Classes *Cyclostomes, Fishes, Amphibians, Reptiles, Birds and Mammals.* Comparative characteristics of animals. *References*: [1] p. 108-230, [5] p. 267-366, [6] p. 342-485. *IWS:* Work through the lecture material. Describe the basic life forms of animals.
12	**Adaptations of animals to survive in different habitats** The place of animals in ecosystems. Features of the anatomical structure and physiological and biochemical adaptations of animals that enable them to survive in various environmental conditions. Excretion and osmoregulation in animals. Nitrogenous excretions: ammonia, urea, uric acid, etc. Thermoregulation in animals. *References*: [1] p. 255-256, 488-489, 607-611, [5] p. 114-124, [10] p. 334-337. *IWS:* Repeat and systematize the lecture material. View the previously prepared table that describes the advantages and disadvantages of living in aquatic, soil and extraterrestrial-air environments. Conduct an analysis and conclude on the availability of the most favorable living environment for animals.
13	**Animal tissues, organs and features of their functioning** Animal tissues: epithelial, muscle, connective tissues. Blood. Composition and function. Blood types. Nervous tissue. The importance of nervous regulation in the evolutionary aspect. Behavioral adaptations of animals. Comparative structure of the nervous system of representatives of different taxonomic groups. Structure and function of the brain and spinal cord. Higher nervous activity. Structure and function of the peripheral nervous system. *References*: [1] p. 110, 269-284, 380-389, 486-487, [5] pp. 8-10, 369-374, [12] pp. 506-527, 595-603. *IWS:* Prepare for laboratory work: Write down the main types of animal tissues and their corresponding characteristics and signs. Conduct a comparative analysis: 1) Structures of the nervous system in representatives of different taxonomic groups (description should be given in the form of a table); 2) Structure and function of the central and peripheral nervous system of man.

14	**Information Perception, Animal Sensory Systems** The body's connection with the external environment. Sensory systems and their structure. Perception of light, sounds, smells, tastes, gravitational field. Sensory Systems of Skin Sensitivity. Animal behavior and its evolutionary aspects. *References*: [1] p. 366-377, [5] p. 443-470, [7] p. 407-442, [12] p. 486-512. *IWS:* Prepare short reports on the ethological (behavioral) structure of populations and social hierarchy in animals belonging to different taxonomic groups. To substantiate the existence of a relationship between animal behavior and the complexity/features of the functioning of the body's sensory systems. Prepare for the test.
15	**General properties of microorganisms** The position of microorganisms in nature. Distribution of microorganisms by taxa. Harmful and beneficial microorganisms. General properties of microorganisms. Participation of microorganisms in the circulation of substances in the biosphere. *References*: [5] p. 101-104, [10] p. 182-195, 250-252, [11] pp. 16-20, 425-431. *IWS:* List the main taxonomic subdivisions of prokaryotes. Write down in a notebook a list of harmful and beneficial microorganisms and their importance in human life. Reflect and write down a conclusion regarding: 1) The impossibility of life on Earth without prokaryotes; 2) The ecological significance of biotic relationships of microorganisms with each other and with other groups of organisms.
16	**Microorganisms in the Processes of Transformation of Natural and Synthetic Compounds** Microflora of water, air and soil, their role in self-purification processes. Aquatic ecosystems. Self-purification of water bodies. The use of microorganisms for water purification. Sanitary and bacteriological examination of water. Sanitary-indicative microorganisms. Sources of microbial contamination of water bodies. Intestinal group of bacteria. Water disinfection. Sanitary microbiology of water and soil. Soil as a habitat of microorganisms and a product of their vital activity. Microzonality. Formation of humus. Self-purification of the soil from organic contaminants. Soil microbocenoses and their development. Effects on plants and animals. *References*: [5] p. 27, 101-104, 245, [11] p. 211-220, 336, 345-346, 425-428, 450-451. *IWS:* Describe the role of bacteria in the processes of soil formation and self-purification of water bodies.
17	**Microbial decomposition of natural substances and synthetic compounds. Microbial Biotechnology** Transformation of biodegradable natural organic compounds by microorganisms. Destruction and transformation of xenobiotics by microorganisms and their interaction with metals. Modern microbial biotechnologies. Obtaining microbial protein, amino acids, enzymes, vitamins from microorganisms. Obtaining medicines. Other ways of using microbiology in science and the national economic sector. Biotechnology in solving environmental problems. *References*: [5] p. 27, 101-104, 245, [11] p. 211-220, 336, 345-346, 425-428, 450-451.

	IWS: Find information about: 1) The use of secondary metabolites of microorganisms in medicine and other sectors of the national economy; 2) Production of organic acids by microbiological method; 3) The relationship between microorganisms and their production of antibiotics as a means of competition.
18	**Molecular level of organization of life** Elemental composition of organisms. Chemical composition of the cell. Water. Mineral elements. Macromolecules, their features and biological significance. Proteins. Carbohydrates. Lipids. Nucleic acids. Biologically active substances of the cell. *References*: [3] p. 214-230, [4] p. 19-27, [5] p. 34-56, [12] p. 32-88. *IWS:* Repeat and systematize lecture materials. To characterize the role of phospholipids in the cell.
19	**Cellular level of life organization** A cell is a structural and functional unit of living organisms. Schwann and Schleiden's cell theory. General ideas about the structure of prokaryotic and eukaryotic cells. Cell structure. Cytoplasm. The surface apparatus of the cell. Cell membranes. Transport of substances through membranes. *References*: [2] p. 5-50, [5] p. 210-342, [6] p. 8-19, [9] p. 91-103. *IWS:* Prepare a report on modern methods of cell structure research. To characterize the possibilities of using microscopic methods in biology.
20	**Cellular level of life organization** Double-membrane organelles: Mitochondria, plastids. Endoplasmic reticulum. Golgi apparatus. Lysosomes. Non-membrane organelles. Organelles of movement. Cell center. Ribosomes. Core. Features of the structure of a plant cell. Cell walls, vacuoles, plastids, inclusions. *References*: [2] p. 5-50, [5] p. 210-342, [6] p. 8-19, [9] p. 91-103. *IWS:* Conduct a comparative analysis of prokaryotic and eukaryotic cells. To substantiate the existence of advantages in cells of both types.
21	**Reproduction and individual development of organisms** Cell cycle. Cell division. Metosis and meiosis: their phases and biological significance. Interphase, karyokinesis (mitosis), cytokinesis. Mitosis or indirect division. Prophase, metaphase, anaphase and telophase. Amitosis or direct fission. Importance of amitosis. *References*: [2] p. 5-50, [5] p. 210-342, [6] p. 8-19, [9] p. 91-103. *IWS:* Explain the essence of the cell cycle: phases of the cell cycle; morphophysiological processes in the cell in preparation for division.

22	**Reproduction and individual development of organisms** Forms of reproduction: asexual, sexual. Meiosis. Asexual reproduction in unicellular organisms. Reproduction in plants. Vegetative propagation. Sexual reproduction. Double fertilization. Reproduction in animals. Vegetative reproduction in lower animals. Sexual reproduction. Individual development of organisms. Embryonic development. Blastomeres, morula, blastula, gastrula. Postembryonic development. *References*: [1] p. 529-535, [5] p. 189-203, [7] p. 38-57, 476-480, [9] pp. 93-99, [10] p. 254-272. *IWS:* To substantiate the importance of reproduction as the main feature of life. To give a classification of forms of reproduction. To carry out a comparative analysis of the features of embryonic development in organisms of different groups. Types of postembryonic development: direct and indirect development.
23	**Metabolism and energy conversion in the cell** Regulation of metabolism. Enzymes and their importance for life. Classification of enzymes. Energy sources for organisms. Autotrophic and heterotrophic organisms. *References*: [5] p. 464-474, [7] p. 95-104, [9] p. 28-33, [12] p. 137-142. *IWS:* To provide a description of the basic properties of enzymes and their importance for the life and regulation of cell metabolism. Schematically depict the mechanism of action of enzymes and their structure. To reveal the concept of enzymatic catalysis. Explain how the rate of enzymatic reactions is determined. Determine the effect of environmental factors on enzymatic activity.
24	**Metabolism and energy conversion in the cell** Energy metabolism and its stages. Aerobic and anaerobic respiration. Types of fermentation. Substrate phosphorylation. Oxidative phosphorylation. The tricarboxylic acid (Krebs) cycle. Incomplete oxidation. *References*: [5] p. 464-474, [7] p. 95-104, [9] p. 28-33, [12] p. 137-142. *IWS:* Repeat the features of the functioning of the tricarboxylic acid cycle (Krebs cycle) and the respiratory chain. Determine what their biological role is.
25	**Plastic metabolism** The main anabolic processes in the cell are photosynthesis, chemosynthesis, protein biosynthesis. Autotrophic nutrition. Plant photosynthesis. Light and dark stages of photosynthesis. Importance of photosynthesis. Bacterial photosynthesis. Bacterial chemosynthesis. Ways to feed animals. Heterotrophic nutrition. Different methods of heterotrophic nutrition. Mammalian nutrition. Features of nutrition of herbivores and predators. *References*: [5] p. 464-477, [7] p. 29-37, [12] p. 147-161. *IWS:* List and compare the main types of anabolic processes occurring in the cell: photosynthesis, chemosynthesis, protein biosynthesis. Find their similarities and differences.

26	**Heredity and variability** Basic concepts of genetics. Patterns of heredity. The Law of Gamete Purity. Linked inheritance. Chromosomal theory of heredity. Extranuclear heredity. Interaction of genotype and environmental conditions. Molecular organization of prokaryotic and eukaryotic genes. Organization of the genome in different groups of organisms. *References*: [1] p. 194-197, [5] p. 492-514, [7] p. 272, 283-302, [12] p. 57-95. *IWS:* Repeat the basic concepts and laws of genetics, patterns of heredity.
27	**Heredity and variability** Variability and its forms. Types of mutations. The Law of Homologous Series. Genetics of populations. Effects of toxic substances on heredity. Artificial selection and its forms. Features of selection of plants, animals and microorganisms. *References*: [1] p. 194-197, [5] p. 492-514, [7] p. 272, 283-302, [12] p. 57-95. *IWS:* Prepare for the test.

Practical classes

As part of the teaching of the discipline "Biology", it is planned to conduct practical classes, which occupy more than 16% of the total classroom load. Practical classes include topics that allow you to better understand the lecture material, master the methodology of biological research.

The content of these classes and the methods of their conduct contribute to ensuring the development of the creative activity of the individual. They develop scientific thinking and the ability to use special terminology, allow you to test knowledge, in connection with which this type of work is an important means of operational feedback. Therefore, practical classes perform not only cognitive and educational functions, but also contribute to the growth of students as creative workers in the field of ecology.

The main tasks of the cycle of practical classes:

- ✓ *to help students systematize, consolidate and deepen theoretical knowledge in the field of biology, ecology and environmental protection;*
- ✓ *teach them techniques for solving practical problems;*
- ✓ *teach students to work with scientific and reference literature;*
- ✓ *to form the ability to learn independently, to help master the methods, ways and techniques of self-education and self-development.*

No	*Title of the topic of the lesson and a list of the main questions (list of didactic support, links to literature and tasks for the IWS)*
1	***Biology is – a system of wildlife sciences*** *The study of living matter at different levels of its organization using biological methods. Observation method. Comparative method. Experimental method. Monitoring. Modeling. Field research methods. Statistical approach.*

	References: [1] p. 10-51, [5] p. *8-21, [6]* p. *4-5, [7]* p. *5-17, [10]* p. *15-19.* *IWS: Draw diagrams and make a table reflecting various areas and subdivisions of biology and methods by which the study of living matter is carried out at various levels of its organization. Pay attention to the methods that are specific to biology and those that are common to environmental science. Modern Methods of Biological Research.*
2	***Historical development of the organic world*** *Theories of the origin of life on Earth. Evolution and Development of Evolutionary Views.* *References: [1] p. 482-498, 502-511, [5] pp. 688-602, [10] p. 96-140.* *IWS: Review and systematize the lecture material. On its basis, create tables-schemes that reflect: 1) Names of the main groups of theories of the origin of life on Earth and their brief description; 2) Geochronological history of the Earth, indicating the main aromorphoses and idioadaptations that occurred in individual eras and periods.*
3	***Adaptations of plants to survive in different habitats*** *Osmosis (osmotic pressure) and its importance for the nutrition and existence of plant organisms. Isolation of metabolic products and osmoregulation in plants.* *References: [1] p. 20-22, 27-30, 64-67, [5] pp. 141, [7] p. 101-104, [10] p. 234-237.* *IWS: Describe and sketch the main stages observed during the process of plasmolysis in a plant cell. Based on the laboratory tests, conclude which process (plasmolysis or deplasmolysis) proceeds at a higher rate. Explain the resulting ratio. Consider whether the phenomenon of plasmolysis will occur in cells exposed to high temperatures.*
4	***Taxonomy of animals*** *Fauna of the Earth. Principles of classification and comparative characteristics of animals.* *References: [1] p. 108-230, [5] p. 267-366, [6] p. 342-485.* *IWS: Explain the principles and approaches on which the modern biological classification of living organisms is built. Give the principles of their nomenclature.*
5	***Adaptations of animals to survive in different habitats*** *Human Biology. The internal environment of the human body. The concept of homeostasis. Principles of regulation of the integrity of the human body.* *References: [1] p. 255-256, 488-489, 607-611, [5] pp. 114-124, [10] pp. 334-337.* *IWS: Prepare reports on the principles of the human body, the levels of its organization and ways to maintain homeostasis.*
6	***Animal tissues, organs and features of their functioning***

	Human musculoskeletal system. Blood circulation and lymph circulation. Breath. Digestion. Selection. *References: [1] p. 110, 269-284, 380-389, 486-487, [5] pp. 8-10, 369-374, [12] pp. 506-527, 595-603.* *IWS: To evaluate the advantages and disadvantages of the human senses in comparison with other representatives of the animal world.*
7	***Animal tissues, organs and features of their functioning*** *Humoral regulation. Neural regulation. Formation of human behavior and psyche. Biorhythms.* *References: [1] p. 112, 146, [2] p. 269-342, 357-362, 380, 390, [7] pp. 374-459, [10] p. 505-603.* *IWS: Prepare for a discussion about neurohumoral regulation of the human body.*
8	***Metabolism and energy conversion in the cell*** *Enzymes. Enzyme catalysis. Mechanism of action of enzymes. Structure of enzymes. Rate of enzymatic reactions. Factors influencing the rate of enzymatic reactions. Inhibition of enzymes.* *References: [5] p. 464-474, [7] p. 95-104, [9] p. 28-33, [12] p. 137-142.* *IWS: Repeat the main features characteristic of the metabolism in the cell. What is their main difference from the phenomena and reactions that occur in inanimate objects?*
9	***Writing a Modular Test***

Laboratory classes

As part of the teaching of the discipline "Biology", laboratory work is provided, which occupy more than 33% of the classroom load.
During laboratory classes, environmental students should master the basic research methods used today in biology, get acquainted with the structure of the microscope and the basic techniques of working with it, learn how to use biological methods and approaches for environmental protection.

No	*Title of the laboratory work*	*Number of classroom hours*
1	*Cell structure. The use of microscopic methods in biology. Structure of an optical microscope. Production of live preparations of plant and animal cells.*	*4*
2	*Study of the phenomenon of photosynthesis in plants. Influence of environmental factors on the intensity of photosynthesis. Metabolic and non-*	*4*

	metabolic mechanisms of nutrient uptake by plants. Osmotic pressure. Turgor. Phenomena of plasmolysis and deplasmolysis. Stages of plasmolysis.	
3	*Plant tissue research. The importance of different types of tissues for plant survival in adverse conditions. Morphology of plants. Vegetative organs of plants: root, shoot, leaf. Modifications of vegetative organs (metamorphoses) and adaptive significance of modifications.*	*4*
4	*Morphology of flowering plants. Generative organs of plants. The formula of the flower and its importance as a taxonomic criterion. Inflorescence. Fruit.*	*4*
5	*Features of working with microorganisms. Furniture and equipment. Workplace. Rules of work and conduct. Sterilization of utensils and equipment. Methods of cultivation of microorganisms. Nutrient media. Distribution of microorganisms in nature.*	*4*
6	*Animal tissues: epithelial, muscle, connective. Blood. Composition and functions. Blood types. Nervous tissue.*	*4*
7	*Study of pro- and eukaryotic cells in stained smears. Stages of production of dyed preparations.*	*4*
8	*Morphology of protozoa. The importance of protozoa in the processes of purification and clarification of contaminated water. The simplest ones are indicator (indicative) organisms of the quality of activated sludge of treatment plants.*	*4*
9	*Study of biochemical activity of plant and animal tissues. Influence of environmental factors on enzymatic activity. Practical use of biochemical parameters in laboratory diagnostics, as well as in environmental bioindication and biotesting. Qualitative detection and quantification of biochemical activity. Units of enzymatic activity.*	*4*
	Total hours	***36***

6. Independent work of a student

Independent work takes up almost 49% of the time of studying the course "Biology", including the time allocated for preparation for writing a modular test and preparation for the exam.

The main task of students' independent work is to master scientific knowledge in the field of biology, which is not included in the list of lecture questions through personal search for information; systematization and repetition of the material covered; formation of active interest and creative approach to learning. In the process of independent work within the credit module "Biology", the student must learn to deeply analyze the fundamental and applied aspects of biology.

No	*Name of the topic to be submitted for self-study*	*Number of hours of IWS*

	Chapter 1. Biology in the system of natural sciences	
1	***Biology is – a system of wildlife sciences*** *Draw diagrams and make a table showing the various areas and subdivisions of biology, as well as its interaction with other sciences.* *References: [1] p. 10-5, [5] p. 8-21, [6] p. 4-5, [7] p. 5-17, [10] p. 15-19.*	*3*
2	***The Diversity of Life on Earth*** *To study the basic and secondary taxonomic ranks (categories) used to classify living organisms. Pay attention to the differences between individual groups of taxa for the Plant and Animal Kingdoms. Using the studied algorithm for determining taxonomic affiliation, give in the notebook the biological classification of the species Homo sapiens (Homo sapiens). Prepare for discussions on human impact on global biospheric processes and prospects for the conservation of animal and plant diversity in rapidly changing living conditions.* *References: [1] p. 11-24, [5] p. 18, 108, 249-254, 579-580, [6] pp. 13-144, [7] p. 6-7, 109-110, 174-175, 267-269, [12] pp. 22-29, 254-356, 476-577.*	*3*
3	***Historical development of the organic world*** *Review and systematize the lecture material. On its basis, create tables-schemes that reflect: 1) Names of the main groups of theories of the origin of life on Earth and their brief description; 2) Geochronological history of the Earth, indicating the main aromorphoses and idioadaptations that occurred in individual eras and periods. Prepare for discussions on the following topics: 1) "Evolution of the biosphere" and 2) "V.I. Vernadsky's teachings about the noosphere".* *References: [1] p. 482-498, 502-511, [5] p. 688-602, [10] pp. 96-140.*	*3*
	Chapter 2. Botany with Fundamentals of Ecology and Phytocenology	
4	***Taxonomy of plants and their general characteristics*** *Work through the lecture material. Write down the characteristic features of the main systematic groups of plants. Describe and sketch the life forms of plants.* *References: [1] p. 18-20, 71-99, [5] p. 194-242, [6] p. 174-266, [7] pp. 198-206.*	*5*
5	***Adaptations of plants to survive in different habitats*** *Prepare a table describing the advantages and disadvantages of living in aquatic, soil and non-terrestrial-air environments. Conduct an analysis and conclude on the presence of the most favorable environment for life.*	*5*

	References: [1] p. 20-22, 27-30, 64-67, [5] pp. 141, [7] p. 101-104, [10] p. 234-237.	
6	***Plant tissues and organs*** *Prepare for laboratory work: Write down the main types of plant tissues and their corresponding characteristics and signs.* *References: [1] p. 483-485, [5] p. 175-180, [6] p. 204-207.*	*5*
7	***Fundamentals of Phytocenology*** *Find information on the use of knowledge about ecological successions in practice. Prepare to discuss the types of terrestrial ecosystems and the distribution of the main terrestrial communities. Systematize information on the features and composition of the main terrestrial biomes: tundra, taiga, coniferous forests, deciduous forests, steppe, savannah, tropical rain forests, deserts and semi-deserts.* *References: [1] p. 239-242, 252-260, [7] p. 160-162, [8], [12] p. 272, 433-437, 545-546.*	*3*
	Chapter 3. Zoology with Fundamentals of Ecology	
8	***Taxonomy of animals*** *Work through the lecture material. Write down the characteristic features of the main taxonomic groups of animals. Describe the basic life forms of animals. Prepare for laboratory work: repeat the features of the morphological structure of protozoa. Prepare for the discussion of the following issues: 1) The importance of protozoa in the processes of purification and clarification of polluted water; 2) The simplest ones are indicator (indicative) organisms of the quality of activated sludge of treatment plants.* *References: [1] p. 108-230, [5] p. 267-366, [6] p. 342-485.*	*4*
9	***Adaptations of animals to survive in different habitats*** *Review and systematize the lecture material. View the previously prepared table that describes the advantages and disadvantages of living in aquatic, soil and extraterrestrial-air environments. Conduct an analysis and conclude on the availability of the most favorable living environment for animals.* *References: [1] p. 255-256, 488-489, 607-611, [5] p. 114-124, [10] p. 334-337.*	*3*
10	***Animal tissues, organs and features of their functioning*** *Prepare for laboratory work: Write down the main types of animal tissues and their corresponding characteristics and signs. Conduct a comparative analysis: 1) Structures of the nervous system in representatives of different taxonomic groups (description should be given in the form of a table); 2) Structure and function of the central and peripheral nervous system of man.*	*4*

	References: [1] p. 110, 269-284, 380-389, 486-487, [5] pp. 8-10, 369-374, [12] pp. 506-527, 595-603.	
11	***Information Perception, Animal Sensory Systems*** *Prepare short reports on the ethological (behavioral) structure of populations and social hierarchy in animals belonging to different taxonomic groups. To substantiate the existence of a relationship between animal behavior and the complexity/features of the functioning of the body's sensory systems. Prepare for the test.* *References: [1] p. 366-377, [5] p. 443-470, [7] p. 407-442, [12] p. 486-512.*	*3*
Chapter 4. Microbiology and its possibilities in solving environmental problems		
12	***General properties of microorganisms*** *List the main taxonomic subdivisions of prokaryotes. Write down in a notebook a list of harmful and beneficial microorganisms and their importance in human life. Reflect and write down a conclusion regarding: 1) The impossibility of life on Earth without prokaryotes; 2) The ecological significance of biotic relationships of microorganisms with each other and with other groups of organisms.* *References: [5] p. 101-104, [10] p. 182-195, 250-252, [11] pp. 16-20, 425-431.*	*3*
13	***Microorganisms in the Processes of Transformation of Natural and Synthetic Compounds*** *To describe the role of bacteria in the processes of soil formation and self-purification of water bodies.* *References: [5] p. 27, 101-104, 245, [11] p. 211-220, 336, 345-346, 425-428, 450-451.*	*3*
14	***Microbial decomposition of natural substances and synthetic compounds. Microbial Biotechnology*** *Find information about: 1) Use of secondary metabolites of microorganisms in medicine and other sectors of the national economy; 2) Production of organic acids by microbiological method; 3) The relationship between microorganisms and their production of antibiotics as a means of competition.* *References: [5] p. 27, 101-104, 245, [11] p. 211-220, 336, 345-346, 425-428, 450-451.*	*2*
Chapter 5. Cellular structure of organisms		
15	***Molecular level of organization of life*** *Review and systematize lecture materials. To characterize the role of phospholipids in the cell.*	*4*

	References: [3] p. 214-230, [4] p. 19-27, [5] pp. 34-56, [12] pp. 32-88.	
16	***Cellular level of life organization*** *Prepare a report on modern methods of cell structure research. To characterize the possibilities of using microscopic methods in biology. Carry out a comparative analysis of prokaryotic and eukaryotic cells. To substantiate the existence of advantages in cells of both types.* *References: [2] p. 5-50, [5] p. 210-342, [6] pp. 8-19, [9] pp. 91-103.*	*3*
17	***Reproduction and individual development of organisms*** *To substantiate the importance of reproduction as the main feature of life. Give a classification of forms of reproduction. Explain the essence of the cell cycle: phases of the cell cycle; morpho-physiological processes in the cell in preparation for division. To carry out a comparative analysis of the features of embryonic development in organisms of different groups. Types of postembryonic development: direct and indirect development.* *References: [2] p. 5-50, [5] p. 210-342, [6] pp. 8-19, [9] pp. 91-103.*	*2*
	Chapter 6. Physiological, biochemical and genetic bases of life	
18	***Metabolism and energy conversion in the cell*** *To provide a description of the basic properties of enzymes and their importance for life and the regulation of cell metabolism. Schematically depict the mechanism of action of enzymes and their structure. To reveal the concept of enzymatic catalysis. Explain how the rate of enzymatic reactions is determined. Determine the effect of environmental factors on enzymatic activity. Repeat the features of the functioning of the tricarboxylic acid cycle (Krebs cycle) and the respiratory chain. What is their biological role?* *References: [5] p. 464-474, [7] pp. 95-104, [9] pp. 28-33, [12] pp. 137-142.*	*4*
19	***Plastic metabolism*** *List and compare the main types of anabolic processes occurring in the cell: photosynthesis, chemosynthesis, protein biosynthesis. Find their similarities and differences.* *References: [5] p. 464-477, [7] p. 29-37, [12] p. 147-161.*	*4*
20	***Heredity and variability*** *Repeat the basic concepts and laws of genetics, patterns of heredity. Prepare for the test.* *References: [1] p. 194-197, [5] p. 492-514, [7] p. 272, 283-302, [12] p. 57-95.*	*2*
21	*Preparation for modular control test (MCT)*	*4*
22	*Exam Preparation*	*30*

Total Hours	**102**

Provision of program results by the components of the educational component

Program results	Lectures	Practical & Laboratory Lessons, individual task
To understand the basic environmental laws, rules and principles of environmental protection and nature management	Biology – is a system of life sciences. The diversity of life on Earth. Historical development of the organic world. Taxonomy of plants and their general characteristics. Taxonomy of plants and their general characteristics. Plant tissues and organs. Taxonomy of animals. Animal tissues, organs and features of their functioning. Perception of information, sensory systems of animals. General properties of microorganisms. Molecular level of life organization. Cellular level of organization of life. The cellular level of the organization of life. Reproduction and individual development of organisms. Reproduction and individual development of organisms. Metabolism and energy conversion in the cell. Plastic exchange. Heredity and variability	Historical development of the organic world Taxonomy of animals Metabolism and energy conversion in the cell
To understand the basic concepts, theoretical and practical problems in the field of natural sciences that are necessary for analysis and decision-making in the field of ecology, environmental protection and optimal use of nature	Biology as the foundation of theoretical ecology. Microbial decomposition of natural substances and synthetic compounds. Microbial Biotechnology	Osmosis (osmotic pressure) and its importance for the nutrition and existence of plant organisms. Isolation of metabolic products and osmoregulation in plants. Human Biology. The internal environment of the human body. The concept of homeostasis. Principles of regulation of the integrity of the human body.
To identify the factors that determine the formation of landscape and biological diversity	Biodiversity of the Earth and its ecological importance.	Adaptations of plants to survive in different habitats Adaptations of animals to survive in different habitats

	Plant life forms. Features of their practical use. *Fundamentals of Phytocenology* *Importance of photosynthesis.* *Microorganisms in the processes of transformation of natural and synthetic compounds.* *Interaction of genotype and environmental conditions.* *Genetics of populations. The effect of toxic substances on heredity. Artificial selection and its forms. Features of selection of plants, animals and microorganisms.*	
To raise the professional level by continuing education and self-education	*History of the development of biology*	*Human musculoskeletal system. Blood circulation and lymph circulation. Breath. Digestion. Selection. Humoral regulation. Neural regulation. Formation of human behavior and psyche. Biorhythms.*
To carry out laboratory researches with use of modern devices, to provide sufficient accuracy of measurement and reliability of results, to process the obtained results	*Research Methods in Biology*	*The study of living matter at different levels of its organization using biological methods. Observation method. Comparative method. Experimental method. Monitoring. Modeling. Field research methods. Statistical approach.* *Cell structure. The use of microscopic methods in biology. Structure of an optical microscope. Production of live preparations of plant and animal cells.* *Study of the phenomenon of photosynthesis in plants. Influence of environmental factors on the intensity of photosynthesis. Metabolic and non-metabolic mechanisms of nutrient uptake by plants. Osmotic pressure. Turgor. Phenomena of plasmolysis and*

		deplasmolysis. Stages of plasmolysis. *Plant tissue research. The importance of different types of tissues for plant survival in adverse conditions. Morphology of plants. Vegetative organs of plants: root, shoot, leaf. Modifications of vegetative organs (metamorphoses) and adaptive significance of modifications.* *Morphology of flowering plants. Generative organs of plants. The formula of the flower and its importance as a taxonomic criterion. Inflorescence. Fruit.* *Features of working with microorganisms. Furniture and equipment. Workplace. Rules of work and conduct. Sterilization of utensils and equipment. Methods of cultivation of microorganisms. Nutrient media. Distribution of microorganisms in nature.* *Animal tissues: epithelial, muscle, connective. Blood. Composition and functions. Blood types. Nervous tissue.* *Study of pro- and eukaryotic cells in stained smears. Stages of production of dyed preparations.* *Morphology of protozoa. The importance of protozoa in the processes of purification and clarification of contaminated water. The simplest ones are indicator (indicative) organisms of the quality of activated sludge of treatment plants.* *Study of biochemical activity of plant and animal tissues. Influence of environmental factors on enzymatic activity. Practical use of biochemical parameters in laboratory diagnostics, as well as in*

		environmental bioindication and biotesting. Qualitative detection and quantification of biochemical activity. Units of enzymatic activity.

Policy & Control

7. Academic discipline policy (educational component)

Rules for attending classes and behavior in the classroom

Students are obliged to take an active part in the educational process, not to be late for classes and not to miss them without a valid reason, not to interfere with the teacher's classes, not to be distracted by actions that are not related to the educational process.

Rules for assigning incentive and penalty points

Incentive points can be awarded by the teacher only for the performance of creative work on the discipline or additional completion of online profile courses with the receipt of the appropriate certificate:

- *https://courses.prometheus.org.ua/courses/course-v1:NMU+NMU102x+2018_T1*
- *https://courses.prometheus.org.ua/courses/course-v1:Prometheus+HISTOLOGY101+2017_T1/about*
- *https://www.coursera.org/learn/the-big-stuff-evolution-and-ecology*
- *https://www.coursera.org/learn/modeling-simulation-natural-processes*

The amount of incentive points may not exceed 10% of the rating scale.
Penalty points within the academic discipline are provided for untimely or unsatisfactory defense of laboratory work and sloppy preparation of laboratory protocols (see CRO).

Deadlines and retakes policy

In case of arrears in academic discipline or any force majeure, students must contact the teacher through the available (provided by the teacher) communication channels to resolve problematic issues and agree on an algorithm of actions for working out. In the absence of a modular test (MCR) on the day of writing, the student who provided the certificate of illness can write the MCR outside the classroom hours. Repeated writing of the ICR is not allowed.

Academic Integrity Policy

Plagiarism and other forms of dishonest work are unacceptable. Plagiarism includes the lack of references when using printed and electronic materials, quotes, opinions of other authors. Cheating during tests is prohibited. Inadmissible hints and cheating during tests and classes; passing a test for another student; copying copyrighted material without the permission of the author of the work.
The policy and principles of academic integrity are defined in Section 3 of the Code of Honor of the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute". Read more: https://kpi.ua/code.

Academic Conduct and Ethics Policy

Students should be tolerant, respect the opinion of others, formulate objections in the correct form, and constructively maintain feedback in the classroom.
The norms of ethical behavior of students and employees are defined in Section 2 of the Code of Honor of the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute". Read more: https://kpi.ua/code.

8. Types of control and rating system for assessing learning outcomes (RCOs)

Distribution of study time by types of classes and tasks in the discipline according to the working curriculum:

Semester	*Study time*	*Distribution of study hours*	*Control measures*

	Loans	Acad. Sci. H.	Lecture	Practical	Lab	IWS	MCT	KR	Semester Certification
1	7	210	54	18	36	102	1	–	Exam

The student's rating in the credit module consists of the points that he/she receives for:

1) active participation in the work of six practical classes;

2) performance and defense of 9 laboratory works;

3) performance of modular control work;

4) the answer in the exam.

Rating Points System and Evaluation Criteria

1. *Work in practical classes:*

Subject to good preparation and active participation in the discussion of all issues – 3 points, "excellent";

In-depth disclosure of one of the issues of the discussion, fluency in the material submitted for consideration – 2 points, "good";

Active participation in the discussion of certain debatable issues – 1 point, "satisfactory".

In case of absence from a practical lesson without a valid reason – (-2 points).

One or two of the best students may be given 1 point to encourage them.

Maximum number of points for work in practical classes: 3 points × 6 lessons = 18 points.

2. *Performance and defense of laboratory work:*

The grade for the laboratory work consists of the grades for:

Incoming control – 1 point,

Performance and defense of the work – 1 point.

Subject to good preparation, a properly executed protocol, satisfactory and timely defense of the work, the student receives 2 points for each completed laboratory work.

If there are shortcomings made in the performance (or defense) of the work, the student's grade for these positions is reduced.

In case of unsatisfactory entrance control, the student is not allowed to perform laboratory work.

In case of incorrect performance of work or violation of the protocol, the work is not counted and must be retaken. In this case, penalty points (-1 point) are awarded.

For late completion and registration of laboratory work without a valid reason, penalty points (-1 point) are awarded.

With especially careful work with the equipment, good mastering of the technique of conducting an experiment, the best students can add 1 point to encourage them.

Maximum number of points for laboratory work: 2 points × 9 works = 18 points.

3. *Module Test*:*

Modular control consist of four questions.

The weight score for each answer is 6. Each of the answers is evaluated separately, after which the points obtained are summed up.

The maximum number of points for a modular test is 6 points × 4 = 24 points.

Evaluation criteria for individual questions of modular tests:

Completeness and signs of response	**Points**
"Excellent": Complete answer to the question	*6*
"Good": The answer does not provide enough facts, examples, and conclusions, or there are some inaccuracies	*4... 5*
"Satisfactory": Partial answer given, specific wording of laws and terms is missing or serious errors have been made	*1... 3*
"Unsatisfactory": Question not counted or missing	*0*

**Modular tests can also be carried out in the form of testing.*

In total, students have to answer 48 questions related to different sections and topics of the discipline.

The weight score for each correct answer is 0.5 points. Each of the answers is evaluated separately, after which the points obtained are summed up.

The maximum number of points for writing a modular test is 0.5 points × 48 questions = 24 points.

Thus, the maximum amount of points of the starting component that a student can receive from the credit module "Biology" is:

$$RS = 6 \times 3 + 2 \times 9 + 6 \times 4 = 60 \text{ points}$$

The exam component is equal to 40% of R:

$$R_{Exam} = 40 \text{ points}$$

Thus, the rating scale for the credit module "Biology" is:

$$R = RS + R_{Exam} = 60 + 40 = 100 \text{ points.}$$

Students who have a rating of less than 36 points at the end of the semester, as well as those who want to improve their grade in the ECTS system, complete a test work. At the same time, the points for the test are added to the points that they received for the performance and defense of laboratory work, and this rating is final. The task of the test consists of questions related to the different topics of the work program. The list of questions for the test is given in Section 9 of the Syllabus.*

For the correct answer to each question, students receive 7 points. Therefore, the maximum number of points for a test is 7 points × 6 = 42 points.

The system of evaluation of individual questions of the test work:

Completeness and signs of answer	**Points**
"Excellent": Complete and correct answer to the question	*7*
"Good": The answer does not provide a sufficient number of facts, examples, does not draw conclusions, or makes some inaccuracies;	*4... 6*

"Satisfactory": A partial answer has been given, the specific form of the laws and terms is missing or gross errors have been made;	*1... 3*
"Unsatisfactory": Question not counted or missing	*0*

** The test can also be carried out in the form of testing.*
In total, students have to answer 42 questions related to different sections and topics of the discipline.

The weight score for each correct answer is 1.0 points. Each of the answers is evaluated separately, after which the points obtained are summed up.

The maximum number of points for writing a test is 1.0 points × 42 = 42 points.

According to the results of academic work in the first 7 weeks, the "ideal student" should score 10 points. At the first certification (8th week), a student receives an "enrolled" if his current rating is at least 5 points. According to the results of 13 weeks of study, the "ideal student" should score 31 points. At the second certification (14th week), the student receives "passed" if his current rating is at least 15 points.
A prerequisite for admission to the exam is the enrollment of all practical and laboratory classes, as well as the writing of a modular test. The permissible level of the starting rating must be at least 36 points.
At the exam, students receive an exam ticket. Each ticket contains 4 tasks that relate to different sections of the credit module. The answer to each question is worth 10 points.
Grading system for exam questions:

Completeness and signs of answer	***Points***
"Excellent": Complete answer to the question	*10*
"Good": The answer does not provide enough facts, examples, and conclusions, or there are some inaccuracies; Technical errors were made in the calculations	*6... 9*
"Satisfactory": Partial answer given, specific wording of laws and terms is missing or serious errors have been made	*1... 5*
"Unsatisfactory": Question not counted or missing	*0*

Table of correspondence of rating points to grades on the university scale:

Points	*Score*
100-95	*Perfectly*
94-85	*Very good*
84-75	*Well*
74-65	*Satisfactory*
64-60	*Enough*
Less than 60	*Disappointing*
Admission conditions are not met	*Not allowed*

9. Additional information on the discipline (educational component)

APPROXIMATE LIST OF TASKS FOR MCT

1. *Describe the methods and approaches used in biology. To give examples of the study of living matter at different levels of its organization using biological methods. Provide a list of biology units involved in the study of each specific level of organization of living things. To analyze the impact of the development of biology on scientific knowledge of the world and scientific and technological progress.*

2. *To give schemes of biological classification of living organisms and the principles of their nomenclature. Characterize the Earth's biodiversity; explain its ecological significance and implementation mechanisms.*
3. *Explain the basic principles of conservation of flora and fauna. Analyze the effects of anthropogenic environmental pollution on plants and animals. What is the purpose of the Red Book? List the subdivisions from which it is formed. What is the purpose of the Green Book of Ukraine?*
4. *Identify and substantiate the characteristics of living matter. List the theories of the origin of life on Earth and their main postulates. Substantiate the plausibility of various theories of the origin of life.*
5. *Describe the theory of biochemical evolution and the nature of the first organisms. Determine the role of natural selection in this process. Compare the processes of macro- and microevolution. To characterize the forms, directions and paths of macroevolution.*
6. *To reveal the role of osmotic pressure and substantiate its importance for the nutrition and existence of plant organisms.*
7. *To substantiate the biospheric role and characterize the main features of the representatives of the kingdom Fungi and the Lichen group. To demonstrate the possibilities of using lichens as indicators of air purity in areas of man-made pollution.*
8. *To characterize the role, economic significance and features of the subkingdoms Lower Plants and Algae.*
9. *To characterize the features of higher plants associated with the terrestrial way of life. Analyze plant adaptations to survive in different habitats.*
10. *To give a comparative characteristic of gymnosperms and angiosperms. Point out the environmental benefits of these groups.*
11. *Give the division of plant tissues into types. Describe in detail the functions, structural features and significance of: creative tissues; basic tissues; conductive tissues (trachea, tracheids and sieve tubes); integumentary tissues; mechanical fabrics. To reveal the importance of different types of tissues for the survival of plants in various environments and adverse living conditions.*
12. *To reveal the importance of the pollination process in plants and list its main methods. Describe the process of double fertilization in plants and explain its evolutionary-adaptive significance.*
13. *Characterize the subkingdom Unicellular. Describe the features of the structure, physiology and reproduction of representatives of different types of this subkingdom. To substantiate the role of protozoa in human activity and their importance in the processes of purification and clarification of polluted water.*
14. *To provide a comparative and morphological characterization of the Sponge and Intestinal cavities types. Describe the features of the structure, physiology and reproduction of representatives of these types, their role in nature and importance in human life. Make generalizations about systems in which evolutionary changes and complications have occurred.*
15. *To provide a comparative and morphological characterization of the types: Flatworms, Roundworms and Annelids. Describe the features of the structure, physiology and reproduction of representatives of these types, their role in nature and importance in human life. Make generalizations about systems in which evolutionary changes and complications have occurred.*
16. *To provide a comparative morphological characterization of the phyla Mollusca and Echinoderma. Describe the features of the structure, physiology and reproduction of representatives of these types, their role in nature and importance in human life. Make generalizations about systems in which changes or complications have occurred.*
17. *To carry out a comparative analysis of the classes of Arthropods, taking into account the structure of the body, the organs of locomotion, the digestive, respiratory, circulatory, excretory and nervous systems. To conclude on the evolutionary complication within this phylum.*
18. *To give the characteristic features of the Chordate type (features of the external and internal structure, the course of vital processes). List the subphyla, superclasses and classes of animals included in a given taxon. To conclude on the diversity of the phylum Chordates and the ecological significance of such diversity.*

19. *To list and describe the general properties of microorganisms that determine their ecological significance in nature and as objects of biotechnology. Determine the place and position of microorganisms in nature using biological and ecological classifications. Harmful and beneficial microorganisms. General properties of microorganisms.*
20. *Describe the participation of microorganisms in the circulation of substances in the biosphere. Give diagrams and examples.*
21. *To reveal the importance of the microflora of water, air and soil, and their role in the processes of self-purification of the natural environment. Describe the processes that occur during self-purification of water bodies. To draw a conclusion about the possibilities of using microorganisms for water purification.*
22. *List the sources of microbial contamination of water bodies. Determine the importance of bacteria of the Escherichia coli group in the contamination process. Provide a list of sanitary-indicative microorganisms. What are the stages of sanitary and bacteriological examination of water?*
23. *To characterize the soil as the habitat of microorganisms and the product of their vital activity. List the groups of microorganisms involved in the formation of humus. To compare the features of microorganisms that are important in the self-purification of the soil from organic contaminants; resistant to degradation of natural organic compounds and xenobiotics.*
24. *List the properties that allow microorganisms to carry out the destruction and transformation of xenobiotics of various origins. To provide a list of possibilities for the use of microorganisms in modern microbial biotechnologies: obtaining microbial protein, amino acids, enzymes and vitamins with the participation of microorganisms.*
25. *Characterize the chemical composition of the cell. To reveal the essence of the concepts of macro- and microelements, biogenic elements. List the main macromolecules that make up the cell. Describe their features, structure and biological significance. To reveal the essence of the concept of "biologically active substances of the cell".*
26. *To characterize the chemical composition, essence and properties of the cytoplasm of cells. Structure and function of the cell membrane. Transport of substances through membranes.*
27. *Describe the structure, properties, and functions of the cell's double-membrane organelles.*
28. *Describe the structure, properties, and functions of single-membrane cell organelles.*
29. *Describe the structure, properties, and functions of non-membrane cell organelles.*
30. *Describe and characterize the structural features of a plant cell.*
31. *To characterize enzymes: their properties, features and importance for life and regulation of cell metabolism. Classification of enzymes. Schematically depict the mechanism of action of enzymes and their structure. How is the rate of enzymatic reactions determined?*
32. *Describe the essence and explain the physiological significance of glycolysis.*
33. *Compare the processes of aerobic and anaerobic respiration. To substantiate the energy benefits of aerobic respiration and the need for the existence of anaerobic respiration.*
34. *To characterize the types of energy metabolism of anaerobic organisms. Types of fermentation.*
35. *To reveal the features of the functioning of the tricarboxylic acid cycle (Krebs cycle) and the respiratory chain. What is their biological role?*
36. *Describe the main types of anabolic processes occurring in the cell: photosynthesis, chemosynthesis, protein biosynthesis, etc. Stages of protein biosynthesis.*

LIST OF EXAM QUESTIONS AND QUESTIONS FOR THE TEST

1. *Schematically depict the structure of the biological sciences. To characterize the relationships of biology with other sciences. To reveal the specifics and scope of competence of ecology in comparison with other biological sciences.*
2. *To give examples of the study of living matter at different levels of its organization using biological methods. Provide a list of biology units involved in the study of each specific level of organization of living things. Describe the methods and approaches used in biology.*
3. *To characterize the possibilities of using microscopic methods in biology. Describe the structure of an optical microscope and the stages of manufacturing live and fixed preparations of plant and animal cells.*
4. *List the most significant discoveries in the field of biology and related sciences. To analyze the impact of the development of biology on scientific knowledge of the world and scientific and technological progress.*
5. *To provide schemes of biological classification of living organisms and the principles of their nomenclature.*
6. *Characterize the Earth's biodiversity; explain its environmental significance and implementation mechanisms.*
7. *Explain the basic principles of conservation of flora and fauna. What is the purpose of the Green Book of Ukraine?*
8. *Analyze the consequences of anthropogenic environmental pollution for wildlife. What is the purpose of the Red Book? List the subdivisions from which it is formed.*
9. *To analyze and provide an opinion on the prospects for the conservation of animal and plant diversity in rapidly changing living conditions.*
10. *Describe the processes that lead to biological contamination of individual territories and regions. Analyze the causes and consequences of this phenomenon.*
11. *To give examples of the emergence and spread of new dangerous diseases in the modern world. Conduct an analysis of the environmental causes and social consequences of this phenomenon.*
12. *Carry out a comparative analysis of prokaryotic and eukaryotic cells. To substantiate the existence of advantages in cells of both types.*
13. *To characterize the main properties of prokaryotes and the features of their structure.*
14. *Analyze the features of viruses and bacteria as the smallest microscopic organisms. Origin and properties of viruses.*
15. *Identify and substantiate the characteristics of living matter.*
16. *List the theories of the origin of life on Earth and their main postulates. Substantiate the plausibility of various theories of the origin of life.*
17. *To present the basics of the theory of evolution and the main stages in the development of evolutionary views.*
18. *To characterize the synthetic theory of evolution and its main provisions. The role of natural selection.*
19. *To present modern views on the evolution of the organic world. List the facts that serve as evidence for the theory of evolution.*
20. *Compare the processes of macro- and microevolution. To characterize the forms, directions and paths of macroevolution.*
21. *Describe the theory of biochemical evolution and the nature of the first organisms. Determine the role of natural selection in this process.*
22. *To reveal the current state of knowledge regarding the origin of man.*

23. *Characterize the kingdom of the Plant. To give the main properties and economic significance of its representatives.*
24. *List the life forms of plants and their ecological significance.*
25. *Justify the role and characterize the kingdom of Fungi.*
26. *To characterize the role, economic importance and characteristics of the subkingdom: Lower plants; Algae and Lichens.*
27. *To demonstrate the possibilities of using lichens as indicators of air purity in areas of man-made pollution.*
28. *To characterize the features of higher plants associated with the terrestrial way of life.*
29. *Analyze plant adaptations to survive in different habitats.*
30. *To reveal the role of osmotic pressure and substantiate its importance for the nutrition and existence of plant organisms.*
31. *Compare metabolic and non-metabolic mechanisms of nutrient uptake by plants.*
32. *Explain the essence of the phenomena of plasmolysis and deplasmolysis. Draw the main stages of plasmolysis.*
33. *To give a comparative characteristic of gymnosperms and angiosperms. Point out the environmental benefits of these groups.*
34. *Determine the ecological benefits of seed plants. To provide an analysis of the features of anatomy, morphology and physiological and biochemical properties of plants, on which these advantages are based.*
35. *To reveal the role of higher plants in nature and human life.*
36. *Give the division of plant tissues into types. Describe in detail the functions, structural features and significance of: creative tissues; basic tissues; conductive tissues (trachea, tracheids and sieve tubes); integumentary tissues; mechanical fabrics.*
37. *To reveal the importance of different types of tissues for the survival of plants in various environments and adverse living conditions.*
38. *To describe the functions, structural features and modifications (metamorphoses) of the main vegetative organs of plants: root, shoot, leaf. To provide an opinion on the adaptive value of modifications.*
39. *To reveal the significance of the appearance of a system of generative organs in plants. Describe their structure. The formula of the flower and its importance as a taxonomic criterion. Give a classification of the types of inflorescences and fruits.*
40. *To reveal the importance of the pollination process in plants and list its main methods.*
41. *Describe the process of double fertilization in plants and explain its evolutionary-adaptive significance.*
42. *To determine the role of plant communities in the Earth's ecosystems. Describe their spatial structure, significance for the formation of landscapes and successional changes that occur in them.*
43. *To characterize the diversity and ecological significance of the Earth's wildlife. To give the principles of classification and comparative characteristics of different systematic groups.*
44. *Characterize the subkingdom Unicellular (Protozoa). Determine the biological and ecological features and place of protozoa in nature.*
45. *Describe the features of the structure, physiology and reproduction of representatives of the class: Sarcodes, Flagellates, Ciliates; Spore-catchers.*
46. *To substantiate the role of protozoa in human activity and their importance in the processes of purification and clarification of polluted water. Indicator organisms.*

47. *Characterize the phylum Sponges, Intestinal cavities, Flatworms, Roundworms, Annelids, Mollusks; Arthropods; Echinoderms. Describe the features of the structure, physiology and reproduction of representatives of the phylum, their role in nature and importance in human life.*
48. *Give a list of parasitic representatives of the phyla Protozoa, Flatworms and Roundworms. Describe the features of their life cycles and analyze the danger of these representatives to humans and animals.*
49. *Characterize the class: Crustaceans; Arachnids and their role in nature and human life. Describe the features of their structure, physiology, adaptive adaptations and behavioral reactions.*
50. *Describe the class Insects as the most numerous class on Earth. Give a list of the main series belonging to this class, representatives of each series and their adaptive features. To analyze the prospects for the use of insects in the national economy and the importance of insects in nature.*
51. *To carry out a comparative analysis of the classes of Arthropods, taking into account the structure of the body; locomotor organs; digestive, respiratory, circulatory, excretory and nervous systems. To conclude on the evolutionary complication within this phylum.*
52. *To provide a comparative morphological characterization of the phyla Annelids and Arthropods. Make generalizations about systems in which evolutionary changes and complications have occurred.*
53. *Give the characteristic features of the Chordate type. List the subphyla, superclasses and classes of animals included in a given taxon. To conclude on the diversity of the phylum Chordates and the ecological significance of such biodiversity.*
54. *To carry out a comparative analysis of the classes of Vertebrates, taking into account the peculiarities of the structure of the body; nervous system; sensory organs and reproduction of representatives of these classes. To draw a conclusion about the adaptive capabilities of this subtype in different environmental conditions.*
55. *To provide a comparative description of the classes of Vertebrates, taking into account the peculiarities of their anatomical structure; digestive, respiratory, circulatory and excretory systems. To prove the existence of an evolutionary complication within this subtype.*
56. *To analyze the features of the anatomical structure of animals for survival in different habitats.*
57. *List the features of the anatomical structure and physiological and biochemical adaptations of animals that enable them to survive in different environmental conditions.*
58. *Give the division of animal tissues into types. Describe in detail the functions, structural features and significance of: epithelial, muscular and connective tissues.*
59. *To provide an exhaustive description of the structure, composition and features of the functioning of nervous tissue. To point out the importance of nervous regulation processes in the evolutionary aspect.*
60. *To conduct a comparative analysis of the structure of the nervous system of representatives of different taxonomic groups. To link the structural features of the nervous system with the complexity and perfection of behavioral adaptations of animals.*
61. *To characterize the functions of blood as a liquid connective tissue of the animal body. Describe the composition of blood, the mechanisms of maintaining homeostasis, the features of its classification into groups.*
62. *Describe the structure and function of the brain and spinal cord. Analyze their participation in the processes of higher nervous activity.*
63. *To characterize the structure and function of the peripheral nervous system. What subsystems is it divided into?*

64. *Analyze the importance of the body's sensory systems for the body's connection with the external environment. Describe the structure and features of the functioning of systems that provide the perception of: light; Sounds; Smells; Flavors; gravitational field; skin sensitivity.*
65. *Describe the basic principles of regulation of the integrity of the internal environment of the human body. Explain the concept of homeostasis.*
66. *To reveal the importance of endocrine glands for maintaining homeostasis in the human body. Give a list-classification of glands and the secretions they produce.*
67. *Describe the structural features of the human musculoskeletal system.*
68. *To characterize the features of blood circulation and lymph circulation in the human body.*
69. *Describe the human respiratory system, its structure and function.*
70. *To characterize the processes that occur during the digestion of food in the gastrointestinal tract and the absorption of nutrients.*
71. *Schematically describe the human digestive system. What features of the structure and functioning ensure the completeness of the digestion of food and the absorption of the necessary nutrients by the body?*
72. *To characterize the structure, functions, components and conditions of functioning of the excretory system of the human body.*
73. *Schematically describe the processes of humoral regulation in the human body.*
74. *To substantiate the importance and possibilities of microbiology in solving environmental problems.*
75. *To list and describe the general properties of microorganisms that determine their ecological significance in nature and as objects of biotechnology.*
76. *Determine the place and position of microorganisms in nature using biological and ecological classifications.*
77. *To reveal the taxonomic diversity of microorganisms and their importance in the environment. Harmful and beneficial microorganisms. General properties of microorganisms.*
78. *Describe the participation of microorganisms in the circulation of substances in the biosphere. Give diagrams and examples.*
79. *To reveal the importance of the microflora of water, air and soil, and their role in the processes of self-purification of the natural environment.*
80. *Describe the processes that occur during self-purification of water bodies. To draw a conclusion about the possibilities of using microorganisms for water purification.*
81. *Provide a list of sanitary-indicative microorganisms. What are the stages of sanitary and bacteriological examination of water?*
82. *List the sources of microbial contamination of water bodies. Determine the importance of bacteria of the Escherichia coli group in the contamination process.*
83. *To characterize the soil as the habitat of microorganisms and the product of their vital activity. List the groups of microorganisms involved in the formation of humus.*
84. *To compare the features of microorganisms that are important in the self-purification of the soil from organic contaminants; resistant to degradation of natural organic compounds and xenobiotics.*
85. *To characterize the relationships and mutual influence of plants, animals and microorganisms in the formation of soil and its microbocenoses.*
86. *Describe the mechanisms of formation and maintenance of immunity in the human body.*
87. *List the properties that allow microorganisms to carry out the destruction and transformation of xenobiotics of various origins.*

88. *To provide a list of possibilities for the use of microorganisms in modern microbial biotechnologies: obtaining microbial protein, amino acids, enzymes and vitamins with the participation of microorganisms.*
89. *To characterize the biological and ecological properties of microorganisms that allow obtaining highly effective drugs through their use. Other ways of using microbiology in science and the national economic sector.*
90. *Characterize the chemical composition of the cell. To reveal the essence of the concepts of macro- and microelements, biogenic elements.*
91. *List the main macromolecules that make up the cell. Describe their features, structure and biological significance. To reveal the essence of the concept of "biologically active substances of the cell".*
92. *Describe the cell as a structural and functional unit of living organisms. Conduct a comparative analysis of the cell structure of prokaryotes and eukaryotes.*
93. *To give the main provisions of the cell theory of Schwann and Schleiden. Schematically depict the structure of a eukaryotic cell.*
94. *To characterize the chemical composition, essence and properties of the cytoplasm of cells. Structure and function of the cell membrane. Transport of substances through membranes.*
95. *Describe the structure, properties, and functions of the cell's double-membrane organelles.*
96. *Describe the structure, properties, and functions of single-membrane cell organelles.*
97. *Describe the structure, properties, and functions of non-membrane cell organelles.*
98. *Describe and characterize the structural features of a plant cell.*
99. *To substantiate the importance of reproduction as the main feature of life. Give a classification of forms of reproduction.*
100. *Explain the essence of the cell cycle: phases of the cell cycle; morpho-physiological processes in the cell in preparation for division.*
101. *Describe the process of mitosis: phases and biological significance.*
102. *Describe the process of meiosis: phases and biological significance.*
103. *Characterize the variety of modes of asexual reproduction. Types of cell division underlying asexual reproduction.*
104. *What is the mechanism by which sexual reproduction of organisms occurs? To give the forms of sexual reproduction and its biological (evolutionary) significance.*
105. *Carry out a comparative analysis of asexual and vegetative reproduction. Analyze the possibilities of these forms of reproduction and their advantages.*
106. *Characterize the methods of plant propagation.*
107. *Describe the stages of individual development of organisms. Embryonic and post-embryonic development.*
108. *To carry out a comparative analysis of the features of embryonic development in organisms of different groups. Types of postembryonic development: direct and indirect development.*
109. *To characterize enzymes: their properties, features and importance for life and regulation of cell metabolism. Classification of enzymes.*
110. *Describe the ways in which different organisms obtain energy. Autotrophic and heterotrophic organisms. Mixotrophic nutrition.*
111. *To characterize the main stages of energy metabolism.*
112. *Explain the nature and physiological significance of glycolysis.*
113. *Compare the processes of aerobic and anaerobic respiration. To substantiate the energy benefits of aerobic respiration and the need for the existence of anaerobic respiration.*

114. *To characterize the types of energy metabolism of anaerobic organisms. Types of fermentation.*
115. *To reveal the features of the functioning of the tricarboxylic acid cycle (Krebs cycle) and the respiratory chain. What is their biological role?*
116. *To reveal the concept of enzymatic catalysis. Schematically depict the mechanism of action of enzymes and their structure.*
117. *Analyze the influence of environmental factors on enzymatic activity. Describe the process of enzyme inhibition. How is the rate of enzymatic reactions determined?*
118. *Describe the main types of anabolic processes occurring in the cell: photosynthesis, chemosynthesis, protein biosynthesis, etc.*
119. *Describe in detail the light and dark phases of plant photosynthesis. Substantiate the importance of photosynthesis. Describe the influence of environmental factors on the intensity of photosynthesis.*
120. *To characterize the features of the course and substantiate the ecological significance of bacterial photo- and chemosynthesis.*
121. *Ways to feed animals. Heterotrophic nutrition. Different methods of heterotrophic nutrition. Mammalian nutrition.*
122. *To give the equation of the energy balance of consumers. To substantiate the main sources of energy intake and expenditure by different groups of organisms: herbivores, predators, saprotrophs.*
123. *To reveal the mechanisms and patterns of heredity and variability. To characterize the effect of toxic substances on heredity.*
124. *List and decipher the basic concepts of genetics. Explain the molecular genetic basis of heredity.*
125. *Describe the molecular organization of the genome of prokaryotes and eukaryotes. Analyze the possibilities of interaction between genotype and environmental conditions.*
126. *Describe and compare the organization of the genome in different groups of organisms. Give a schematic representation of the types of mutations.*
127. *To provide a comparative characterization of the forms of variability of organisms. To substantiate the importance of variability for evolution.*
128. *Provide a description of the forms and types of artificial selection. Describe the features of the selection of plants, animals and microorganisms.*

Work program of the discipline (syllabus):

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