

National University of Life and Environmental Sciences of Ukraine

Department of plants physiology, biochemistry and bioenergetic

«APPROVED»

Faculty of Plant protection, Biotechnology and Ecology

«21» May 2026

CURRICULUM OF ACADEMIC DISCIPLINE
BIOCHEMISTRY

Area of knowledge G “Engineering, Manufacturing and Construction”

Specialty G21 «Biotechnology and bioengineering»

Academic program «Biotechnology and bioengineering»

Faculty of Plant protection, Biotechnology and Ecology

Developed by: Head of department, Dr. of Sci., Prof. Prylutska S.V., Dr., ass. Prof. Tkachenko T.A.

Description of discipline «BIOCHEMISTRY»

The discipline "Biochemistry" studies the chemical composition of the living organisms and environment, as well as the relationships between them. Comprehensive knowledge of the structure, physical, chemical and biological properties of chemical and organic compounds, which are a component of the environment and all living things, their rational complementarity, are essential and necessary for the further application of the knowledge and skills of biotechnologists in their professional activities. In the living nature, there is a constant balance between diversity and stability due to the presence of numerous regulatory mechanisms and communications, which are based on complex biochemical transformations. Therefore, the study of biochemical foundations lays the foundation for understanding the deep processes of interaction between different living organisms, both among themselves and in ecosystems.

The academic discipline Biochemistry consists in familiarizing students with the structure, properties of chemical elements and their compounds, the main classes of bioorganic compounds, their classification, functions and properties, biochemical mechanisms of adaptation of living organisms and the transformation of exo- and endogenous compounds. Theoretical aspects of the discipline are reinforced by students in laboratory classes in order to acquire and consolidate practical skills when working in a chemical, biochemical, biotechnological laboratory, which will allow them to plan scientific research and analyse the obtained experimental data in the future.

Area of knowledge, specialty, academic programme, academic degree		
Area of knowledge	G Engineering, Manufacturing and Construction	
Academic degree	«Bachelor»	
Specialty	G21 «Biotechnology and bioengineering»	
Academic program	«Biotechnology and bioengineering»	
Characteristics of discipline		
Type	Normative	
Total number of hours	180	
Number of ECTS credits	4	
Number of modules	2	
Coursework	50 hours	
Form of assessment	Exam	
Indicators of the discipline for full-time and part-time forms of university study		
	Full-time	Part-time
Year of study	2	2
Term	4	4
Lectures	45 h	4 h
Practical, seminars	-	-
Labs	60 h	6 h
Self-study	75 h	170 h
Number of hours per week for full-time students	7h	

1. The aim, competences and expected learning outcomes of the discipline

The aim of discipline "Biochemistry" is studying the chemical composition of the living organisms and environment, as well as the relationships between them. Comprehensive knowledge of the structure, physical, chemical and biological properties of chemical and organic compounds, which are a component of the environment and all living things, their rational complementarity, are essential and necessary for the further application of the knowledge and skills of biotechnologists in their professional activities. In the living nature, there is a constant balance between diversity and stability due to the presence of numerous regulatory mechanisms and communications, which are based on complex biochemical transformations. Therefore, the study of biochemical foundations lays the foundation for understanding the deep processes of interaction between different living organisms, both among themselves and in ecosystems.

List of educational components that precede the study of the academic discipline (if any) Inorganic chemistry, Organic Chemistry, Analytic Chemistry. Cell Biology

Competencies of the academic discipline:

Competence acquired (IC):

The ability to solve complex specialized tasks and practical problems characterized by complexity and uncertainty in biotechnology and bioengineering, or in a learning process involving the application of theories and methods of biotechnology and bioengineering.

General competence (GC):

GC 01. Ability to apply knowledge in practical situations

GC 02. Ability to communicate in written and oral English (professional)

GC 03. Ability to communicate in a foreign language

GC05. Ability to learn and master modern knowledge

GC 09. Ability to preserve and increase moral, cultural, scientific values and achievements of society based on understanding the history and patterns of development of the subject area, its place in the general system of knowledge about nature and society and in the development of society, technology and engineering, to use various types and forms of physical activity for active recreation and leading a healthy lifestyle. К01. Здатність застосовувати знання у практичних ситуаціях

Special (professional, subject) competences (SC):

SC 12. Ability to use thorough knowledge of chemistry and biology to the extent necessary to achieve other outcomes of the educational program

SC 14. Ability to work with biological agents used in biotechnological processes (microorganisms, fungi, plants, animals, viruses, their individual components)

SC 15. Ability to conduct experimental research on the improvement of biological agents, including causing changes in the structure of the hereditary apparatus and functional activity of biological agents

Additional (professional, subject) competencies (AC)

AC 27. Ability to use serological and immunological tests, genome mapping, immunodiagnostic methods, planning and organizing diagnostics and identification of pathologies of fruit and vegetable crops, technological processes of plant cell

regeneration, managing them according to modern methods of control of technological operations and finished products; production design according to environmental protection requirements.

Program learning outcomes (PR):

PR02. Be able to perform qualitative and quantitative analysis of substances of inorganic, organic and biological origin, using appropriate methods.

PR06. Be able to determine and analyze the main physicochemical properties of organic compounds that are part of biological agents (proteins, nucleic acids, carbohydrates, lipids).

PR11. Be able to perform basic genetic and cytological research to improve and increase the biosynthetic ability of biological agents, taking into account the principles of biosafety, bioprotection and bioethics (induced mutagenesis using physical and chemical mutagenic factors, selection and accumulation of auxotrophic mutants, transfer of genetic information, etc.).

PR12. Using microbiological, chemical, physical, physicochemical and biochemical methods, be able to carry out chemical control (determination of the concentration of disinfectant solutions, titrating agents, concentration of nutrient medium components, etc.), technological control (concentration of carbon and nitrogen sources in the culture liquid during the process; concentration of the target product); microbiological control (determination of the microbiological purity of nutrient media after sterilization, microbiological purity of a biological agent, etc.), microbiological purity and sterility of biotechnological products for various purposes.

PR22. Be able to take into account social, environmental, ethical, economic aspects, requirements of labor protection, industrial sanitation and fire safety when forming technical solutions. Be able to use various types and forms of physical activity for active recreation and leading a healthy lifestyle.

PR25. Be able to use methods of microscopic studies, technologies of monoclonal antibodies, antigens, immunodiagnosics, identification of antigens in plant tissues, isoenzymes and storage proteins, DNA markers, basic principles of PCR, DNA probes, molecular genetic markers.

2. Program and Structure of the discipline Biochemistry

Modules and topics	Number , hours													
	full-time								part-time					
	numb er	tot al	including					total	including					
			1	pr	lab	ind	indep		1	pr	lab	ind	indep	
2	3	4	5	6	7	8	9	10	11	12	13	14		
Module I. Molecular and chemical composition of living organisms.														
Theme 1. Introduction to the Biochemistry.	1	7	2		2		3	8						8
Theme 2. Modern biochemical methods.	2-3	10	4		2		4	10	1					9
Theme 3. The molecular and chemical composition of living organisms.	4	10	2		4		4	10	1					9
Theme 4. Buffer systems.	5	10	2		4		4	10			1			9
Theme 5. The role of water in the life of living organisms.	5	10	2		4		4	9						9
Theme 6. The molecular and supramolecular organization of cells.	6	8	2		2		4	9						9
Theme 7. Xenobiotics, bioactivity and biotransformation	7	10	4		2		4	9						9
Number for thematic module 1	65		18		20		27	65	2		1			62
Module II. Bioorganic compounds - structure and properties														
Theme 1. Protein	7	10	2		4		4	10	1					9
Theme 2. Amino acids	8	10	2		4		4	10			1			9
Theme 3. Physico-chemical properties of proteins and amino acids	9	10	2		4		4	10			1			9

Theme 4. The levels of structural organization of protein.	9	8	2		2		4	9					9
Theme 5. Plant proteins. Nitrogen cycle	10	8	2		2		4	9					9
Theme 6. Carbohydrates.	11	10	2		4		4	11	1		1		9
Theme 7. Nucleic acids.	11	10	2		4		4	10			1		9
Theme 8. Structure and properties of DNA.	12	10	2		4		4	9					9
Theme 9. Structure and properties of RNA.	13	10	2		4		4	9					9
Theme 10. Lipids.	13	10	2		4		4	10			1		9
Theme 11. Biologically active substances of plants	14-15	8	4		2		4	9					9
Theme 12. Antioxidant system of living organisms	15	9	3		2		4	9					9
Number for thematic module 2		115	27		40		48	115	2		5		108
Total number		180	45		60		75	180	4		6		170

3. Topics of Lectures

№	Topic	Number, hours
1	Introduction to the Biochemistry	2
2	Modern biochemical methods	4
3	The molecular and chemical composition of living organisms	2
4	Buffer systems	2
5	The role of water in the life of living organisms	2
6	The molecular and supramolecular organization of cells	2
7	Xenobiotics, bioactivity and biotransformation	4
8	Protein	2
9	Amino acids	2
10	Physical and chemical properties of proteins and amino acids	2

11	The levels of structural organization of protein	2
12	Plant proteins. Nitrogen cycle	2
13	Carbohydrates	2
14	Nucleic acids	2
15	Structure and properties of DNA	2
16	Structure and properties of RNA	2
17	Lipids	2
18	Biologically active substances of plants	4
19	Antioxidant system of living organisms	3
	Total	45

4. Topics of Labs

No	Topic	Number, hours
1	Safety techniques in a biochemical laboratory. Provision of first aid in case of accidents.	2
2	Familiarization with the operation of laboratory devices and equipment (potentiometer, magnetic stirrer, centrifuge, photoelectrocolorimeter, spectrophotometer)	2
3	Preparation of solutions of a given concentration (molar, percentage, etc.)	4
4	Preparation of buffer solutions: acid (acetate buffer system ($\text{CH}_3\text{COOH} + \text{CH}_3\text{COONa}$); hydrophosphate ($\text{K}_2\text{HPO}_4 + \text{KH}_2\text{PO}_4$); bicarbonate ($\text{H}_2\text{CO}_3 + \text{NaHCO}_3$); hemoglobin ($\text{HHb} + \text{KHb}$); oxyhemoglobin ($\text{HHbO}_2 + \text{KHbO}_2$), basic (ammonia buffer: $\text{NH}_4\text{OH} + \text{NH}_4\text{Cl}$), phosphate buffer system, hydrogen carbonate buffer system ($\text{H}_2\text{CO}_3, \text{NaHCO}_3$).	4
5	Determination of pH in buffer solutions, water, soil, biological fluids.	2
6	Study of osmotic phenomena in living cells	2
7	Preparation and research of the properties of colloidal solutions.	2
8	Qualitative determination of mineral substances. Ashing methods. Microchemical analysis of ash.	4
9	Qualitative reactions of non-protein nitrogenous compounds.	2
10	Qualitative reactions of nitrates in plant material.	2
11	Color (qualitative) reactions of proteins and amino acids.	4
12	Protein precipitation reactions. Physicochemical properties of proteins.	4
13	Isolation of proteins from plant material.	2
14	Determination of the isoelectric point (IP) of proteins.	2
15	Qualitative reactions of monosaccharides.	2

16	Qualitative reactions of polysaccharides. Hydrolysis of starch and fiber.	2
17	Research of the quantitative content of glucose in plant material	2
18	Isolation of nucleoproteins from yeast.	2
19	Qualitative reactions to the components of nucleoproteins (proteins, monosaccharides (ribose and deoxyribose), purine bases, phosphoric acid).	4
20	Lipid solubility and emulsion formation.	2
21	Determination of chemical parameters of fats.	2
22	Determination of the amount of biologically active substances (anthocyanins) in plant material	2
23	Determination of the activity of antioxidant enzymes in plant leaves	4
	Total	60

5. Topics of self-study

№	Topic	Number, hours
1	The history of the development of biochemistry. The contribution of outstanding domestic and foreign scientists to the development of biochemistry as a science.	5
2	Scientific discoveries in the field of Biochemistry. Nobel laureates.	5
3	Methods of isolation and purification, separation of proteins - salting out, electrophoresis, chromatography, Western blot analysis, PCR, etc.	5
4	Technologies for the selection and storage of biological materials (cell suspensions, tissues, blood, etc.).	5
5	Source of vegetable proteins. Characteristics of plant proteins and their importance. Amino acid composition of plant proteins.	5
6	The role of amino acids in the protection of agricultural crops from stress.	5
7	Biologically active substances of plant origin. Their role in the processes of photosynthesis and respiration.	5
8	Phytohormones and their regulatory role.	5
9	Accumulation of nutrients in plant cells and tissues.	5
10	Ways of entry of substances into the cell and mechanisms of removal from the cell.	5
11	Selective accumulation of chemical and radioactive elements by plant organs and tissues. Consequences.	5
12	Structural, biochemical and physiological features/differences of plant and animal cells.	5

13	Plant antibiotics - classification, mechanism of action and role.	5
14	Molecular biological and biochemical mechanisms of action of chemical carcinogens. Stages, metabolic transformations, cell penetration, etc.	5
15	Plant tumors and their causes. Methods of preventing the development of the tumor process and fighting it.	5
	Total	75

6. Topics of Coursework

№	Topic	Number, hours
1	Cellular bioenergetics	2
2	Bioluminescence and bioluminescent analysis in biochemistry	2
3	Biochemical foundations of immunity	2
4	Biochemistry of the origin of life on Earth	2
5	Biochemistry of rational nutrition	2
6	Study of the accumulation and localization of heavy metals in the soil-plant system	2
7	Use of enzymes as analytical reagents	2
8	Influence of environmental factors on metabolic processes in the body	2
9	Coenzymes, their biological role	2
10	Microelements in wildlife	2
11	Nanopesticides, their influence on metabolic processes	2
12	Redox enzymes, their biological role	2
13	Peculiarities of plant metabolism depending on the conditions of mineral nutrition	2
14	Pigments in plant organisms, ways of their synthesis.	
15	Approaches to the study of the primary structure of proteins and polypeptides. Electrophoresis and chromatography of proteins	2
16	Enzymes in food technology	2
17	Physiological and biochemical adaptations of plants under different water supply regimes	2
18	Functional biochemistry of the endoplasmic reticulum	2
19	Functional biochemistry of mitochondria	2
20	Biochemical role of chaperone proteins	2
21	Comparative morphology and biochemistry of apoptosis and necrosis	2
22	Molecular mechanisms of cell death	2
23	Biochemical aspects of carcinogenesis	2
24	Artificial membranes: principles of obtaining, use as model	

	systems for studying the functional properties of ion channels, active transport systems, receptors	2
25	Repair of DNA damage. Types of repair	2
	Total	50

7. Methods of assessing expected learning outcomes:

- exam;
- module tests;
- essays;
- defense of labs;
- presentations.

8. Teaching methods:

- method of practice-oriented learning;
- method of blended learning;
- method of learning through research;
- method of educational discussions and debates;
- method of teamwork, brainstorming.

9. Results Assessment.

Assessment of knowledge of a higher education applicant is carried out on a 100-point scale and is translated into a national assessment in accordance with the current "Regulations on exams and credits at NULES of Ukraine"

9.1. Distribution of points

Type of learning activity	Learning	Assessment
Module 1. Molecular and chemical composition of living organisms		
Module test 1.		100
Total for module 1		100
Module 2. Bioorganic compounds - structure and properties		
Module test 2.		100
Total for module 2		100
Study work	$(M1 + M2)/2 * 0,7 \leq 70$	
Examination	30	
Total per course	$(\text{Study work} + \text{Exam}) \leq 100$	

9.2. Scale for assessing student`s knowledge

Rating of a higher education applicant, points	National system assessment (exam)
90-100	excellent
74-89	good
60-73	satisfactory
0-59	unsatisfactory

9.3. Assessment Policy

Політика дедлайнів перескладання	щодо та	Роботи, які здаються із порушенням термінів без поважних причин, оцінюються на нижчу оцінку. Перескладання модулів відбувається із дозволу лектора за наявності поважних причин (наприклад, лікарняний).
Політика академічної доброчесності	щодо	Списування під час контрольних робіт та екзаменів заборонені (в т.ч. із використанням мобільних девайсів). Самостійні роботи, реферати повинні мати коректні текстові посилання на використану літературу та/або електронні джерела.
Політика відвідування	щодо	Відвідування занять є обов'язковим. За об'єктивних причин (наприклад, хвороба, міжнародне стажування) навчання може відбуватись індивідуально (в он-лайн формі за погодженням із деканом факультету).

10. Educational and methodological support:

- electronic educational course of the educational discipline (on the eLearn educational portal of NUBiP of Ukraine - <https://elearn.nubip.edu.ua/course/view.php?id=3693>);
- abstracts of lectures and their presentations (in electronic form);
- textbooks, training aids, workshops;
- methodical materials on the study of the academic discipline for students of higher education full-time and part-time forms of higher education.

11. Recommended sources of information

1. Lehninger Principles of Biochemistry. D.L. Nelson, M.M Cox. Publisher: W.H. Freeman (5th Edition), 2009, ISBN-10: 0-7167-7108-X. ISBN-13: 978-0-7167-7108-1. 1100 p. DOI:[10.1007/978-3-662-08289-8](https://doi.org/10.1007/978-3-662-08289-8).

https://www.researchgate.net/publication/48376766_Lehninger_Principles_of_Biochemistry

2. Fundamentals of Biochemistry A Textbook H.P. GAJERA, S.V. PATEL, B.A. GOLAKIYA. INTERNATIONAL BOOK DISTRIBUTING CO. First Edition, 2008, 557 p. ISBN: 978-81-8189-165-5

<https://labalbaha.wordpress.com/wp-content/uploads/2014/04/fundamentals-of-biochemistry.pdf>

3. Biochemistry (4-th Edition). U. Satyanarayana, U. Chakrapani. ELSEVIER. 2014, 2014. 809 p. ISBN: 978-81-312-3601-7

<https://recnotes.com/wp-content/uploads/2020/11/Biochemistry-U-Satyanaryan-4th-Edition.pdf>

4. Cell biology. Thomas D. Pollard, William C. Earnshaw. Elsevier Science, 2002. 804 p.

5. Principles and Techniques of Biochemistry and Molecular Biology (7-th edition). Edited by KEITH WILSON and JOHN WALKER. CAMBRIDGE UNIVERSITY PRESS. 2010. 761 p. ISBN 978-0-521-51635-8 (hardback) – ISBN 978-0-521-73167-6 (pbk.)

<https://www.kau.edu.sa/Files/0017514/Subjects/principals%20and%20techniques%20of%20biochemistry%20and%20molecular%20biology%207th%20ed%20wilson%20walker.pdf>

6. Біологічна і біоорганічна хімія. Підручник у 2 томах/ Л.І. Остапченко, В.К. Рибальченко /– К.: Видавничо-поліграфічний центр «Київський університет», 2015. – 918 с.

7. Біохімія. Підручник / Л.І. Остапченко, Т.Р. Андрійчук, Ю.Д. Бабенюк та ін. / За ред. Л.І. Остапченко – К.: Видавничо-поліграфічний центр «Київський університет», 2012. – 796 с.

8. Біохімія. Підручник / Кучеренко М.Є., Бабенюк Ю.Д., Васильєв О.М., Виноградова Р.П., Войціцький В.М., Курський М.Д., Рибальченко В.К., Цудзевич Б.О. – К.: ВПЦ «Київський університет», 2002. – 480 с.

9. Молекулярна біологія. Підручник / Сиволоб А.В. – К: ВПЦ «Київський університет», 2008. – 384 с.

10. Кучеренко М.Є., Бабенюк Ю.Д., Войціцький В.М. Сучасні методи біохімічних досліджень. К.: Фітосоціоцентр, 2001. – 424 с.

11. Thomas D. Pollard, William C. Earnshaw, Ph. D. Cell biology. – Elsevier Science (USA), 2002. – 804 p.

12. Тарасенко Л.М., Непорада К.С., Григоренко В.К. Функціональна біохімія. – Вінниця, Нова книга, 2007. – 378с.

13. Губський Ю.І. Біологічна хімія. – Київ-Вінниця:, Нова книга, 2007. – 656с.