

**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 E “Natural Sciences, Mathematics and Statistics”

Specialty E2 “Ecology”

Academic program “Ecology”

Faculty Plant protection, Biotechnology and Ecology

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Kyiv – 2026

### **Description of discipline «BIOCHEMISTRY»**

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

The task of the course is to acquaint students with the structure and properties of chemical elements and their compounds, the main classes of bioorganic compounds with their classification, functions and properties, biochemical mechanisms of transformation of exo- and endogenous compounds and adaptation of living organisms. 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 analyze the obtained experimental data in the future.

<b>Area of knowledge, specialty, academic programme, academic degree</b>		
Area of knowledge	E "Natural Sciences, Mathematics and Statistics"	
Academic degree	«Bachelor»	
Specialty	E2 «Ecology»	
Academic program	«Ecology»	
<b>Characteristics of discipline</b>		
Type	Normative	
Total number of hours	120	
Number of ECTS credits	4	
Number of modules	2	
Form of assessment	Exam	
<b>Indicators of the discipline for full-time and part-time forms of university study</b>		
	Full-time	Part-time
Year of study	2	
Term	4	
Lectures	30 h	
Practical, seminars	-	
Labs	30 h	
Self-study	60 h	
Number of hours per week for full-time students	4 h	

## 1. The aim, competencies and program results of the educational discipline

The aim of the educational discipline "Biochemistry" is the formation of theoretical foundations and practical skills of modern physicochemical, spectral, molecular, biophysical, biochemical methods that are widely used in ecology and agrotechnology. Theoretical aspects of the discipline are consolidated in laboratory classes, so students need to acquire and consolidate skills when working in a biochemical laboratory, which will allow them to plan scientific research and analyze the obtained experimental data in the future.

**List of educational components that precede the study of the academic discipline (if any) Chemistry**

### Competences acquired:

#### Integral competences (IC):

The ability to solve complex specialized problems and solve practical problems in the field of ecology, environmental protection and balanced nature management, which involves the application of basic theories and methods of environmental sciences, which are characterized by the complexity and uncertainty of conditions.

#### General competences (GC):

GC1. Knowledge and understanding of the subject area and professional activity.

#### Special (professional) competences (SC):

SC16. Ability to critically reflect on the basic theories, methods and principles of natural sciences.

SC19. Ability to assess the impact of technogenesis processes on the state of the environment and identify environmental risks associated with production activities.

#### Program learning results of the academic discipline (PLR):

PLR7. Solve problems in the field of environmental protection using generally accepted and/or standard approaches and international and domestic experience.

PLR21. Be able to choose optimal methods and tools for research, data collection and processing.

## 2. The 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		
<b>Module I Molecular and chemical composition of living organisms and environment</b>														
Theme 1. Introduction to the Biochemistry.	1	8	2	-	2	-	4							
Theme 2. Modern biochemical methods.	2	8	2	-	2	-	4							
Theme 3. The	3	8	2	-	2	-	4							

molecular and chemical composition of living organisms.														
Theme 4. The role of water in the life of living organisms. Buffer systems.	4	8	2	-	2	-	4							
Theme 5. The molecular and supramolecular organization of cells.	5	8	2	-	2	-	4							
Theme 6. Protein and amino acids.	6		2	-	2	-	4							
Theme 7. Carbohydrates.	7		2	-	2	-	4							
Theme 8. Nucleic acids.	8		2	-	2	-	4							
Theme 9. Lipids.	9		2	-	2	-	4							
Number for thematic module 1	72		18	-	18	-	36							
<b>Module 2. Biotransformation of substances and biochemical levels of interaction between living organisms</b>														
Theme 1. Basic concepts of substance and energy metabolism in nature. Enzymatic reactions.	10	8	2	-	2	-	4							
Theme 2. Phytohormones.	11	8	2	-	2	-	4							
Theme 3. Secondary plant metabolites.	12	8	2	-	2	-	4							
Theme 4. Biological activity of xenobiotics	13	8	2	-	2	-	4							
Theme 5. Allelopathy and its role in the ecology of agrosystems	14	8	2	-	2	-	4							
Theme 6. Ecological and biochemical interaction of	15	8	2	-	2	-	4							

plants and animals													
Number for thematic module 2	48	12	-	12	-	24							
<b>Total number</b>	<b>120</b>	<b>30</b>		<b>30</b>		<b>60</b>							

### 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	The role of water in the life of living organisms. Buffer systems	2
5	The molecular and supramolecular organization of cells	2
6	Protein and amino acids	2
7	Carbohydrates	4
8	Nucleic acids	2
9	Lipids	2
10	Basic concepts of substance and energy metabolism in nature. Enzymatic reactions	2
11	Phytohormones	2
12	Secondary plant metabolites	2
13	Biological activity of xenobiotics	2
14	Allelopathy and its role in the ecology of agrosystems	2
15	Ecological and biochemical interaction of plants and animals	2
	<b>Total</b>	<b>30</b>

### 4. Topic of Lab works

№	Topic	Number, hours
1	Determination of pH in water and soil	2
2	Osmotic properties of cells	2
3	Preparation of buffer solutions: acidic (acetate buffer system ( $\text{CH}_3\text{COOH} + \text{CH}_3\text{COONa}$ ); hydrogen phosphate ( $\text{K}_2\text{HPO}_4 + \text{KH}_2\text{PO}_4$ ); bicarbonate ( $\text{H}_2\text{CO}_3 + \text{NaHCO}_3$ ); hemoglobin (HHb + 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 ( $\text{H}_2\text{CO}_3, \text{NaHCO}_3$ ).	2
4	Qualitative determination of mineral substances. Ashing methods. Microchemical analysis of ash.	2
5	Qualitative reactions to non-protein nitrogenous compounds.	2

6	Color (qualitative) reactions to proteins and amino acids.	2
5	Qualitative reactions to nitrates in plant material.	2
7	Protein precipitation reactions. Physicochemical properties of proteins.	2
8	Isolation of proteins from plant material.	2
9	Qualitative reactions to monosaccharides.	2
10	Qualitative reactions to polysaccharides. Hydrolysis of starch and fiber.	2
11	Isolation of nucleoproteins from yeast.	2
12	Qualitative reactions to the components of nucleoproteins (proteins, monosaccharides (ribose and deoxyribose), purine bases, phosphoric acid).	2
13	Determination of chemical parameters of fats.	2
14	Evaluation of the content of dangerous chemicals. Qualitative reactions to mercury, lead, cadmium, dioxins	2
15	Determination of ammonium ions in groundwater	2
	<b>Number</b>	<b>30</b>

### 5. Topic of self-study

№	Theme	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.	4
2	Scientific discoveries in the field of Biochemistry. Nobel laureates.	4
3	Methods of isolation and purification, separation of proteins - salting out, electrophoresis, chromatography, Western blot analysis, PCR, etc.	4
4	Technologies for the selection and storage of biological materials (cell suspensions, tissues, blood, etc.).	4
5	Source of vegetable proteins. Characteristics of plant proteins and their importance. Amino acid composition of plant proteins.	4
6	The role of amino acids in the protection of agricultural crops from stress.	4
7	Biologically active substances of plant origin. Their role in the processes of photosynthesis and respiration.	4
8	Phytohormones and their regulatory role.	4
9	Accumulation of nutrients in plant cells and tissues. Ways of entry of substances into the cell and mechanisms of removal from the cell.	4
10	Selective accumulation of chemical and radioactive elements by plant organs and tissues. Consequences.	4

11	Structural, biochemical and physiological features/differences of plant and animal cells.	4
12	Plant antibiotics - classification, mechanism of action and role.	4
13	Molecular biological and biochemical mechanisms of action of chemical carcinogens. Stages, metabolic transformations, cell penetration, etc.	4
14	Plant tumors and their causes. Methods of preventing the development of the tumor process and fighting it.	4
15	Chemical composition of medicinal plants.	4
	<b>Total</b>	<b>60</b>

### 6. Methods of assessing expected learning outcomes:

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

### 7. 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.

### 8. Results assesment.

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"

#### 8.1. Distribution of points

Type of learning activity	Learning	Assessment
<b>Module 1. Molecular and chemical composition of living organisms and environment</b>		
Module test 1.		100
<b>Total for module 1</b>		100
<b>Module 2. Biotransformation of substances and biochemical levels of interaction between living organisms</b>		
Module test 2.		100
<b>Total for module 2</b>		100
Study work	$(M1 + M2)/2 * 0,7 \leq 70$	

Examination	30
<b>Total per course</b>	(Study work + Exam) ≤ 100

## 8.2. Scale for assessing student`s knowledge

Students Rating, points	National grading (exam)
90-100	excellent
74-89	good
60-73	satisfactory
0-59	unsatisfactory

## 8.3. Assessment Policy

<b>Політика дедлайнів перекладання</b>	<b>щодо та</b>	Роботи, які здаються із порушенням термінів без поважних причин, оцінюються на нижчу оцінку. Перекладання модулів відбувається із дозволу лектора за наявності поважних причин (наприклад, лікарняний).
<b>Політика академічної доброчесності</b>	<b>щодо</b>	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.
<b>Політика відвідування</b>	<b>щодо</b>	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).

## 9. 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.

## 10. 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](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.