National University of Life and Environmental Sciences of Ukraine

Department of physiology, biochemistry plants and bioenergetic

"APPROVED"
Dean of Faculty of Plant protection,
Biotechnology and Ecology
Kolomiets Y.V.
23 " May 2024

"APPROVED"
at the meeting of the department
physiology, biochemistry plants and bioenergetic
Protocol from "22" May 2024 № 10

Head of department
(Prylutska S.V.)

"APPROVED"
Garant of EP 162 «Biotechnology and bioengineering»
Kvasko O.Yu.
Garant of EP

WORK PROGRAM OF THE DISCIPLINE
BIOCHEMISTRY

Field of knowledge 16 "Chemical and Bioengineering"
Specialty 162 «Biotechnology and bioengineering»
Field of knowledge «Biotechnology and bioengineering»
Faculty Plant protection, Biotechnology and Ecology
Developer: Head of department, Dr of Sci., Prof. *Prylutska S.V.*, ass. Prof. *Tkachenko T.A.*

Kyiv – 2024

Description of discipline «BIOCHEMISTRY»

Field of knowledge, direction of training, specialty, education and qualification level		
Education degree	«Bachelor»	
Speciality	162 «Biotechnology and bioengineering»	
Field of knowledge	«Biotechnology and bioengineering»	
Characteristics of discipline		
Kind	Normative	
Total number of hours	120	
Number of ECTS	4	
Number of content modules	2	
Coursework	30 hours (according to defined topics)	
Form of control	Exam	
Indicators discipline for full-time students		
	Full-time	Part-time
Year of training	2	2
Semester	4	4
Lectures	45 h	4 h
Practical, seminars	-	-
Labs	60 h	6 h
Independent work	15 h	110 h
Individual task	-	-
Number of weekly hours for full-time students: classroom	7h	

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

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 task of 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.

Competencies of the academic discipline:

Integral Competence (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 competences (GC):

GC 01. Ability to apply knowledge in practical situations

GC 03. Ability to communicate in a foreign language

GC 04. Skills in using information and communication technologies

GC 05. Ability to learn and master modern knowledge

GC 09. The ability to preserve and multiply moral, cultural, scientific values and achievements of society based on an understanding of 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 technologies, to use various types and forms of motor activity for active recreation and leading a healthy lifestyle.

Special (professional, subject) competences (SC):

SC 11. Ability to use thorough knowledge of chemistry and biology to the extent necessary to achieve other outcomes of the educational program

SC 13. Ability to work with biological agents used in biotechnological processes (microorganisms, fungi, plants, animals, viruses, their individual components)

SC 14. The ability to carry out experimental research on the improvement of biological agents, including causing changes in the structure of the hereditary apparatus and the functional activity of biological agents

Program learning results (PR):

PR02. To be able to carry out 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 carry out basic genetic and cytological research on improving and increasing the biosynthetic capacity 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 (determining the concentration of disinfectant solutions, titration agents, concentration of nutrient medium components, etc.), technological control (concentrations of carbon and nitrogen sources in the culture liquid during the process; concentrations target product); microbiological control (determination of microbiological purity of nutrient media after sterilization, microbiological purity of biological agent, etc.), microbiological purity and sterility of biotechnological products for various purposes.

PR22. Be able to take into account social, ecological, ethical, economic aspects, requirements of labor protection, industrial sanitation and fire safety during the formation of technical solutions. To be able to use different types and forms of motor activity for active recreation and leading a healthy lifestyle.

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

2. Program and Structure of educational discipline

The names of content modules and themes	Number , hours												
	full-time							part-time					
	number	total	including					total	including				
			l	pr	lab	ind	indep		l	pr	lab	ind	indep
1	2	3	4	5	6	7	8	9	10	11	12	13	14
Thematic Module I. **Molecular and chemical composition of living organisms**.													
Theme 1. Introduction to the Biochemistry.	1	5	2		2		1	7					7
Theme 2. Modern biochemical methods.	2-3	7	4		2		1	8	1				7
Theme 3. The molecular and chemical composition of living organisms.	4	7	2		4		1	8	1				7
Theme 4. Buffer systems.	5	7	2		4		1	8			1		7
Theme 5. The role of water in the life of living organisms.	5	7	2		4		1	7					7
Theme 6. The molecular and supramolecular organization of cells.	6	5	2		2		1	7					7
Theme 7. Xenobiotics, bioactivity and biotransformation	7	6	4		2								
Number for thematic module 1	**44**		**18**		**20**		**6**	**45**	**2**		**1**		**42**
Thematic Module II. **Bioorganic compounds - structure and properties**													

Theme 1. Protien	7	7	2		4		1	8	1				7
Theme 2. Amino acids	8	7	2		4		1	8			1		7
Theme 3. Physico-chemical properties of proteins and amino acids	9	7	2		4		1	8			1		7
Theme 4. The levels of structural organization of protein.	9	5	2		2		1	7					7
Theme 5. Plant proteins. Nitrogen cycle	10	4	2		2								
Theme 6. Carbohydrates.	11	7	2		4		1	10	1		1		8
Theme 7. Nucleic acids.	11	7	2		4		1	9			1		8
Theme 8. Structure and properties of DNA.	12	7	2		4		1	8					8
Theme 9. Structure and properties of RNA.	13	7	2		4		1	8					8
Theme 10. Lipids.	13	7	2		4		1	9			1		8
Theme 11. Biologically active substances of plants	14-15	6	4		2								
Theme 12. Antioxidant system of living organisms	15	5	3		2								
Number for thematic module 2	**76**		**27**		**40**		**9**	**75**	**2**		**5**		**68**
Total number	**120**		**45**		**60**		**15**	**120**	**4**		**6**		**110**

3. Theme of Lab works

№	Theme	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 (CH_3COOH + CH_3COONa); hydrophosphate (K_2HPO_4 + +KH_2PO_4); bicarbonate (H_2CO_3 + $NaHCO_3$); hemoglobin (HHb + KHb); oxyhemoglobin ($HHbO_2$ + $KHbO_2$), basic (ammonia buffer: NH_4OH + NH_4Cl), phosphate buffer system, hydrogen carbonate buffer system (H_2CO_3, $NaHCO_3$).	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**

4. Independent work

№	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.	1
2	Scientific discoveries in the field of Biochemistry. Nobel laureates.	1
3	Methods of isolation and purification, separation of proteins - salting out, electrophoresis, chromatography, Western blot analysis, PCR, etc.	1
4	Technologies for the selection and storage of biological materials (cell suspensions, tissues, blood, etc.).	1
5	Source of vegetable proteins. Characteristics of plant proteins and their importance. Amino acid composition of plant proteins.	1
6	The role of amino acids in the protection of agricultural crops from stress.	1
7	Biologically active substances of plant origin. Their role in the processes of photosynthesis and respiration.	1
8	Phytohormones and their regulatory role.	1
9	Accumulation of nutrients in plant cells and tissues.	1
10	Ways of entry of substances into the cell and mechanisms of removal from the cell.	1
11	Selective accumulation of chemical and radioactive elements by plant organs and tissues. Consequences.	1
12	Structural, biochemical and physiological features/differences of plant and animal cells.	1
13	Plant antibiotics - classification, mechanism of action and role.	1
14	Molecular biological and biochemical mechanisms of action of chemical carcinogens. Stages, metabolic transformations, cell penetration, etc.	1
15	Plant tumors and their causes. Methods of preventing the development of the tumor process and fighting it.	1
	Total	**15**

5. Means of diagnosing learning outcomes:

- exam;
- modular tests;
- essays;
- protection of laboratory work;
- presentations.

6. Teaching methods:

- verbal method (lecture, discussion, interview, etc.);
- practical method (laboratory, practical classes);
- visual method (illustration method, demonstration method);
- working with educational and methodical literature (summarizing, summarizing, annotating, reviewing, writing an essay, preparing a presentation and report);
- video method (remote, multimedia, web-oriented, etc.);
- independent work (task performance).

7. Evaluation methods:

- exam;
- oral or written survey;
- modular testing;
- team projects;
- abstracts, essays;
- laboratory protection;
- presentations and speeches at scientific events.

8. Distribution of points,

which are received by those obtaining higher education. The assessment of the knowledge of a higher education student takes place on a 100-point scale and is translated into national assessments according to the table. 1 of the current "Regulations on examinations and assessments at NUBiP of Ukraine"

Student rating, points	National assessment based on the results of the compilation	
	exam	credit
90-100	excellent	Credited
74-89	good	
60-73	Satisfactorily	
0-59	Non-Satisfactorily	Non-Credited

To determine the rating of the student (listener) for mastering the discipline R_{DIS} (up to 100 points) the obtained rating for certification (up to 30 points) is added to the rating of the student (listener) for academic work Rew (up to 70 points): R_{DIS} = Rew + R_{AT} .

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

Basic:

1. D.L. Nelson, M.M Cox. Lehninger Principles of Biochemistry. Publisher: W.H. Freeman (15th Edition), 2009, ISBN-10: 0-7167-7108-X. ISBN-13: 978-0-7167-7108-1. 1100 p.
2. Біологічна і біоорганічна хімія. Підручник у 2 томах/ Л..І. Остапченко, В.К. Рибальченко /– К.: Видавничо-поліграфічний центр «Київський університет», 2015. – 918 с.
3. 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.
4. 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.
5 Молекулярна біологія. Підручник / Сиволоб А.В. – К: ВПЦ «Київський університет», 2008. – 384 с.
6. Кучеренко М.Є., Бабенюк Ю.Д., Войціцький В.М. Сучасні методи біохімічних досліджень. К.: Фітосоціоцентр, 2001. – 424 с.

Additional:

1. Thomas D. Pollard, William C. Earnshaw, Ph. D. Cell biology. – Elseviar Sciense (USA), 2002. – 804 p.
2. Тарасенко Л.М., Непорада К.С., Григоренко В.К. Функціональна біохімія. – Вінниця, Нова книга, 2007. – 378с.
3. Губський Ю.І. Біологічна хімія. – Київ-Вінниця:, Нова книга, 2007. – 656с.

Information Resources.

1. Electronic bases of books, publications, encyclopedias, etc. (PubMed, HighWire). http://review3d.ru/lehninger-a-nelson-d-l-cox-m-m-lenindzher-a-nelson-d-l-koks-m-m-principles-of-biochemistry-osnovy-bioximii.
2. Electronic library: http://review3d.ru/.
3. https://www.youtube.com/watch?v=ojhdTFmkY1c
https://www.youtube.com/user/amritacreate/videos
https://www.youtube.com/watch?v=FUo428guKt0
https://www.youtube.com/watch?v=CC3t67e2GsU
https://www.youtube.com/watch?v=QacQmS3aaTI
https://www.youtube.com/watch?v=HSGlfbV7W84
https://www.youtube.com/watch?v=JdXbTWfOc18
https://www.youtube.com/watch?v=ZuhQtTX6_4U

https://www.youtube.com/watch?v=23W5Z_redfs