



# BIOCHEMISTRY

## Working program of educational discipline (Syllabus)

### Requisites of the Course

Cycle of Higher Education	<i>First (bachelor's)</i>
Branch of knowledge	<i>16 Chemical and Bioengineering</i>
Specialty	<i>163 Biomedical Engineering</i>
Educational program	<i>Medical Engineering</i>
Course status	<i>Mandatory discipline</i>
Mode of study	<i>full-time / day / mixed / remote</i>
Year of study/Semester	<i>1<sup>st</sup> year (autumn, spring semester)</i>
ECTS workload	<i>4 ECTS credits / 120 hours</i>
Testing and Assessment	<i>Final Test, Module Test</i>
Course schedule	<i>According to the schedule on the site <a href="http://rozklad.kpi.ua/">http://rozklad.kpi.ua/</a></i>
Language of instruction	<i>English</i>
Information about course supervisor / teachers	<b><u>Lecturer: 1 course (autumn semester, Biochemistry-1. Bioorganic chemistry)</u></b> <i>Associate Professor of BME, Candidate of Biological Sciences Kalashnikova Larysa , e-mail – <a href="mailto:doc_hom2000@yahoo.com">doc_hom2000@yahoo.com</a></i> <b><u>1 course (spring semester, Biochemistry-2. Biochemistry)</u></b> <i>Candidate of Biological Sciences, Associate Professor of BME Svitlana Vovianko, e-mail: <a href="mailto:sivovianko@gmail.com">sivovianko@gmail.com</a>, Telegram - <a href="https://t.me/vovianko_svitlana">https://t.me/vovianko_svitlana</a></i> <b><u>Practical: 1 course (autumn semester, Biochemistry-1. Bioorganic chemistry)</u></b> <i>Associate Professor of BME, Candidate of Biological Sciences Kalashnikova Larysa , e-mail – <a href="mailto:doc_hom2000@yahoo.com">doc_hom2000@yahoo.com</a></i> <b><u>1 course (spring semester, Biochemistry-2. Biochemistry)</u></b> <i>Candidate of Biological Sciences, Associate Professor of BME Svitlana Vovianko, e-mail: <a href="mailto:sivovianko@gmail.com">sivovianko@gmail.com</a>, Telegram - <a href="https://t.me/vovianko_svitlana">https://t.me/vovianko_svitlana</a></i>
Course placement	<i>Platform «Sikorsky» - course «Biochemistry-2. Biochemistry» (li45uk)</i>

### Distribution of hours

Semester	Lectures	Practical	Laboratory	Self-study
<i>autumn semester</i>	36	36		48
<i>spring semester</i>	36	36		48

### Curriculum of the discipline

#### 1. Course description, goals, objectives, and learning outcomes

*The discipline "Biochemistry" belongs to the cycle of normative disciplines and forms a systematic knowledge of the relationship between the structure and patterns of functioning of major biologically important classes of organic compounds and biopolymers, forms an understanding of basic chemical and biochemical processes occurring in living organisms at the molecular level.*

*The main tasks of studying the discipline are to provide students with knowledge about the basics of the chemical structure of biological molecules, including biopolymers and a set of biochemical processes in the body.*

Course "Biochemistry-1. Bioorganic Chemistry" studies the relationship between the structure and patterns of functioning of the main biologically important classes of organic compounds and biopolymers, to understand the basic chemical and biochemical processes occurring in a living organism at the molecular level.

Course "Biochemistry-2. Biochemistry" studies the molecular basis of the functioning of organs and systems of the human body, the patterns of transition of chemical processes occurring in the body, to physiological functions, which will form students' systematic knowledge of metabolic processes in the body for further use in practice to model organs and systems and the development of algorithms to support and restore their functions.

The main purpose of the Course «Biochemistry-2. Biochemistry» is to form students' ability to apply physical, chemical, biological and mathematical methods in the analysis, modeling of the functioning of living organisms and biotechnical systems.

Skills are required to study the Course:

- Basic knowledge of bioorganic chemistry; ability to identify biologically important organic compounds, to analyze the conformity of the structure of bioorganic compounds to the physiological functions they perform in the human body, to predict the possible ways of transformation of functional groups in the most important classes of organic compounds in the process of metabolism.

**General competencies** (OPP was put into effect by the Rector's Order NON/ 89/2021 of 19.04.2021):

**GC 1** - Ability to apply knowledge in practical situations.

**GC 2** - Knowledge and understanding of the subject area and understanding of professional activity.

**GC 3** - Ability to communicate in the state language both orally and in writing.

**GC 4** - Skills in the use of information and communication technologies.

**GC 5** - Ability to perform research at the appropriate level.

**GC 6** - Ability to search, process and analyze information from various sources.

**GC 7** - Ability to generate new ideas (creativity).

**GC 8** - Ability to make well-grounded decisions.

**GC 9** - Ability to communicate with representatives of other professional groups of different levels (with experts from other fields of knowledge / types of economic activity).

**GC 10** - Safe activities skills.

**Special (professional) competencies** (OPP was put into effect by the Rector's Order NON/ 89/2021 of 19.04.2021):

**PC 4** - Ability to provide technical and functional characteristics of systems and tools used in medicine and biology (in prevention, diagnosis, treatment and rehabilitation).

**PC 5** - Ability to apply physical, chemical, biological and mathematical methods in the analysis, modeling of the functioning of living organisms and biotechnical systems.

**PC 8** - Ability to perfect research and observations on the interaction of biological, natural and artificial systems (prostheses, artificial organs, etc.).

**The program learning outcomes after studying the discipline "Medical Microprocessor Systems" are** (OPP was put into effect by the Rector's Order NON/ 89/2021 of 19.04.2021):

**PLO 1** - Understanding of fundamental-applied, medical-physical and bioengineering bases of technologies and equipment for research of processes of a human body.

**PLO 10** - Knowledge of the basic physical and physicochemical patterns of biological objects functioning.

**PLO 14** - Possession of tools for experimental research (medical devices, biomaterials for medical purposes).

**PLO 17** - Knowledge of general information about the human body and its functions from the standpoint of a systems approach and their use in biomedical engineering.

**PLO 24** - Knowledge of the basic methods and tools used to quantify the functioning of physiological systems.

**PLO 29** - Professional communication with healthcare professionals in the state and foreign languages (English or one of the other official EU languages) and understanding of their requirements for biomedical products and services.

**PLO 41** - Apply knowledge of chemistry and bioengineering for the creation, synthesis and application of artificial biotechnical and biological objects.

## **2. Prerequisites and postrequisites of the course (place in the structural and logical scheme of education according to the relevant educational program)**

The course The discipline "Biochemistry" belongs to the cycle of professional training and has an interdisciplinary nature. According to the structural and logical scheme of the specialist training program, the discipline "Biochemistry" is closely related to other disciplines of professional training: Quantitative Physiology, Biophysics, Materials Science and Construction Materials. It is immediately preceded by the disciplines of basic school training

## **3. Course Overview**

The main parts and subjects that will be considered in the process of studying the course:

### **Section 1. Fundamentals of the structure and reactivity of organic compounds**

Topic 1.1. Fundamentals of the structure of organic compounds. Classification of organic compounds. Nomenclature of organic compounds.

Topic 1.2. The concept of isomerism. Classification of isomerism. The concept of conformation and configuration

Topic 1.3. Electronic structure of carbon. Types of chemical. communication and their characteristics. Electronic effects in molecules of organic compounds. Interaction of atoms in molecules

Topic 1.4. General regularities of reactivity of bioorganic compounds

Topic 1.5. Methods of research of bioorganic compounds

Section 2 Structure, properties and functions of biologically important classes of bioorganic compounds.

Topic 2.1. Structure, properties and biological significance of carbon compounds.

Topic 2.1. Structure, properties and biological significance of cyclic compounds

Topic 2.1. Classification, structure and significance of biologically important heterocyclic compounds

Topic 2.1 Structure, reactivity and biological significance of heterofunctional compounds

### **Section 3. Biopolymers and bioregulators of natural origin. Their structure and medical and biological significance.**

Topic 3.1. Lipids and low molecular weight bioregulators

Topic 3.2 Bioregulators of natural origin. Carbohydrates. Structure and chemical properties. Classification of carbohydrates

Topic 3.3. Structure of peptides and proteins

Topic 3.4 Enzymes as biocatalysts

Topic 3.5 Nucleic acids. Structure and functions of DNA. Features of RNA structure. RNA types.

## Section 4. Metabolism

Topic 4.1. Molecular basis of life.

Topic 4.2. Biological membranes.

Topic 4.3. Basic laws of metabolism.

Topic 4.5. Bioenergy.

Topic 4.6. Carbohydrate metabolism.

Topic 4.7. Lipid metabolism.

Topic 4.8. Protein metabolism.

## Section 5. Biochemistry of the human body

Topic 5.1. Blood biochemistry.

Topic 5.2. Liver biochemistry. Xenobiotic metabolism

Topic 5.3. Kidney biochemistry.

Topic 5.4. Biochemistry of nervous tissue.

Topic 5.5. Biochemistry of muscle, connective and bone tissue.

Topic 5.6. Biochemistry of hormonal regulation

Topic 5.7. Biochemistry of nutrition.

Topic 5.8. Biochemistry of pathological processes.

## 4. Coursebooks and teaching resources

### Basic:

1. Halenova T. "Biological and bioorganic chemistry". Workbook for foreign students of specialization "Medicine". Part 1: General bioorganic chemistry / Compliers T. Halenova, V. Konopelniuk, A. Dranitsina et al. – K : Kyiv University Publishing and Printing Centre, 2019. – 67 p.  
[https://biology.univ.kiev.ua/images/stories/Kafedry/Biochimiya/Biblioteka/Biological\\_Chemistry\\_Part\\_1.pdf](https://biology.univ.kiev.ua/images/stories/Kafedry/Biochimiya/Biblioteka/Biological_Chemistry_Part_1.pdf)
2. Mardashko A. A. et al. *Biological and Bioorganical chemistry: teaching textbook*. – Kyiv: Caravela, 2017.
3. Fundamentals of structure and reactivity of organic compounds: methodical instructions for 1st year students' self-work in Biological and Bioorganic Chemistry (module 1) / compiled by A.O. Syrovaya, L.G. Shapoval, V.N. Petiunina et al. – Kharkiv: KhNMU, 2014. – 45 p.  
[http://repo.knmu.edu.ua/bitstream/123456789/5618/1\\_Основы%20строения%20англ\\_BB.pdf](http://repo.knmu.edu.ua/bitstream/123456789/5618/1_Основы%20строения%20англ_BB.pdf)
4. GAJERA H.P., PATEL S.V., GOLAKIYA B. A. *Fundamentals of Biochemistry NTERNATIONAL BOOK DISTRIBUTING CO*, 2008ю- 557 p.  
<https://labalbaha.files.wordpress.com/2014/04/fundamentals-of-biochemistry.pdf>
5. Jan Koolman, Klaus-Heinrich Roehm. *Color Atlas of Biochemistry Second edition, revised and enlarged Thieme Stuttgart · New York, 2005. – 476 p.*
6. Jelena Dodonova *Bioorganic chemistry (Set of lectures) Vilnius 2016.- 246 p*  
[https://www.chgf.vu.lt/files/doc/set-of-lectures\\_bioorganic-chemistry.pdf](https://www.chgf.vu.lt/files/doc/set-of-lectures_bioorganic-chemistry.pdf)
7. *Principles of Organic Chemistry: A Compendium of Video Lectures Syeda Sadia Khatoon and Attaur-Rahman\**  
[http://ifs.se/IFS/Documents/Other/Video%20Lectures%20book%20Organic%20Chemistry\\_Attaur-Rahman%20Khatoon.pdf](http://ifs.se/IFS/Documents/Other/Video%20Lectures%20book%20Organic%20Chemistry_Attaur-Rahman%20Khatoon.pdf)
8. Synelnyk T.B. Kostiuk O.S. Ostapchenko L.I. *BIOORGANIC CHEMISTRY Synelnyk T.B. Kostiuk O.S. Ostapchenko L.I. Kyiv, \_2021.-367*

[https://biology.univ.kiev.ua/images/stories/Kafedry/Biochimiya/Biblioteka/EXTBOOK\\_Bioorganic\\_chemistry\\_2021.pdf](https://biology.univ.kiev.ua/images/stories/Kafedry/Biochimiya/Biblioteka/EXTBOOK_Bioorganic_chemistry_2021.pdf)

9. Зіменковського Б.С., Ніженковської І.В. [Електронний ресурс]: Біологічна і біоорганічна хімія : базовий підручник : у 2 кн. / кол. авт. ; за ред. чл.-кор. НАМН України, проф.. — Кн. 1 : Біоорганічна хімія / [Б.С. Зіменковський, В.А. Музиченко, І.В. Ніженковська, Г.О. Сирова] ; за ред. Б.С. Зіменковського, І.В. Ніженковської. — К. : ВСВ «Медицина», 2014. — 272 с.  
[https://balka-book.com/files/2017/04\\_19/10\\_44/u\\_files\\_store\\_3\\_258795.pdf](https://balka-book.com/files/2017/04_19/10_44/u_files_store_3_258795.pdf)
10. Миронович Л.М. Біоорганічна хімія [Електронний ресурс]: Скорочений курс: Навчальний посібник. — Київ: Каравела, 2008. — 184 с.  
[https://essuir.sumdu.edu.ua/bitstream-download/123456789/40407/1/bioorganic\\_chemistry.pdf](https://essuir.sumdu.edu.ua/bitstream-download/123456789/40407/1/bioorganic_chemistry.pdf)
11. Мардашко О.А., Миронович Л.М., Стапанова Г.Ф. Біологічна і біоорганічна хімія: Навчальний посібник. — Київ: Каравела, 2016. — 244 с.  
<https://studfile.net/preview/4583234/>
12. Губський Ю.І. Біоорганічна хімія. — Вінниця: Нова книга1/ Ю.И. Губский [и др.] ; под редакцией Ю.И. Губского, И.В. Ниженковской, 2004. — 256 с
13. Губський Ю.І. Біологічна хімія. Книга 2 : Биологическая химия / Ю.И. Губский [и др.] ; под редакцией Ю.И. Губского, И.В. Ниженковской. — 2018. — 582 с. Киев : ВСU "Медицина", 2018.
14. Кольман, Ян. Наглядная биохимия : [справочное издание] ; пер. с нем. /Я. Кольман, К. - Г. Рем ; под ред. П. Д. Решетова. Москва: Мир, 2000. — 469 с.
15. Ленинджер А. [Електронний ресурс]: Основы биохимии. — М.: Мир, 1985. — Том 1. — 365 с.  
[http://d.theupload.info/download/5sdxgtjvgzvzgz5dcr57qeur3yfkdmu8/lenindzher\\_a\\_\\_osnovy\\_bi ohimii\\_\\_v\\_3-h\\_t\\_\\_t\\_1.djvu](http://d.theupload.info/download/5sdxgtjvgzvzgz5dcr57qeur3yfkdmu8/lenindzher_a__osnovy_bi ohimii__v_3-h_t__t_1.djvu)
16. Ленинджер А. [Електронний ресурс]: Основы биохимии. - М.: Мир, 1985. — Том 2. — 369 с.  
[http://d.theupload.info/download/q8d6vsji1qs13f4qiwmmeje61q87lnx1/lenindzher\\_a\\_\\_osnovy\\_bi ohimii\\_\\_v\\_3-h\\_t\\_\\_t\\_2.djvu](http://d.theupload.info/download/q8d6vsji1qs13f4qiwmmeje61q87lnx1/lenindzher_a__osnovy_bi ohimii__v_3-h_t__t_2.djvu)
17. Ленинджер А. [Електронний ресурс]: Основы биохимии. - М.: Мир, 1985. — Том 3. — 321 с.  
[http://d.theupload.info/download/jxzy4mhmfw0352zzvcixyigk5i82o42w/lenindzher\\_a\\_\\_osnovy\\_bi ohimii\\_\\_v\\_3-h\\_t\\_\\_t\\_3.djvu](http://d.theupload.info/download/jxzy4mhmfw0352zzvcixyigk5i82o42w/lenindzher_a__osnovy_bi ohimii__v_3-h_t__t_3.djvu)

#### Supplementary:

1. An Introduction to Organic Chemistry  
<http://www.cnm.manchester.ac.uk/people/jonathan/CH0001081100.pdf>
2. David L. Nelson, Michael M. Cox. Lehninger Principles of Biochemistry. Seventh Edition, 2017. — 3270 p.
3. Davydov V.V., Bozhkov A.I., Rudko N.P. Foundations of biological chemistry (Tutorial on biochemistry for foreign students of medical department of higher education institutions) — Kharkov : V.N. Karazin Kharkov National University, 2015. — 400 p.
4. GAJERA H.P., PATEL S.V., GOLAKIYA B. A. Fundamentals of Biochemistry NTERNATIONAL BOOK DISTRIBUTING CO, 2008ю- 557 p.  
<https://labalbaha.files.wordpress.com/2014/04/fundamentals-of-biochemistry.pdf>
5. Organic Chemistry 1: An open textbook - Lumen Learning ...  
<https://courses.lumenlearning.com/suny-potsdam-organicchemistry/>
6. Sharon Walker, David McMahon. Biochemistry Demystified, 2008 by The McGraw-Hill Companies — 385 p.
7. Synelnyk T.B. Kostiuk O.S. Ostapchenko L.I. BIOORGANIC CHEMISTRY Synelnyk T.B. Kostiuk O.S. Ostapchenko L.I. Kyiv, \_2021.-367  
[https://biology.univ.kiev.ua/images/stories/Kafedry/Biochimiya/Biblioteka/EXTBOOK\\_Bioorganic\\_chemistry\\_2021.pdf](https://biology.univ.kiev.ua/images/stories/Kafedry/Biochimiya/Biblioteka/EXTBOOK_Bioorganic_chemistry_2021.pdf)



8. Гонський Я.І., Максимчук Т.П. Біохімія людини. – Тернопіль: Укрмедкнига, 2001. – 736с.  
<https://www.twirpx.com/file/287594/>
9. Биохимия [Электронный ресурс]: учебник для вузов/ под ред. Е.С.Северина - 5-е изд., - М.: ГЭОТАР-Медиа, 2009. - 768 с. –  
<http://www.studmedlib.ru/cgi-bin/mb4>
10. Нельсон Д. Основы биохимии Ленинджера : в 3 т. Т. 1 / Д. Нельсон, М. Кокс ; пер. с англ. – М.: БИНОМ. Лаборатория знаний, 2011. – 694 с.
11. Нельсон Д. Основы биохимии Ленинджера : в 3 т. Т. 2 / Д. Нельсон, М. Кокс ; пер. с англ. – М.: БИНОМ. Лаборатория знаний, 2014. – 636 с.
12. Нельсон Д. Основы биохимии Ленинджера : в 3 т. Т. 3 / Д. Нельсон, М. Кокс ; пер. с англ. – М.: БИНОМ. Лаборатория знаний, 2015. – 448 с. .
13. Овчинников Ю.А. Биоорганическая химия Москва, "Просвещение" 1987.- 816 с.
14. Тюкавкина Н.А., Бауков Ю.И., [Электронный ресурс]: Биоорганическая химия. - М., Медицина, 2008. – 584 с.  
<https://chem.teset.sumdu.edu.ua/media/documents/Tykavkina.pdf>
15. Черных В. П., Зименковский Б. С., Гриценко И. С. [Электронный ресурс Органическая химия: учебник для студ. вузов / Под общ. ред. в. П. черных.—2-е изд., испр. и доп.— х.: изд-во нфау; оригинал, 2007.—776 с.  
<http://www.1variant.ru/content/uchebniki/ximiya/166.pdf>

### Educational content

#### 5. Methods of mastering the discipline (educational component)

№ s/n	Subject	Program learning outcomes	The main tasks	
			Control measure	Deadline
<i>Autumn semester, 4 ECTS credits / 120 hours</i>				
1	<i>Theoretical foundations of organic chemistry. Classification of organic compounds. Nomenclature of organic compounds.</i>	<i>PLO 1 PLO 10 PLO 17</i>	<i>Practical work 1</i>	<i>1<sup>st</sup> week</i>
2	<i>Fundamentals of the structure of organic compounds. The concept of isomerism. Classification of isomerism. Conformation. Configuration..</i>	<i>PLO 1 PLO 10 PLO 17</i>	<i>Practical work 2</i>	<i>2<sup>nd</sup> week</i>
3	<i>Electronic structure of carbon. Types of chemical communication and their characteristics. Electronic effects in molecules of organic compounds. Interaction of atoms in molecules</i>	<i>PLO 1 PLO 10 PLO 14 PLO 17</i>	<i>Practical work 3 Quiz 1</i>	<i>3<sup>rd</sup> week</i>
4	<i>General regularities of reactivity of bioorganic compounds</i>	<i>PLO 1 PLO 10 PLO 14 PLO 17</i>	<i>Practical work 4</i>	<i>4<sup>th</sup> week</i>
5	<i>Classification, structure and biological significance of cyclic and heterocyclic compounds. Their biological significance</i>	<i>ППН 10 ППН 14</i>	<i>Practical work 5</i>	<i>5<sup>th</sup> week</i>
6	<i>Structure, properties and biological significance of carbonyl compounds. Biologically important representatives..</i>	<i>PLO 1 PLO 10 PLO 17</i>	<i>Practical work 6 Quiz 2</i>	<i>6<sup>th</sup> week</i>

7	Structure, properties and biological significance of hydroxy derivatives and their thio analogues	PLO 1 PLO 10 PLO 17 PLO 24	Practical work 7	7 <sup>th</sup> week
8	Structure, reactivity and biological significance of poly-and heterofunctional compounds	PLO 1 PLO 10 PLO 14 PLO 17 PLO 41	Practical work 8	8 <sup>th</sup> week
9	Low molecular weight bioregulators Vitamins - structure and biological content. Water-soluble and water-insoluble vitamins	PLO 14 PLO 17 PLO 24	Practical work 9	9 <sup>th</sup> week
10	Low molecular weight bioregulators Alkaloids, terpenes, steroids	PLO 14 PLO 17 PLO 29 PLO 41	Practical work 10 Quiz 3	10 <sup>th</sup> week
11	Lipids as low molecular weight bioregulators	PLO 14 PLO 17 PLO 29 PLO 41	Practical work 11	11 <sup>th</sup> week
12	Carbohydrates. Structure and chemical properties. Classification of carbohydrates	PLO 14 PLO 17 PLO 29 PLO 41	Practical work 12	12 <sup>th</sup> week
13	Structure and properties of biologically important amines	PLO 14 PLO 17 PLO 24 PLO 29	Practical work 13	13 <sup>th</sup> week
14	Structure of peptides and proteins Enzymes as biocatalysts	PLO 14 PLO 17 PLO 24 PLO 41	Practical work 14	14 <sup>th</sup> week
15	Nucleic acids. Structure and functions of DNA. Features of RNA structure. RNA types	PLO 14 PLO 17 PLO 24 PLO 29 PLO 41	Practical work 14 Quiz 4	15 <sup>th</sup> week
16	Methods of research of bioorganic compounds	PLO 14 PLO 17 PLO 24 PLO 29 PLO 41	Practical work 14 Module Test writing	16 <sup>th</sup> week
17	Module Test	PLO 14 PLO 17 PLO 24 PLO 29 PLO 41	Practical work 14 Module Test writing	17 <sup>th</sup> week
18	Final Test		Final Test Pass	18 <sup>th</sup> week
<i>Spring semester, 4 ECTS credits / 120 hours</i>				
1.	Molecular basis of life.	PLO 1 PLO 24 PLO 29	Practical work 1	1 <sup>st</sup> – 2 <sup>nd</sup> week

2.	<i>Biological membranes.</i>	PLO 1 PLO 10 PLO 14	Practical work 2 Quiz 1	3 <sup>rd</sup> week
3.	<i>Basic regularities of metabolism.</i>	PLO 1 PLO 10 PLO 14 PLO 17	Practical work 3 Quiz 2	4 <sup>th</sup> week
4.	<i>Energy metabolism.</i>	PLO 1 PLO 10 PLO 14 PLO 17	Practical work 4	5 <sup>th</sup> week
5.	<i>Carbohydrate Metabolism.</i>	PLO 10 PLO 14 PLO 17 PLO 24	Practical work 5 Quiz 3	6 <sup>th</sup> week
6.	<i>Lipid metabolism.</i>	PLO 10 PLO 14 PLO 17 PLO 24	Practical work 6 Quiz 4	7 <sup>th</sup> week
7.	<i>Protein Metabolism.</i>	PLO 10 PLO 14 PLO 17 PLO 24	Practical work 7 Quiz 5	8 <sup>th</sup> week
8.	<i>Biochemistry of blood.</i>	PLO 14 PLO 17 PLO 24 PLO 29	Practical work 8 Quiz 6	9 <sup>th</sup> week
9.	<i>Biochemistry of liver. Metabolism of xenobiotics.</i>	PLO 14 PLO 17 PLO 24 PLO 29	Practical work 9 Quiz 7	10 <sup>th</sup> week
10.	<i>Biochemistry of kidneys.</i>	PLO 14 PLO 17 PLO 24 PLO 29	Practical work 10	11 <sup>th</sup> week
11.	<i>Biochemistry of nervous tissue.</i>	PLO 14 PLO 17 PLO 24 PLO 29	Practical work 11 Quiz 8	12 <sup>th</sup> week
12.	<i>Biochemistry of muscle tissue, connective tissue, and bone tissue.</i>	PLO 14 PLO 17 PLO 24 PLO 29	Practical work 12 Quiz 9	13 <sup>th</sup> week
13.	<i>Module Test</i>	PLO 10 PLO 14 PLO 17 PLO 24 PLO 29	Module Test writing	14 <sup>th</sup> week
14.	<i>Hormones.</i>	PLO 10 PLO 14 PLO 17 PLO 24 PLO 29	Practical work 13 Quiz 6	15 <sup>th</sup> week
15.	<i>Biochemistry of nutrition.</i>	PLO 14 PLO 17 PLO 24	Practical work 14	16 <sup>th</sup> week



		PLO 29 PLO 41		
16.	Biochemistry of pathological processes.	PLO 14 PLO 17 PLO 24 PLO 29 PLO 41	Practical work 15	17 <sup>th</sup> week
17.	Final Test	ПРН 1 ПРН 10 ПРН 14 ПРН 17 ПРН 24 ПРН 29 ПРН 41	Final Test Pass	18 <sup>th</sup> week

## 6. Self-study

One of the main types of semester control before the hour of opening the initial discipline "Biochemistry" preparing report (5-10 minutes) for one of the practical classes according to the discipline plan.

Next, preparation for classroom classes corresponds to the plan of disciplines. The discipline plan is presented on the MOODLE platform. The MOODLE system can be accessed by following the links

### Approximate subject of reports:

#### **Autumn semester, Biochemistry-1 module. "Bioorganic chemistry":**

- Heterocyclic compounds. Classification, structure, medical and biological significance.
- Nucleosides, nucleotides. Nitrogen bases of pyrimidine and purine series.
- Amines. Structure, properties. Biological significance of biogenic amines (adrenaline, tryptamine, serotonin, histamine) and polyamines (putrescine, cadaverine)
- The concept of keto acid (example acetoacetic acid). Acetoacetic ether.
- Heterofunctional derivatives of the benzene series as drugs.
- Properties of enzymes: catalytic activity, specificity of interaction. Types of specificity.
- Medicinal substances-derivatives of the heterocyclic series. Structure, classification, nomenclature. Pharmacological action.
- General characteristics of poisons and toxins of plant and animal origin.
- Antibiotics. Classification of drugs of the penicillin group. Their structure. Nomenclature. Medicobiological action.
- Low molecular weight bioregulators. Strekhnina group. Structure, nomenclature. Biological significance.

#### **Spring semester, Biochemistry-2 module. "Biochemistry":**

### Approximate subject of reports:

1. Polyunsaturated fatty acids and their biological role.
2. Vitamins – precursors of the coenzymes.
3. Molecular chaperones.
4. Prions and prion infections.
5. Protein-misfolding diseases.
6. Biological nano engines.

## 7. Attendance policy

### Attending classes

Attendance at lectures is optional. Attending practical classes is desirable. All works and activities are aimed at the students' compliance with the assessment rating requirements. A significant part of a student rating is formed through active participation in activities in practical classes. Therefore, skipping a practical class does not allow a student to get points in the semester rating. General assessment takes place according to a scheme of the agreed grading system. Expected learning outcomes, control measures and deadlines are announced to students in the first practical class.

### Control measures missed

Missed control measures (defense of practical work) can be worked out during the next classes, (provided that the task is scheduled for the current lesson), or in consultations.

Skipped express tests/ quizzes cannot be completed.

Skipped Module Test can be worked out in consultations.

### Violation of deadlines, penalty points and rewarding points

Rewarding points		Penalty points*	
Criterion	Weight points	Criterion	Weight points
Practical work improvement	1 point (for each practical work)	Untimely implementation of practical work	From -0.5 points to -5 points (depending on the delivery date)
Online courses completed on the topics that are agreed with the teacher	5 points	Untimely implementation of a Module Test	-5 points
Writing of abstracts, articles, participation in international, national and / or other events or competitions on the subject of the Course	From 5 points to +10 points		

\* if the control measure was missed for a good reason (illness, which is confirmed by a certificate of the established sample) - penalty points are not accrued.

### Academic integrity

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>.

### Norms of ethical behavior

Normative principles of behavior of students and employees, defined in sections 2 of the Code of Honor of the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute". Read more: <https://kpi.ua/code>.

### Procedure for appealing the results of control measures

Students have the opportunity to raise any issue related to the control procedure and expect it to be addressed according to predefined procedures.

The student has the right to appeal the results of the control measure according to the approved provision on appeals in the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic

### **Inclusive education**

The course "Biochemistry" can be taught to the most of students with special educational needs.

### **Distance learning**

Distance learning takes place through the Sikorsky Distance learning Platform «Sikorsky».

Distance learning through additional online courses on certain topics is allowed subject to agreement with students. If a small number of students wish to take an online course on a specific topic, studying the material with such courses is allowed, but students must complete all the tasks provided in the discipline.

The list of courses is offered by the teacher after the students have expressed a desire (because the bank of available courses is updated almost every month).

The student provides a document confirming the completion of the distance course (in the case of a full course) or provides practical tasks from the distance course and subject to an oral interview with the teacher on the topics can receive grades for control measures provided for the studied topics (express control / test tasks, practical work).

Performance of practical works is carried out during independent work of students in a remote mode (with a possibility of consultation with the teacher through e-mail, social networks).

### **Teaching in a foreign language**

Teaching in English is carried out only for foreign students.

At the request of students, it is allowed to study the material with the help of English-language online courses on topics that correspond to the topics of specific classes.

## **8. Monitoring and grading policy**

### **Grading system (current control):**

No s/n	Control measure	%	Weight points	Number	Total
1.	Express control works / quizzes	30	3	10	30
2.	Active work on a practical classes	45	3	15	45
3.	Presentation of a report on a practical classes	5	5	1	5
4.	Module Test (MT)	20	20	1	20
5.	Final Test <sup>1</sup>	100	100	1	100
	Total				100

In the final practical class of the course, students will add their rewarding points, if there are any, to the performance score, and /or subtract their penalty points if there are any, from the performance score, and in case it is in total higher than 60 points, they may either get their Pass or take the Final Test to improve their grade. If the grade for the Final Test is higher than the final performance grade, the student receives the grade based on the results of this Test. If the grade for the Test is lower, the final performance grade is cancelled and the student receives a grade based on the results of the Test.

Students whose final performance grade is 30-60 points have to take the Final Test in order to complete the course.

<sup>1</sup> Taken into account in the amount of the rating together with the grade for CGW in case the student has not scored 60 points per semester or he wants to improve his grade.

Students whose score is below 30 did not meet the requirements of the course and are not allowed to take the Final Test.

**Calendar control (CC)** is performed twice a semester as monitoring of the current state of compliance with syllabus requirements.

The purpose of calendar control is to improve the quality of student learning and monitor the implementation of the schedule of the educational process by students.

Criterion		The first CC	The second CC	
Deadline of calendar controls		8th week	14th week	
Conditions for obtaining a positive calendar control	Current grade	≥ 24 балів	≥ 40 балів	
	Execution of practical work	КП №№1-4	+	+
		КП №№5-8	-	+
	Express control works /quizzes	At least 4 of any lectures	+	-
		At least 8 of any lectures	-	+
Module Test	Estimated MCW	-	+	

In the case of a plagiarism or an academic poor quality during training the control measure is not credited.

### Semester certification of students

Mandatory requirements for the admission to the Final Test		Criterion
1	Current grade	RD ≥ 40
2	All practical works are completed	More than 10 points
3	Writing at least 6 express control works / quizzes	More than 10 points

The results are announced to each student separately in the presence or remotely (by e-mail). It is also recorded in the "Electronic Campus" system.

Optional requirements for admission to closure:

1. Active work during practical classes.
2. Positive result of the first and the second calendar control.
3. Attending of lectures.

The final performance score or the results of the Final Test are adopted by university grading system as follows:

Number points	Assessment on the university scale
100-95	Excellent / Відмінно
94-85	Very good / Дуже добре
84-75	Good / Добре
74-65	Satisfactory / Задовільно
64-60	Satisfactory enough/ Достатньо
Less 60	Unsatisfactory / Незадовільно
The course requirements are not met	Not allowed / Не допущено

## **9. Additional information on the course (educational component)**

*The list of questions for preparation for modular control work, and also for preparation for credit is given in appendix 1 ("Biochemistry-1.Bioorganic chemistry") and appendix 2 ("Biochemistry-2. Biochemistry")*

*Distance learning through additional online courses on certain topics is allowed subject to agreement with students. If a small number of students wish to take an online course on a specific topic, studying the material with such courses is allowed, but students must complete all the tasks provided in the discipline.*

*The list of courses is offered by the teacher after the students have expressed a desire (because the bank of available courses is updated almost every month).*

*The student provides a document confirming the completion of the distance course (in the case of a full course) or provides practical tasks from the distance course and subject to an oral interview with the teacher on the topics can receive grades for control measures provided for the studied topics (express control / quizzes, practical work).*

### **Work program of the course (syllabus):**

*is developed by Associate Professor of BME, Candidate of Biological Sciences, Larisa Kalashnikova.*

*is developed by Associate Professor of BME, Candidate of Biological Sciences, Svitlana Vovianko.*

*Approved by the Department of Biomedical Engineering (protocol № \_\_\_ to \_\_\_\_\_)*

*Approved by the Methodical Commission of the Faculty of Biomedical Engineering (protocol № \_\_ to \_\_\_\_\_)*

1. The subject of bioorganic chemistry. The purpose and objectives of the discipline. Fundamentals of the structure of organic compounds. The theory of A.M. Butlerova.
2. The phenomenon of hybridization. The mechanism of formation of hybrid states of the carbon atom
3. Classification of organic compounds by the structure of the carbon chain and the multiplicity of bonds
4. Classes of organic compounds. Functional groups that determine the class of organic compounds.
5. Functional and characteristic group of organic compounds. Define and compare. Classification of organic compounds by the number of functional groups.
6. Methods of imaging organic molecules
7. Types of nomenclature of organic molecules. Basic rules of forming the name of organic compounds for each type of nomenclature.
8. The phenomenon of isomerism. Structural isomerism. Classes of structural isomerism. Their characteristics.
9. Spatial isomerism. Classification of spatial isomers.
10. The nature of the phenomenon of chirality. Chiral carbon atom. Types of chirality of organic compounds
11. Describe the types of chemical bonds.
12. The phenomenon of isomerism. Spatial isomerism. isomerism. Types of spatial isomerism. Their characteristics. Compare the concepts of configuration and conformation.
13. The concept of conformers. Application of Newman's structural formulas.
14. Describe the mesomeric effect
15. Describe the inductive effect
16. Types of conjugation in organic molecules
17. What are enantiomers. What properties do they have. The concept of mirror isomerism What is a racemic mixture. Methods of separation of racemates.
18. Diastomerism. Types of diastomers. Methods of calculating the number of diastomers.
19. Ways to display the spatial structure of organic compounds on paper.
20. Systems of isomer designation.
21. Bronsted acids
22. Brandsted Basics
23. Lewis acids and bases.
24. Pearson's principle. The concept of chemical hardness.
25. Compare the concepts of acids and bases according to the theories of Bransted-Lowry, Lewis, Pearson.
26. Classification and isomerism of hydroxy acids. Chemical properties and biological significance of hydroxy acids
27. Biological significance of keto acids and their derivatives.
28. Phenolic acids and their derivatives.
29. Amines. Their biological activity and toxicity.



30. *Classification of carboxylic acids, some representatives of monocarboxylic acids.*
31. *Derivatives of carboxylic acids. Structure and properties of dicarboxylic acids. Higher fatty acids.*
32. *Structure, properties and classification of lipids, their functions in the body.*
33. *Structure and classification of carbohydrates. Chemical properties of carbohydrates. Optical isomerism of carbohydrates .. The concept of glycosides.*
34. *Homopolysaccharides as polyglycosides. Structure, biological role and application of starch, its components and biological role of glycogen, fiber, its role in the vital processes of the organism.*
35. *Heteropolysaccharides. The role of glucuronic acid, glucosamine and galactosamine in the formation of heteropolysaccharides.*
36. *Vitamins - classification, structure, functional features. .*
37. *Structure and medical and biological significance of prostaglandins and leukotrienes.*
38. *The concept of hormones - structure and functional significance for the body.*
39. *Alkaloids biological activity and toxicity*
40. *The structure and classification of amino acids by the structure of the carbon chain, the ability to synthesize in the body and the polarity of the radical. General properties of amino acids.*
41. *Structure and properties of proteins and peptides. Structural organization of proteins. Hydrolysis of a simple protein.*
42. *Levels of structural organization of protein molecules. Methods of combining  $\alpha$ -amino acids in protein molecules. Connections that form the primary, secondary, tertiary and Quaternary structures. Globular and fibrillar proteins.*
43. *Pyrimidine and purine bases. Structure of nucleosides and nucleotides*
44. *Phosphorylated nucleotide derivatives, values: ADP and ATP; AMP, GMF, UMF, CMF.*
45. *Macromolecular structure and functions of nucleic acids. DNA structures*
46. *Macromolecular structure and functions of nucleic acids. RNA structure (ribosomal, transport, matrix).*

*Appendix 2 to the syllabus of the course  
"Biochemistry-2. Biochemistry"*

***The list of questions for preparation for the Module Test,  
And also for preparation for the Final test***

- 1. Chemical composition of the human body.*
- 2. Name the main fluid volumes in humans. Explain how and why their ionic composition differs.*
- 3. Explain the primary, secondary, tertiary and quaternary structure of proteins. Give examples.*
- 4. Carbohydrates and their biological role in the human body.*
- 5. Name the general properties that all lipids have. What classes and on what principle are lipids classified?*
- 6. Describe the biological role of lipids.*
- 7. Describe architecture of biological membranes.*
- 8. Describe functions of biological membranes.*
- 9. Types of transport across biological membranes. Give examples.*
- 10. Describe the biological role of nucleic acids.*
- 11. How is metabolism regulated? Give examples.*
- 12. What substances have large free energy of hydrolysis? Explain their role in energy metabolism.*
- 13. Discover the relationship between the structure and properties of enzymes*
- 14. Explain how enzyme activity is regulated.*
- 15. Explain the concept of vitamins and their classification.*

16. *Water soluble vitamins. General characteristics and role in metabolism.*
17. *Fat soluble vitamins: properties, role in metabolism, manifestations of insufficiency and hypervitaminosis.*
18. *Antioxidant properties of water- and fat-soluble vitamins.*
19. *List and compare the main pathways of glucose catabolism.*
20. *Explain the biological role of glycolysis. Write the net biochemical equation for the metabolism of a molecule of glucose by glycolysis, including all cofactors.*
21. *Write a balanced net equation for the catabolism of acetyl-CoA to CO<sub>2</sub> in a Citric Acid Cycle. Why the cycle operates only when O<sub>2</sub> is present?*
22. *Describe the structure of mitochondria. What metabolic processes occur in different parts of mitochondria?*
23. *Describe a respiratory chain of mitochondria.*
24. *Explain ATP synthase mechanism. How ATP synthesis is regulated?*
25. *What is gluconeogenesis? What organs have the highest velocity of this process?*
26. *What biologically active substances are amino acid derivatives?*
27. *What is urea cycle and where does it take place?*
28. *Biochemistry of red blood cells.*
29. *Mechanism of hemoglobin transport of O<sub>2</sub> and CO<sub>2</sub>.*
30. *Blood buffer systems. Their role in the acid-base balance.*
31. *List and give brief characteristic of biochemical functions of liver.*
32. *Detoxification functions of liver. Describe biotransformation reactions of xenobiotics and endogenous toxins.*
33. *List and give brief characteristic of the biochemical functions of kidneys.*
34. *Explain how the membrane resting potential is generated and maintained.*
35. *Mechanisms of action potential generation.*
36. *Explain the mechanism of synaptic transmission.*
37. *Explain the mechanism of muscle contraction (The sliding filament model)*
38. *Explain the role of calcium ions in muscle contraction. Point out the difference between skeletal muscle, heart muscle and smooth muscle.*
39. *List the endocrine glands of a human. Name what hormones they produce.*
40. *Classification of hormones by chemical nature. Give examples.*
41. *Structure and biological role of thyroid hormones.*
42. *Structure and biological role of catecholamines.*
43. *Structure and biological role of pancreatic hormones.*
44. *Structure and biological role of steroid hormones.*