



BIOCHEMISTRY-2. 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>1st year (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 http://rozklad.kpi.ua/</i> |
| Language of instruction | <i>English</i> |
| Information about course supervisor / teachers | <i>Lecturer: Candidate of Biological Sciences, Associate Professor of BME Svitlana Vovianko, e-mail: sivovianko@gmail.com, Telegram - https://t.me/vovianko_svitlana Practical: Candidate of Biological Sciences, Associate Professor of BME Svitlana Vovianko, e-mail: sivovianko@gmail.com, Telegram - https://t.me/vovianko_svitlana</i> |
| Course placement | <i>Platform «Sikorsky» - course «Biochemistry-2. Biochemistry» (li45uk)</i> |

Distribution of hours

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

Curriculum of the discipline

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

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 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 "Biochemistry-2. Biochemistry" belongs to the cycle of professional training and has an interdisciplinary nature. According to the structural and logical scheme of preparation of bachelor's degree program the course "Biochemistry-2. Biochemistry" is closely related to the following courses of professional training: "Biochemistry-1. Bioorganic chemistry", "Human Anatomy and Physiology", "Quantitative Physiology", "Materials science and construction materials". It is immediately preceded by the course "Biochemistry-1. Bioorganic chemistry".

3. Course Overview

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

Part 1. Metabolism

Subject 1.1. Molecular basis of life.

Subject 1.2. Biological membranes.

Subject 1.3. Basic regularities of metabolism.

Subject 1.4. Energy metabolism.

Subject 1.5. Carbohydrate Metabolism.

Subject 1.6. Lipid metabolism.

Subject 1.7. Protein Metabolism.

Part 2. Biochemistry of the human body

Subject 2.1. Biochemistry of blood.

Subject 2.2. Biochemistry of liver. Metabolism of xenobiotics.

Subject 2.3. Biochemistry of kidneys.

Subject 2.4. Biochemistry of nervous tissue.

Subject 2.5. Biochemistry of muscle tissue, connective tissue, and bone tissue.

Subject 2.6. Hormones.

Subject 2.7. Biochemistry of nutrition.

Subject 2.8. Biochemistry of pathological processes.

4. Coursebooks and teaching resources

Basic:

1. Mardashko A. A. et al. *Biological and Bioorganical chemistry: teaching textbook*. – Kyiv: Caravela, 2017.
2. Jan Koolman, Klaus-Heinrich Roehm. *Color Atlas of Biochemistry Second edition, revised and enlarged Thieme Stuttgart · New York, 2005*. – 476 p.

Supplementary:

1. 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.
2. Sharon Walker, David McMahon. *Biochemistry Demystified, 2008 by The McGraw-Hill Companies* – 385 p.
3. David L. Nelson, Michael M. Cox. *Lehninger Principles of Biochemistry. Seventh Edition, 2017*. – 3270 p.

Educational content

5. Methods of mastering the discipline (educational component)

| № s/n | Subject | Program learning outcomes | The main tasks | |
|---|--------------------------|---------------------------------|----------------------------|--|
| | | | Control measure | Deadline |
| Spring semester, 4 ECTS credits / 120 hours | | | | |
| 1. | Molecular basis of life. | PLO 1 PLO 10 PLO 14 | Practical work 1 | 1 st – 2 nd week |
| 2. | Biological membranes. | PLO 1 PLO 10 | Practical work 2 Quiz 1 | 3 rd week |

| | | | | |
|-----|---|--|-------------------------------------|-----------------------------|
| | | PLO 14 | | |
| 3. | <i>Basic regularities of metabolism.</i> | PLO 1 PLO 10 PLO 14 PLO 17 | <i>Practical work 3 Quiz 2</i> | <i>4th week</i> |
| 4. | <i>Energy metabolism.</i> | PLO 1 PLO 10 PLO 14 PLO 17 | <i>Practical work 4</i> | <i>5th week</i> |
| 5. | <i>Carbohydrate Metabolism.</i> | PLO 10 PLO 14 PLO 17 PLO 24 | <i>Practical work 5 Quiz 3</i> | <i>6th week</i> |
| 6. | <i>Lipid metabolism.</i> | PLO 10 PLO 14 PLO 17 PLO 24 | <i>Practical work 6 Quiz 4</i> | <i>7th week</i> |
| 7. | <i>Protein Metabolism.</i> | PLO 10 PLO 14 PLO 17 PLO 24 | <i>Practical work 7 Quiz 5</i> | <i>8th week</i> |
| 8. | <i>Biochemistry of blood.</i> | PLO 14 PLO 17 PLO 24 PLO 29 | <i>Practical work 8 Quiz 6</i> | <i>9th week</i> |
| 9. | <i>Biochemistry of liver. Metabolism of xenobiotics.</i> | PLO 14 PLO 17 PLO 24 PLO 29 | <i>Practical work 9 Quiz 7</i> | <i>10th week</i> |
| 10. | <i>Biochemistry of kidneys.</i> | PLO 14 PLO 17 PLO 24 PLO 29 | <i>Practical work 10</i> | <i>11th week</i> |
| 11. | <i>Biochemistry of nervous tissue.</i> | PLO 14 PLO 17 PLO 24 PLO 29 | <i>Practical work 11 Quiz 8</i> | <i>12th week</i> |
| 12. | <i>Biochemistry of muscle tissue, connective tissue, and bone tissue.</i> | PLO 14 PLO 17 PLO 24 PLO 29 | <i>Practical work 12 Quiz 9</i> | <i>13th week</i> |
| 13. | <i>Module Test</i> | PLO 10 PLO 14 PLO 17 PLO 24 PLO 29 | <i>Module Test writing</i> | <i>14th week</i> |
| 14. | <i>Hormones.</i> | PLO 10 PLO 14 PLO 17 PLO 24 PLO 29 | <i>Practical work 13 Quiz 6</i> | <i>15th week</i> |
| 15. | <i>Biochemistry of nutrition.</i> | PLO 14 PLO 17 PLO 24 PLO 29 PLO 41 | <i>Practical work 14</i> | <i>16th week</i> |

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

6. Self-study

Preparing for the classes is carried out in accordance with the plan of the course with the links to the MOODLE platform, and the implementation of tests for self-control, posted on the MOODLE platform.

Students are invited to choose a topic and prepare a short report (5-10 minutes) for one of the practical classes according to the plan of the course.

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.*

Policy and control

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 Institute” (approved by the order №NON/128/2021 from 20.05.2021) - <https://osvita.kpi.ua/index.php/node/182>

Inclusive education

The course "Biochemistry-2. 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 tests / 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 | 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.

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 |
| Current grade | | ≥ 24 points | ≥ 40 points |
| Requirements to obtain a positive calendar control | Execution of practical work | PW No.1-4 | + |
| | | PW No. 5-8 | - |
| | Express tests /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 | $RD \geq 40$ |
| 2 | All practical works are completed | More than 0 points |
| 3 | Writing at least 6 express control works / quizzes | More than 6 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 the admission to the Final Test:

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 / 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 Module Test, and also for preparation for credit is given in appendix 1.

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 tests / quizzes, practical work).

Work program of the course (syllabus):

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 _____)

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 CO₂ in a Citric Acid Cycle. Why the cycle operates only when O₂ 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 O₂ and CO₂.
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.*