National Technical University of Ukraine
"Igor Sikorsky Kyiv Polytechnic Institute"

Department of
biomedical engineering

Biochemistry. Part 2. Biochemistry

Syllabus of the academic discipline (Syllabus)

Requisites for basic discipline	
Level of higher education	*First (bachelor's)*
Field of study	*16 Chemical Engineering and Bioengineering*
Speciality	*163 Biomedical Engineering*
Educational program	*Medical Engineering*
Course status	*Required (standard) discipline*
Mode of study	*full-time / day / mixed / remote*
Year of study, semester	*1st year of study, spring semester*
Course workload	*4 ECTS credits / 120 hours*
Semester control / Control measures	*Final test, Module test, Essay*
Course schedule	*According to the schedule on the site http://rozklad.kpi.ua/*
Language of instruction	*English*
Information about course leader / teachers	***Lecturer:*** *Ph.D. in Biology, Associate Professor of the Department of Biomedical Engineering, Svitlana Vovianko, e-mail – s.vovianko-fbmi@lll.kpi.ua* ***Practical:*** *Candidate of Biological Sciences, Associate Professor, Department of Biomedical Engineering, Svitlana Vovianko, e-mail – s.vovianko-fbmi@lll.kpi.ua*
Course placement	*Platform "Sikorsky" - https://do.ipo.kpi.ua: course "Biochemistry. Part 2. Biochemistry"(ok26et)*

Distribution of hours

Semester	Lectures	Practical	Self-study
spring semester	*36*	*36*	*48*

Curriculum of the discipline

1. Course Description, Aim, Subject Matter and Learning Outcomes

The academic discipline "Biochemistry. Part 2. Biochemistry" studies the molecular foundations of the functioning of organs and systems of the human body, as well as the patterns by which chemical processes occurring in the body are transformed into physiological functions. This enables the formation of students' systematic knowledge of metabolic processes in the body for their further use in practical activities, including modeling the functioning of organs and systems and developing algorithms for supporting and restoring their functions.

The main objective of the academic discipline "Biochemistry. Part 2. Biochemistry" is to develop in students an understanding of the basic chemical and biochemical processes occurring in a living organism at the molecular level, as well as the ability to apply physical, chemical, and biological methods in the analysis and modeling of the functioning of living organisms and biotechnical systems.

To study the discipline Biochemistry, the following skills and knowledge are required:

– knowledge of the fundamentals of bioorganic chemistry; understanding the relationship between the structure of biomolecules and their reactivity; ability to predict possible pathways and conditions of transformation of functional groups in the most important classes of organic compounds during metabolism; ability to identify biologically important organic compounds based on knowledge of their chemical properties and basic methods of investigation of organic compounds; ability to analyze the correspondence between the structure of bioorganic compounds and the physiological functions they perform in the human body.

Integral competence *(EP was put into effect by the Rector's Order NON/434/2024 of June 10, 2024):*

IC - *The ability to solve complex, specialized problems and practical problems in biomedical engineering and in the process, which provides the use of specific theories and methods of chemical, biological and medical engineering, and is characterized by the complexity and non-strict terms*

General competencies *(EP was put into effect by the Rector's Order NON/434/2024 of June 10,2024):*

ЗК 06 - Ability to search, process, and analyse information from various sources.

Professional competencies *(EP was put into effect by the Rector's Order NON/434/2024 of June 10, 2024):*

ФК 05 - Ability to apply physical, chemical, biological, and mathematical methods in the analysis and modeling of the functioning of living organisms and biotechnical systems

Programme learning outcomes after completing the course “Biochemistry. Part 2. Biochemistry” include *(EP was put into effect by the Rector's Order NON/434/2024 of June 10, 2024):*

ПРН 17 Application of knowledge in chemistry and bioengineering to create, synthesize, and apply artificial biotechnical and biological objects.

ПРН 18 Understanding of fundamental-applied, medical-physical, and physico-chemical principles governing the functioning of biological objects, as well as bioengineering fundamentals of technologies and equipment for researching human body processes.

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

The academic discipline “Biochemistry. Part 2. Biochemistry” belongs to the cycle of professional training and has an interdisciplinary character.

Prerequisites: the course is taught in the 2nd semester of the 1st year of study and is directly preceded by the discipline “Biochemistry. Part 1. Bioorganic Chemistry”.

Postrequisites: according to the structural and logical scheme of the specialist training program, the discipline “Biochemistry. Part 2. Biochemistry” is closely related to other professional training courses, including “Materials Science and Structural Materials”, “Quantitative Physiology”, “Biomaterials and Biocompatibility”.

3. The content of the discipline

The main sections and topics covered in the course are as follows:

Section 1. Biochemistry of Metabolic Processes

Topic 1.1. Basic concepts of biochemistry. Molecular foundations of vital activity. Biological membranes.

Topic 1.2. Fundamental principles of metabolism. The tricarboxylic acid cycle as the central metabolic pathway.
Topic 1.3. Molecular foundations of bioenergetics.
Topic 1.4. Carbohydrate metabolism and its regulation.
Topic 1.5. Lipid metabolism and its regulation.
Topic 1.6. Protein metabolism as a central process of living matter. Amino acid metabolism.
Topic 1.7. Nucleotide metabolism and its regulation.

Section 2. Biochemistry of the Human Body

Topic 2.1. Blood biochemistry.
Topic 2.2. Liver biochemistry. Xenobiotic metabolism.
Topic 2.3. Biochemistry of nervous tissue.
Topic 2.4. Biochemistry of excitable tissues.
Topic 2.5. Muscle biochemistry.
Topic 2.6. Biochemistry of hormonal regulation.
Topic 2.7. Molecular aspects of genetic information transfer.
Topic 2.8. Nutritional biochemistry.

4. Training materials and resources

Basic literature:

1. *Біологічна і біоорганічна хімія : у 2 кн. : підручник. Кн. 2. Біологічна хімія / Ю.І. Губський, І.В. Ніженковська, М.М.Корда та ін. ; за ред. Ю.І. Губського, І.В. Ніженковської. – 3-є вид. – К.: ВСВ «Медицина», 2021. – 544 с. Замовити в Бібліотеці КПІ: https://opac.kpi.ua/F/IMXYQDBTRBQYQ35I2FRI53A4V8X94JUA5U826IP765B9S2CMMR-16257?func=full-set-set&set_number=000077&set_entry=000001&format=999*
2. *Вовянко С.І., Калашнікова Л.Є. «Біохімія» Методичні рекомендації для самостійної роботи студентів для студентів спеціальності 163 – «Біомедична інженерія» / КПІ ім. Ігоря Сікорського. – 2021. – 63 с. https://do.ipo.kpi.ua/course/view.php?id=2946*
3. *Зіменковський, Борис Семенович. Біологічна і біоорганічна хімія : підручник для студентів медичних закладів вищої освіти / за редакцією Б.С. Зіменковського, І.В. Ніженковської, Ю. І. Губського. – Київ : ВСВ "Медицина", 2021–2022. – 2 книги. Замовити в Бібліотеці КПІ: https://opac.kpi.ua/F/?func=direct&doc_number=000636899&local_base=KPI01*
4. *Конспект лекцій з вивчення дисципліни «Біохімія» для студентів спеціальності 163 - Біомедична інженерія освітня програма Біомедична інженерія / Уклад. Д. Х. Штофель. – Вінниця : ВНТУ, 2020.–298 с. Режим доступу: https://bmi.vntu.edu.ua/bioart/program/BC_lect.pdf*
5. *Скоробогатова, Зоя Михайлівна. Біохімія. Короткий курс : навчальний посібник / З.М. Скоробогатова, М.А. Сташкевич, А.Г. Матвієнко ; Національна академія наук України, Інститут фізико-органічної хімії і вуглехімії ім. Л.М. Литвиненка. – Київ : Біокомпозит, 2019–2021. – 2 частини. Замовити в Бібліотеці КПІ: https://opac.kpi.ua/F/?func=direct&doc_number=000608363&local_base=KPI01*

Supporting literature:

1. *Дзержинський, Микола Едуардович. Цитобіохімія крові : навчальний посібник / М.Е. Дзержинський, Т.В. Рибальченко, Т.Б. Синельник, В.К. Рибальченко ; за редакцією Рибальченка ; Міністерство освіти і науки України, Київський національний університет імені Т. Шевченка. – Київ : ВПЦ "Київський університет", 2020. – 413 с. Замовити в*

Бібліотеці КПІ: https://opac.kpi.ua/F/?func=direct&doc_number=000643463&local_base=KPI01

2. *Лисиця, Андрій Валерійович. Біохімія. Практикум : навчальний посібник для студентів біологічних спеціальностей вищих навчальних закладів / А.В. Лисиця. – Суми : Університетська книга, 2023. – 239 с. Замовити в Бібліотеці КПІ: https://opac.kpi.ua/F/?func=direct&doc_number=000642071&local_base=KPI01*
3. *Луньова, Ганна Геннадіївна. Клінічна біохімія : в трьох томах : підручник / Г.Г. Луньова, Г.М. Ліпкан, Л.В. В'юницька [та 31 інших] ; за загальною редакцією Луньової, Г.Г. ; Міністерство охорони здоров'я України, Національна медична академія післядипломної освіти імені П.Л. Шупика. - Львів : Видавництво " Магноліч", 2023. – томи. Замовити в Бібліотеці КПІ: https://opac.kpi.ua/F/?func=direct&doc_number=000642559&local_base=KPI01*
4. *Нельсон, Дейвід Лі, Основи біохімії за Ленінджером / Дейвід Л. Нельсон, Майкл М. Кокс ; [пер. з англ. О. Матишевська та ін. ; наук. ред. пер. С. Комісаренко та ін. ; ред. М. Мартиняк]. - Львів : БаК, 2015. - XXIV, 1256 с.*
5. *Ніженковська, Ірина Володимирівна. Біологічна хімія : тестові завдання з поясненнями для студентів фармацевтичного факультету / Ніженковська І.В., Кузнецова О.В. – Київ : ФОП Лопатіна О.О., 2019. – 312 с. Замовити в Бібліотеці КПІ: https://opac.kpi.ua/F/?func=direct&doc_number=000602013&local_base=KPI01*
6. *Осипенко, Ганна Антонівна. Основи біохімії м'язової діяльності : навчальний посібник для студентів вищих навчальних закладів фізичного виховання і спорту / Г.А. Осипенко. – Київ : Національний університет фізичного виховання і спорту України "Олімпійська література", 2019.–198с. Замовити в Бібліотеці КПІ: https://opac.kpi.ua/F/?func=direct&doc_number=000604897&local_base=KPI01*
7. *Павлоцька, Лариса Федорівна. Біологічна хімія : підручник для студентів вищих навчальних закладів / Павлоцька Л.Ф., Дуденко Н.В., Левітін Є.Я., Цихановська М.Г. [та 4 інших]. – Суми : Університетська книга, 2023. – 507 с. Замовити в Бібліотеці КПІ: https://opac.kpi.ua/F/?func=direct&doc_number=000642043&local_base=KPI01*
8. *Петров, Сергій Анатолійович. Патологічна біохімія : підручник / С.А. Петров ; Міністерство освіти і науки України, Одеський національний університет імені І.І. Мечникова. – Херсон : Олді-плюс, 2021. – 145 с. Замовити в Бібліотеці КПІ: https://opac.kpi.ua/F/?func=direct&doc_number=000640201&local_base=KPI01*
9. *Сибірна, Наталія Олександрівна. Механізми біохімічних реакцій : навчальний посібник / автори: Н.О. Сибірна, Г.Я. Гачкова, О.Г. Стасик, І.В. Бродяк, [та 6 інших] ; за редакцією Н.О. Сибірної ; Міністерство освіти і науки України, Львівський національний університет імені Івана Франка. – Львів : ЛНУ імені Івана Франка, 2021. – 318 с. Замовити в Бібліотеці КПІ: https://opac.kpi.ua/F/?func=direct&doc_number=000642006&local_base=KPI01*
10. *Явоненко, Олександр Федотович. Біохімія : підручник для студентів вищих навчальних закладів / О.Ф. Явоненко, Б.В. Яковенко. – Суми : Університетська книга, 2023. – 379 с. Замовити в Бібліотеці КПІ: https://opac.kpi.ua/F/?func=direct&doc_number=000642533&local_base=KPI01*
11. *Біологічна хімія : навч. посіб. / Л. І. Гребеник та ін. ; за заг. ред. Л. І. Гребеник. – Суми : Сумський державний університет, 2023. – 380 с. Режим доступу: https://essuir.sumdu.edu.ua/bitstream/123456789/91540/1/Hrebenik.pdf*
12. *Гонський Я.І., Максимчук Т.П. Біохімія людини. – Тернопіль: Укрмедкнига, 2001. – 736 с. Режим доступу: https://repository.ldufk.edu.ua/handle/34606048/22152*

13. *Гусак, Віктор Васильович. Біохімія крові. Короткий курс / Гусак В.В., Абрат О.Б. – Івано-Франківськ : Прикарпатський національний університет імені Василя Стефаника, 2023. – 127 с. Режим доступу: https://kbb.pnu.edu.ua/wp-content/uploads/sites/28/2023/11/biokhimiia_krovi_husak_abrat.pdf*
14. *Методичні вказівки до лабораторних робіт з дисципліни «Біохімія» для студентів спеціальності 163 «Біомедична інженерія» всіх форм навчання. – Тернопіль: ТНТУ, 2019. – 78 с. Режим доступу: https://elartu.tntu.edu.ua/bitstream/lib/27942/1/Met_vkaz_biochem_RB_2019.pdf*
15. *Хімія біогенних елементів. Лабораторний практикум [Електронний ресурс] : навчальний посібник для студентів спеціальності 162 «Біотехнології та біоінженерія», освітньої програми «Біотехнології» / КПІ ім. Ігоря Сікорського ; уклад.: Н. Б. Голуб, Л. С. Зубченко, І. І. Левтун. – Київ : КПІ ім. Ігоря Сікорського, 2020. – 52 с. Режим доступу: https://ela.kpi.ua/handle/123456789/35048*
16. *Koolman, Jan. Color Atlas of Biochemistry Second edition, revised and enlarged / J. Koolman, K.-H. Roehm. – Thieme, 2005.–476 p. Режим доступу: https://www.academia.edu/44166391/Color_Atlas_of_Biochemistry_Second_edition_revised_and_enlarged*
17. *Скоробогатова, Зоя Михайлівна. Біохімія в рисунках і схемах. Навчально-наочний посібник для студентів фармацевтичного факультету / З.М. Скоробогатова, Ю.Д. Турсунова та ін. — Донецьк: ДонНМУ ім. М. Горького, 2010. — 225 с.*
18. *Nelson, David L. Lehninger Principles of Biochemistry. 8th Edition / D.L. Nelson, M.M. Cox — Macmillan Learning, 2021. — 4381 p. — ISBN 978-1319228002//*
19. *Walker, Sharon. Biochemistry Demystified / S. Walker, D. McMahon. — The McGraw-Hill Companies, 2008 – 385 p.*

Educational content

5. Methodology for mastering the academic discipline (educational component)

For the study of the discipline, 18 lecture sessions and 18 practical classes are scheduled in each semester. During the practical classes, a module test is planned.

During the study of the course material, the following teaching methods are applied:

Lectures are conducted using the explanatory and illustrative method, the problem-based learning method, and interactive methods during lectures, which are used to establish dialogue with the audience.

Practical classes employ the following methods:

- Reproductive method, through which students consolidate the studied theoretical material and learn to apply it to specific tasks.
- Partially search-based (heuristic) method, which develops the ability to find correct approaches and methods for solving problems.
- Interactive method.
- Demonstration and review of software tools and virtual chemical processes.
- Discussion.

Below is the distribution of classroom hours by course topics and the calendar schedule for their implementation.

Subject	Lectures		Practicals		Control measure
	Week of semester	hrs	Week of semester	hrs	
Topic 1.1. Basic concepts of biochemistry. Molecular foundations of vital activity. Biological membranes.	1-2	4	1-2	4	Practical Assignment (PA) No 1 Quiz №1
Topic 1.2. Fundamental principles of metabolism. The tricarboxylic acid cycle as the central metabolic pathway.	3	2	3	2	Quiz №2
Topic 1.3. Molecular foundations of bioenergetics.	4	2	4	2	PA No 2 Quiz №3
Topic 1.4. Carbohydrate metabolism and its regulation.	5	2	5	2	Quiz №4
Topic 1.5. Lipid metabolism and its regulation.	6	2	6	2	Quiz №5
Topic 1.6. Protein metabolism as a central process of living matter. Amino acid metabolism	7	2	7	2	Quiz №6
Topic 1.7. Nucleotide metabolism and its regulation.	8	2	8	2	Quiz №7
Topic 2.1. Blood biochemistry	9-10	4	9-10	4	Quiz №8
Topic 2.2. Liver biochemistry. Xenobiotic metabolism	11	2	11	2	Quiz №9
Topic 2.3. Biochemistry of nervous tissue	12-13	4	12-13	4	-
Topic 2.4. Biochemistry of excitable tissues.	14	2	14	2	Quiz №10
Topic 2.5. Muscle biochemistry.	15	2	15	2	PA No 3
Topic 2.6. Biochemistry of hormonal regulation	16	2	16	2	Quiz №11
Topic 2.7. Molecular aspects of genetic information transfer	17	2	17	-	Quiz №12
Topic 2.8. Nutritional biochemistry	18	2	18	-	--
Module test			17	2	Module test
Essay			14-17		Essay
***Final* test**			***18***	***(2)***	
Total hrs		**36**		**36**	

The alignment of teaching and assessment methods is reflected in the rating-based assessment system, which provides for the assessment of tests and practical assignments, oral questioning during practical classes, a module test, an essay, and a final pass/fail assessment (credit).

5.1. Lectures

No.	***Lecture title and main questions to be covered***
	Section 1. Biochemistry of Metabolic Processes
1.	**Topic 1.1** **Lecture 1, Part 1:** Subject and Objectives of Biochemistry. History of Biochemistry. • History of biochemistry and the development of biochemistry in Ukraine. • Modern approaches to solving biochemical problems. • Libraries and databases. • Computer modeling. • Applied biochemistry: drug design, pharmacogenetics.

	Lecture 1, Part 2: Chemical Composition of Living Organisms. • Molecular foundations of vital activity. • Principles of molecular organization and functioning of living systems. • Biomolecules and cells. • Chemical composition of living organisms. • Medico-physical patterns of functioning of biological objects.
2.	**Topic 1.1** **Lecture 2:** Biological Membranes • Biochemical functions of membranes. • Fluid-mosaic model of biomembranes; membrane lipids. • Transport of substances across membranes. • Receptors. • Creation, synthesis, and application of artificial biotechnical and biological objects.
3.	**Topic 1.2:** Fundamental Principles of Metabolism. The Tricarboxylic Acid Cycle as the Central Metabolic Process **Lecture 3, Part 1:** Concept of Metabolism • Catabolism and anabolism. • Levels of regulation of metabolic processes. • Stages of nutrient breakdown and energy release in cells. • ATP as the universal energy "currency" and pathways of its synthesis in the body. • Other macroergic and supra-macroergic compounds. **Lecture 3, Part 2:** Common Metabolic Pathways of Substances • Oxidative decarboxylation of pyruvate. • Structure of the pyruvate dehydrogenase (PDH) multienzyme complex. • Tricarboxylic acid (Krebs) cycle as the central metabolic process: mechanism, significance, and energy balance. **Lecture 3, Part 3:** Methods for Studying Energy Metabolism • Energy balance in humans. • Respiratory calorimeter. • Assessment of energy expenditure using the respiratory quotient. • Concept of basal metabolism and its calculation.
4.	**Translation into English:** **Topic 1.3:** Molecular Foundations of Bioenergetics **Lecture 4:** Oxidative Phosphorylation • Macroergic compounds and their biological significance. • Tissue respiration. • Structure and significance of mitochondria. • Redox potential and its importance. • Formation of water and carbon dioxide in tissues through simple and oxidative decarboxylation. • Formation of hydrogen peroxide and the role of enzymes in its detoxification. • Oxidative phosphorylation (Mitchell's chemiosmotic theory) and the significance of the P/O ratio. • Structure of ATP synthase. • Pathology of biological oxidation: inhibitors of tissue respiration, uncouplers of oxidative phosphorylation and tissue respiration. • Methods for studying biological oxidation.
5.	**Topic 1.4:** Carbohydrate Metabolism and Its Regulation **Lecture 5:** Carbohydrate Metabolism and Its Regulation • Anaerobic carbohydrate metabolism. • Mechanisms of glycolysis and glycogenolysis: biological significance, energy balance of

	these processes, substrate-level phosphorylation, regulation of glycolysis, Pasteur effect. • Lactate metabolism in tissues. • Aerobic oxidation of glucose. • Energy balance of complete aerobic oxidation of carbohydrates to carbon dioxide and water. • Pentose phosphate pathway of carbohydrate metabolism: significance and regulation. • Methods for studying carbohydrate metabolism.
6.	**Topic 1.5:** Lipid Metabolism and Its Regulation **Lecture 6:** Lipid Metabolism and Its Regulation • Lipid metabolism: breakdown of triglycerides in tissues, mobilization of fatty acids from fat depots, and their oxidation. • Biosynthesis of long-chain fatty acids, triglycerides, phospholipids, and cholesterol. • Biotransformation of cholesterol and its biological significance. • Methods for studying lipid metabolism.
7.	**Topic 1.6:** Protein Metabolism as a Central Process of Living Matter. Amino Acid Metabolism **Lecture 7:** Protein Metabolism as a Central Process of Living Matter • Nitrogen metabolism in nature. • Dynamic state of body proteins. • General pathways of protein metabolism. • General pathways of amino acid catabolism. • Ammonia detoxification. • Urea biosynthesis. • Amino acid biosynthesis. • Amino acid derivatives. • Biogenic amines. • Methods for studying protein metabolism.
8.	**Topic 1.7:** Nucleotide Metabolism and Its Regulation **Lecture 8:** Nucleotide Metabolism and Its Regulation • Structure of nucleotides. • General scheme of nucleotide metabolism; digestion of nucleoproteins. • Biosynthesis of purine nucleotides and its regulation. • Catabolism of purine nucleotides. • Reutilization of purine bases. • Biosynthesis of pyrimidine nucleotides.
Section 2. Biochemistry of the Human Body	
9.	**Topic 2.1:** Biochemistry of Blood (Part 1) **Lecture 9:** Biochemistry of Blood. Part 1: Biochemistry of Blood Cells. Gas Transport • Blood as a biological fluid and its significance for the organism. • Composition of blood. Functions of blood. • Main physicochemical constants of blood. • Structural features and metabolism of erythrocytes, leukocytes, and platelets. • Oxygen transport function of hemoglobin. • Transport of carbon dioxide by the blood.
10.	**Topic 2.1:** Biochemistry of Blood (Part 2) **Lecture 10:** Blood Plasma and Its Components • Proteins of blood plasma. Characteristics of the main protein fractions and individual proteins. • Proteolytic cascade systems of the blood: coagulation system, fibrinolytic system, complement system, kallikrein-kinin system, and their interconnections. • Bioengineering solutions for medical applications

11.	**Topic 2.2:** Biochemistry of the Liver. Xenobiotic Metabolism **Lecture 11:** Biochemical Functions of the Liver • Biochemical functions of the liver: role in carbohydrate metabolism (glycogenic function), lipid regulation, protein synthesis, urea formation, pigment metabolism, and bile formation. • Role of the liver in bilirubin metabolism. • Methods for studying liver function. **Xenobiotic Metabolism** • Biotransformation of xenobiotics and endotoxins. • Microsomal oxidation and xenobiotic metabolism. • Pathways of xenobiotic transformation in the body. • Organization of microsomal electron transport chains. • Cytochrome P450 and its induction. • Hydroxylation and dealkylation reactions of xenobiotics. • Conjugation reactions of xenobiotics. • Methods for studying xenobiotic metabolism.
12.	**Topic 2.3:** Biochemistry of Nervous Tissue (Part 1) **Lecture 12:** Features of the Chemical Composition and Metabolism of Nervous Tissue • Concept of excitable tissues. • Chemical composition of nervous tissue. • Cerebrospinal fluid. • Features of nervous tissue metabolism. • Energy metabolism in the brain. • Glutamic acid system. • GABA shunt.
13.	**Topic 2.3:** Biochemistry of Nervous Tissue (Part 2) **Lecture 13:** Generation and Conduction of Nerve Impulses • Resting potential. • Generation of the action potential. • Propagation of the action potential. • Chemical basis of neurotransmission. • Neuromodulators and peptides. • Receptors of nervous tissue and their structure. • Bioengineering principles of technologies and equipment for studying nervous processes in the human body.
14.	**Topic 2.4:** Biochemistry of Muscles **Lecture 14:** Biochemistry of Muscles • Features of the cellular structure and chemical composition of muscles. • Structure of filaments and myofibrils. • Molecular mechanisms of muscle fiber contraction. • Excitation–contraction coupling. • Contraction of smooth muscles. • Energy sources of muscle fibers. • Energy metabolism in cardiac muscle.
15.	**Lecture 15:** Biochemistry of Connective Tissue • Features of the cellular structure and chemical composition of connective tissues. • Components of connective tissue. • Collagen: structure, synthesis, and types of collagen. • Elastin: structure and synthesis. • Glycosaminoglycans and proteoglycans. • Specialized extracellular matrix proteins. • Fibronectin. • Adhesive proteins: laminins, nidogen, integrins.

	• Anti-adhesive proteins.
	• Organization of the intercellular matrix in highly specialized structures:
	  ○ Bone and dental tissue
	  ○ Articular cartilage
	  ○ Intercellular matrix of skin tissues
	  ○ Basal membranes
	  ○ Lens

16.	**Lecture 16:** Hormonal Regulation of Metabolism • Physicochemical principles of human body functioning. • Classification of hormones by chemical nature. • Adenylate cyclase and phosphoinositide mechanisms of hormone action. • Hypothalamic hormones. • Pituitary hormones. • Thyroid hormones. • Hormonal control of calcium metabolism. • Pancreatic hormones. • Hormones of the adrenal medulla. • Hormones of the adrenal cortex. • Male and female sex hormones.
17.	**Topic 2.7:** Molecular Aspects of Genetic Information Transfer **Lecture 17:** Template Biosyntheses • Functions of DNA and RNA. • Template biosyntheses. • DNA replication. • DNA repair of errors and damage. • Transcription. • Post-transcriptional RNA modifications (processing). • RNA degradation. • Translation as the mechanism of converting genetic information into phenotypic traits. • Mechanisms of adaptive regulation of gene activity. • Mechanisms of genetic variability. • Pharmacogenetic algorithms.
18.	**Topic 2.8:** Nutritional Biochemistry **Lecture 18:** Nutritional Biochemistry • Human body requirements for nutrients. • Biological value of proteins. • Non-essential and essential amino acids. • Protein requirements and nitrogen balance. • Protein digestion. • Proteolytic enzymes of the gastrointestinal tract. • Role of hydrochloric acid in the stomach. • Absorption of protein hydrolysis products. • Digestive enzymes for carbohydrates and lipids. • Hydrolysis products and their absorption mechanisms. • Methods for studying digestive function. • Water-soluble vitamins. • Fat-soluble vitamins.

5.2. Practical Classes

Practical Classes cover the topics of the lecture sessions.

Distance Learning Platform:

To facilitate better mastery of the course material during remote learning, **email, the "Sikorsky" distance learning platform (based on Moodle), and the ZOOM platform for online meetings** are used. These tools enable:

- Easier distribution of methodological guidelines, learning materials, literature, and other resources.
- Feedback to students regarding assignments and the content of the course.
- Checking and assessing completed tasks.
- Monitoring students' progress in completing the course plan, adherence to deadlines for submission of learning/individual assignments, and their assessment.

6. Self-study

Self-study includes: preparation for lectures and practical classes; completion and defense of an essay; preparation for the module test; preparation for the final test assessment, etc.

6.1. Types of Self-study work:

No.	Type of Work Assigned for Self-study	hrs
1	Review of lecture material and study of topics assigned for independent work	10
2	Preparation for practical classes	18
4	Preparation for the module test	4
5	Completion of an essay	10
6	Preparation for the final test assessment	6
	Total	48

6.2. Preparation for Classroom Sessions

Preparation for classroom sessions is carried out according to the course plan, following the references provided to the Moodle platform, and by completing self-assessment tests available on Moodle. Students are also encouraged to choose a topic and prepare a short report (5–10 minutes) for one of the practical classes according to the course plan.

6.3. Module Test

Four hours of independent work are allocated for preparation for the module test.

6.4. Essay

The essay is one of the main forms of semester assessment in this course. It is completed according to the published requirements. Ten hours of independent work are allocated for preparation and formatting of the essay. The student must choose and have the essay topic approved by the instructor no later than the 4th week of the semester. The essay must be submitted to the instructor by the 14th week. Defense of the essay is scheduled during an additional session between the 15th and 18th weeks.

6.5. Final Test

The Final Test is conducted during the last practical class, after students complete the module test and defend their individual assignment (essay). Based on the total accumulated rating points for the semester, the student receives the credit without additional examinations if the total score is at least 60 points. Students who meet all admission requirements for the credit but have rating points between 40

and 59, or wish to improve their result, must take a credit test or interview on the credit questions. Six hours of independent work are allocated for preparation for the credit. During remote learning, the credit can be conducted according to the class schedule using the Moodle platform and Zoom for online meetings.

Policy and control

7. Policy of academic discipline (educational component)

7.1. Incentive Points

Encouragement points	
Criterion	*Weight (Points*
Preparation of a report on an additional topic for a practical class	*1 point*
Completion of online courses on topics approved by the instructors	*5 points*
Preparation of a research paper for participation in a student scientific competition	*10 points*
Participation in international or national events/competitions, or winning a prize in a university competition related to the course	*10 балів*
Writing a scientific article on a topic related to the course	*10 points*
Writing an abstract on a topic related to the course	*3 points*

However, according to the regulation https://osvita.kpi.ua/node/37, section 2.7, the total amount of incentive points cannot exceed 10% of the rating scale.

7.2. Attendance Rules

Attendance at lectures is not mandatory. Attendance at practical classes is recommended, as these sessions include the completion of quick assessments/tests and the defense of practical assignments.

The assessment system is designed to reward student activity as well as the completion of tasks that help develop practical skills and competencies.

7.3. Rules for Completing the Individual Assignment

An essay is a **scientific and technical document** that contains comprehensive, structured information on a chosen topic. It involves presenting material based on specially selected literature and independently conducted research. Students may write an essay **only on a topic approved by the instructor**.

General Requirements for the Essay:

- Clarity and logical sequence of the material presentation.
- Persuasiveness of arguments.
- Conciseness and accuracy of formulations, avoiding ambiguity.
- Specificity in presenting results.
- Justification of conclusions.

Structure of the Essay:

1. Title page
2. Table of contents

3. List of abbreviations, symbols, units, and terms (if necessary)
4. Introduction
5. Main body of the essay
6. Conclusions
7. List of references
8. Appendices (if necessary)

Title Page Content:

- Name of the university
- Name of the faculty
- Name of the department
- Name of the specialty
- Name of the educational-professional program
- Name of the course
- Essay topic
- Student's full name, year of study, academic group number, year

The title page is followed by a **detailed table of contents**, which should highlight: the introduction, main sections (topics to be covered), subsections (if needed), conclusion, and list of references. Page numbers for each section should be indicated on the right. **Each section starts on a new page.**

The **total length of the essay** may vary from **10 to 15 pages of main text**, depending on the topic and agreement with the instructor. The essay's volume is determined by the student's ability to present and analyze the information concisely and thoroughly.

Mandatory Requirement: Proper references to information sources. All numbers, facts, scientific opinions, citations, and formulas must be cited as [2, p. 54] (the first number corresponds to the source number in the reference list, and the second number indicates the page). Use of chemical formulas, diagrams, charts, and other visual aids is encouraged.

The **reference list** must include **at least 6 sources** and be formatted according to current academic rules. If information is taken from the Internet, the author, article title, and website address must be provided, as for printed literature.

Assessment Criteria:

- Logical structure of the essay
- Completeness and depth of topic coverage
- Correct formulation of conclusions
- Proper formatting
- Justification of the student's own opinion in the conclusion
- Mastery of the topic (assessed during the essay defense)

Deadline for submission: 14th week of the semester.

The essay is **not checked for plagiarism**, but must comply with principles of **academic integrity**. If academic dishonesty is detected, the essay is **canceled and not assessed**.

Suggested Essay Topics:

- Polyunsaturated fatty acids and their biological role
- Vitamins as coenzyme precursors
- Molecular chaperones
- Prions and prion infections
- Folding-related diseases
- Biological nanomotors

7.4. Policy on Deadlines and Retakes

Missed assessments (e.g., defense of practical assignments) can be made up during the next class, provided the assignment scheduled for the current session is completed, or during consultations.

Missed quizzes cannot be made up.

Missed module tests can be made up during consultations.

Essays submitted after the deadline are graded with a reduction in the assigned points.

7.5. Procedure for Appealing Assessment Results

Students have the opportunity to raise any questions related to the assessment process and can expect that these questions will be addressed in accordance with established procedures.

A student has the right to appeal the results of an assessment in accordance with the approved Appeals Policy at Igor Sikorsky Kyiv Polytechnic Institute (approved by Order No. HOH/128/2021 dated 20.05.2021) – https://osvita.kpi.ua/index.php/node/182

7.6. Distance Learning

Distance learning is conducted through the "Sikorsky" Distance Learning Platform.

Distance learning via additional online courses on specific topics is permitted if agreed with the students. If only a small number of students wish to take an online course on a particular topic, studying the material through such courses is allowed, but students must complete all assignments required by the course.

The list of courses is proposed by the instructor after determining student interest (since the available course bank is updated almost monthly).

Students must provide a document confirming completion of the online course (if the full course is completed), or submit completed practical tasks from the online course, and pass an oral interview with the instructor on the topics covered. Upon successful completion, students may receive grades for the assessments associated with the studied topics (quick assessments/tests, practical assignments).

Practical assignments are carried out during independent study in distance mode, with the possibility of consulting the instructor via email or social networks.

7.7. Instruction in a Foreign Language

Instruction in English is provided only for international students.

If students wish, it is permitted to study material using English-language online courses on topics corresponding to the content of specific lessons.

7.8. University Policy

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." More details: https://kpi.ua/code.

Standards of Ethical Conduct

he standards of ethical conduct for students and staff are defined in Section 2 of the Code of Honor of the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute." More details: https://kpi.ua/code.

8. Types of Assessment and Rating System

Ongoing assessment is conducted **during classroom sessions** and aims to **evaluate students' preparedness** for the lessons. During practical classes, it includes **discussion of theoretical questions** as well as **quick assessments/tests during lectures**. It also includes the **module test** and the **completion and defense of the individual assignment (essay)**.

Scheduled Assessment (Calendar Control):

Scheduled assessment is conducted **twice per semester** to monitor the current level of fulfillment of syllabus requirements. There are **two possible outcomes**:

- **Attested (A)** – passed
- **Not Attested (N/A)** – not passed

The result depends on the **number of points accumulated** at the time of the scheduled assessment. In the rating system (RSO), the **minimum number of points required for attestation** is specified for the **first and second scheduled assessments**.

Criteria		First CC (Week 8)	Second CC (Week 14)
Date of calendar control		8th week	14th week
Conditions for a positive result in the calendar control	Current rating (points)	≥ 13 points*	≥ 24 points*
	Module Test	–	–
	Practical Assignments (PA) Nos. 1–2	+	+
	Practical Assignment No. 3	–	+
	Quizzes Nos. 1-7	+	+
	Quizzes Nos. 8-10	–	+
	Quizzes Nos. 11-12	–	–
	Participation in Practical Classes Nos. 1-8	+	+
	Participation in Practical Classes Nos. 9-14	–	+
	Essay	At least 25% completed	Submitted

*- Points correspond to the cumulative rating accumulated by the student up to the date of the calendar control.

Semester Assessment: Final Test (Pass/Fail)

Evaluation of and Assessment Activities

System for Assessing Control Activities:

No.	Assessment Activity	%	Weight (Points)	Quantity	Total
1	Quizes Nos. 1, 2, 3, 4, 5, 7, 9	21	3	7	21
2	Quizes Nos. 6, 11, 12	12	4	3	12
3	Quizes Nos. 8, 10	10	5	2	10
4	Practical Assignments Nos. 1, 3	4	2	2	4
5	Practical Assignment No. 2	3	3	1	3
6	Questioning during Practical Classes	10	1	10	10
7	Module Test	20	20	1	20
8	Essay	20	20	1	20
	Total	100			100

8.1 Quizzes Nos. 1, 2, 3, 4, 5, 7, 9

Weight – 3 points.

Planned Tasks: 7 quizzes. Maximum points: 3 points × 7 quizzes = 21 points.

Assessment Criteria:

Grade	Description	Points
Excellent	Answers are complete and correct (at least 90% of required information)	3 points
Good	Answers are sufficiently complete (at least 75% of required information)	2 points
Satisfactory	Answers are incomplete but demonstrate understanding (at least 60% of required information)	1,5 points
Unsatisfactory	Answers are absent or incorrect (less than 60% of required information)	0 points

8.2 Quizzes Nos. 6, 11, 12

Weight – 4 points.

Planned Tasks: 3 quizzes. Maximum points: 4 points × 3 quizzes = 12 points.

Assessment Criteria:

Grade	Description	Points
Excellent	Answers are complete and correct (at least 90% of required information)	4 points
Good	Answers are sufficiently complete (at least 75% of required information)	3 points
Satisfactory	Answers are incomplete but demonstrate understanding (at least 60% of required information)	2 points
Unsatisfactory	Answers are absent or incorrect (less than 60% of required information)	0 points

8.3 Quizzes. Nos. 8, 10

Weight – 5 points.

Planned Tasks: 2 quizzes. Maximum points: 5 points × 2 quizzes = 10 points.

Assessment Criteria:

Grade	Description	Points
Excellent	Answers are complete and correct (at least 90% of required information)	5 points
Good	Answers are sufficiently complete (at least 75% of required information)	4 points
Satisfactory	Answers are incomplete but demonstrate understanding (at least 60% of required information)	3 points
Unsatisfactory	Answers are absent or incorrect (less than 60% of required information)	0 points

8.4 Practical Assignments Nos. 1, 3

Weight – 2 points.

Planned Tasks: 2 assignments. Maximum points: 2 points × 2 PA = 4 points.

Assessment Criteria:

Grade	Description	Points
Excellent	Answers are complete and correct (at least 90% of required information)	2 points
Good	Answers are sufficiently complete (at least 75% of required information)	1,5 points
Satisfactory	Answers are incomplete but demonstrate understanding (at least 60% of required information)	1 points
Unsatisfactory	Answers are absent or incorrect (less than 60% of required information)	0 points

8.5 Practical Assignment No.2

Weight – 3 points.

Planned Tasks: 1 assignment. Maximum points: 3 points × 1 PA = 3 points.

Assessment Criteria:

Grade	Description	Points
Excellent	Answers are complete and correct (at least 90% of required information)	3 points
Good	Answers are sufficiently complete (at least 75% of required information)	2 points
Satisfactory	Answers are incomplete but demonstrate understanding (at least 60% of required information)	1 points
Unsatisfactory	Answers are absent or incorrect (less than 60% of required information)	0 points

8.6 Questioning during Practical Classes

Weight – 1 points.

Planned Tasks: 10 evaluated responses. Maximum points: 1 points × 10 = 10 points.

Assessment Criteria:

Grade	Description	Points
Excellent	Answers are complete and correct (at least 90% of required information)	1 point
Satisfactory	Answers are incomplete but demonstrate understanding (at least 60% of required information)	0,5 points
Unsatisfactory	Answers are absent or incorrect (less than 60% of required information)	0 points

8.7 Module Test

Weight – 20 points.

Assessment Criteria:

Grade	Description	Points
Excellent	Answers are complete and correct (at least 90% of required information)	18-20 points
Good	Answers are sufficiently complete (at least 75% of required information)	15-17 points
Satisfactory	Answers are incomplete but demonstrate understanding (at least 60% of required information)	12-14 points
Unsatisfactory	Answers are absent or incorrect (less than 60% of required information)	0 points

8.8 Essay

Weight – 20 points.

The essay is evaluated according to the following criteria:

- Logical structure and organization of the plan
- Completeness and depth of topic coverage
- Accuracy and correctness of formulated conclusions
- Proper formatting and presentation
- Justification of the student's own opinion on the topic in the conclusion
- Mastery of the topic (assessed during the **essay defense**)

The essay defense is mandatory.

Assessment Criteria:

Grade	Description	Points
Excellent	The essay is submitted and defended on time; all main requirements are fully met (at least 90%); the student demonstrates a strong understanding of the topic.	18-20 points
Good	The main requirements of the essay are met with minor shortcomings (at least 75%); the student demonstrates a good understanding of the topic. Or: The essay is submitted after the deadline; all main requirements are fully met (at least 90%); the student demonstrates a good understanding of the topic.	15-17 points
Satisfactory	Not all main requirements of the essay are met (at least 60%); the student demonstrates a general understanding of the topic.	12-14 points
Unsatisfactory	The main requirements of the essay are not met, or the student does not demonstrate understanding of the topic.	0 points

To achieve the **highest rating**, a student must: complete all **quizzes** and the **module test** on time; complete, properly format, and **defend the essay** on time.

A student may **appeal a teacher's grade** by submitting a written complaint to the instructor **no later than the day after being informed of the grade**. The appeal will be considered according to the procedures established by the university.

8.9 Semester Assessment of Students

Conditions for eligibility for semester assessment:

- Accumulation of at least **40 points**,
- Completion of the **module test**, and
- Completion and defense of the **essay** with a grade of **at least "satisfactory."**

A student **passes the course without additional examinations** if the total points accumulated are **at least 60**.

A student who has earned **more than 60 points** during the semester but wishes to **improve their result** may participate in the **credit test or oral questioning** on the topics covered in the course. In this case, the **final result** is based on the points earned in the credit test or oral questioning.

If the grade from the credit test is **lower than the accumulated rating**, a **"strict" rating policy** is applied: the student's previous rating (except points for the semester essay) is **cancelled**, and the final grade is calculated **solely based on the credit test results**. This policy encourages students to take responsibility for their decision to participate in the credit test, critically evaluate their level of preparation, and carefully prepare for the assessment.

Students who have met all the eligibility requirements for the credit but have a rating score of less than 60 points **must** take the **Final Test (FT)**.

The final result is calculated as the sum of the points earned on the credit test and the points for the essay.

The final test is conducted during the last scheduled class of the course.

The final test is graded out of 100 points and is calculated as the sum of the points for the credit test and the points for the semester individual assignment (essay). In this case, the grading scale for the credit test is reduced by the maximum points allocated for the essay (20 points). https://osvita.kpi.ua/node/37 (p.3.12)

The **Final Test (FT) assignment** consists of **3 theoretical questions** from different sections of the course. The **maximum total points** for the three questions are **80 points**.

Based on the grading scale: **RD = R_{FT} + R_{essay} = 100 points**

R_{FT} = RD - R_{essay} = 80 points

Point distribution for the questions:

1. Credit theoretical questions **No. 1 and No. 3 – 27 points each,**
2. Credit theoretical question **No. 2 – 26 points**

Assessment Criteria for Credit Theoretical Questions Nos. 1 and 3:

Grade	Description	Points
Excellent	The answer is correct (at least 90% of the required information).	27-25 points
Good	Minor errors are present in the answer (at least 75% of the required information).	24-21 points
Satisfactory	The answer contains deficiencies and some errors (at least 60% of the required information).	20-16 points
Unsatisfactory	The answer is absent or does not meet the requirements for a "Satisfactory" grade.	0 points

Assessment Criteria for Credit Theoretical Question No. 2:

Grade	Description	Points
Excellent	The answer is correct (at least 90% of the required information).	26-24 points
Good	Minor errors are present in the answer (at least 75% of the required information).	23-20 points
Satisfactory	The answer contains deficiencies and some errors (at least 60% of the required information).	16-19 points
Unsatisfactory	The answer is absent or does not meet the requirements for a "Satisfactory" grade.	0 points

Table of translation of rating points to grades on a university scale:

Points	Grade
100-95	Excellent
94-85	Very Good
84-75	Good
74-65	Satisfactory
64-60	Pass
< 60	Unsatisfactory
Failure to meet the admission requirements	Not admitted

9. Additional information on the discipline (educational component)

Appendix 1. Program learning outcomes (extended form)

In accordance with the Order of the Ministry of Education and Science of Ukraine No. 1204 dated November 19, 2018 "On approval of the standard of higher education in the specialty 163 Biomedical Engineering" for the first bachelor's level of higher education", in Appendix 1 establishes the correspondence of learning outcomes to competencies in the discipline "Microprocessor Engineering".

Appendix 2. The list of questions for preparation for module test

The list of questions for preparation for module test, and also for preparation for credit is given in Appendix 2.

Appendix 3. List of Essay Topics

Instructors may make adjustments to the content modules, the grading system (RSO), and the assignments for the module test, essays, and short quizzes, taking into account their own teaching materials and the current circumstances.

Distance Learning

Distance learning through participation in additional online courses on specific topics is allowed with the agreement of the students. If only a small number of students wish to take an online course on a specific topic, studying the material through such courses is permitted, but students must complete all assignments required by the course.

The list of courses is proposed by the instructor after students express their interest (since the pool of available courses is updated almost monthly).

A student must provide a document confirming completion of the online course (if the full course is completed) or submit completed laboratory assignments from the online course. Upon successful completion of an oral interview with the instructor on the covered topics, the student may receive grades for the course assessment tasks corresponding to the studied topics (short quizzes/test tasks, laboratory assignments).

Inclusive Education

Permitted

Syllabus of the Academic Discipline:

Compiled by: Associate Professor of the Department of Biomedical Engineering, PhD in Biology, Svitlana Vovianko

Approved by: Department of Biomedical Engineering (No. 16, June 21, 2024)

Agreed by: Methodological Commission of the Faculty of Biomedical Engineering (Protocol No. 9, June 26, 2024)

Appendix 1.

For syllabus of the discipline " Biochemistry. Part 2. Biochemistry"

Program learning outcomes (extended form)

As a result of studying the academic discipline "Microprocessor Engineering", students will be able to:

Learning outcomes (PRN)		Compliance of Learning Outcomes with Competencies according to the Higher Education Standard 6	
		General Competencies (**soft skills**)	Special Competencies (**professional**)
ПРН 17	*Application of knowledge in chemistry and bioengineering to create, synthesize, and apply artificial biotechnical and biological objects*	*ЗК 06 - Ability to search, process, and analyse information from various sources*	*ФК05 Ability to apply physical, chemical, biological, and mathematical methods in the analysis and modeling of the functioning of living organisms and biotechnical systems*
ПРН 18	*Understanding of fundamental-applied, medical-physical, and physico-chemical principles governing the functioning of biological objects, as well as bioengineering fundamentals of technologies and equipment for researching human body processes*	*ЗК 06 - Ability to search, process, and analyse information from various sources*	*ФК05 Ability to apply physical, chemical, biological, and mathematical methods in the analysis and modeling of the functioning of living organisms and biotechnical systems*

Appendix 2

For syllabus of the discipline "Biochemistry. Part 2. Biochemistry".

The list of questions for preparation for module test, and for final test

1. *Object of study of biochemistry*
2. *Chemical composition of the human body*
3. *Name the main aqueous compartments of the human body. Explain how and why their ionic composition differs.*
4. *Characterize the main components of biological membranes. Explain why phospholipids form the basis of the membrane lipid bilayer.*
5. *How is the asymmetry of cell membranes manifested? What is its significance?*
6. *Explain the fluid mosaic model of biological membranes (modern concept).*
7. *Types of substance transport across membranes. Give examples.*
8. *Explain the functions of biomembranes.*
9. *Which substances are considered high-energy compounds? Explain their role in energy metabolism. Give examples.*
10. *List and briefly explain the mechanisms of regulation of metabolic processes.*
11. *Explain how enzyme activity is regulated. Give examples.*
12. *Explain why the citric acid cycle is considered the central pathway of metabolism. Give examples.*
13. *Explain the functioning of the mitochondrial respiratory chain.*
14. *Explain the structure and function of ATP synthase.*
15. *Explain the role of carbohydrates in the human body.*
16. *List the main pathways of glucose metabolism in tissues.*
17. *Write the overall biochemical equations for aerobic and anaerobic glycolysis, taking cofactors into account. Explain the significance of aerobic and anaerobic glycolysis.*
18. *Pentose phosphate pathway and pentose phosphate cycle. Chemistry and biological significance.*
19. *Concept of gluconeogenesis. Substrates of gluconeogenesis.*
20. *How is glucose balance maintained in the human body?*
21. *Explain the biological role of lipids.*
22. *β-oxidation of fatty acids: localization, energy value, regulation.*
23. *Biosynthesis of higher fatty acids: biosynthesis substrates, cofactors, regulation.*
24. *Ketone bodies: formation, physiological significance.*
25. *Cholesterol and its functions.*
26. *What pathways of amino acid transformation in the human body do you know?*
27. *Describe the glucose-alanine cycle.*
28. *Which toxic substances are formed during amino acid catabolism? How are they detoxified in the human body?*
29. *Purine metabolism: localization, biosynthesis substrates, end products of catabolism, reutilization.*
30. *Pyrimidine metabolism: localization, biosynthesis substrates, end products of catabolism.*
31. *Explain the structure of chromatin.*
32. *List and briefly characterize the template biosyntheses in living cells.*
33. *Explain the structure of the transcription unit.*
34. *Briefly describe the stages of protein biosynthesis.*
35. *Explain how protein biosynthesis is regulated.*

36. *Buffer systems of the blood. Their role in maintaining acid-base balance.*
37. *Transport of carbon dioxide by blood.*
38. *Structure of hemoglobin. Respiratory function of hemoglobin and factors affecting it.*
39. *Biochemistry of erythrocytes: energy supply, antioxidant defense, role of erythrocytes in carbon dioxide transport.*
40. *Briefly characterize the biochemical functions of the liver.*
41. *Role of the liver in carbohydrate metabolism.*
42. *Role of the liver in lipid metabolism.*
43. *Role of the liver in protein metabolism.*
44. *What is the regulatory-homeostatic function of the liver? Give examples.*
45. *Detoxification functions of the liver.*
46. *Biotransformation of xenobiotics and endogenous toxins.*
47. *Features of the chemical composition of nervous tissue.*
48. *Features of energy metabolism in the brain.*
49. *Explain how the resting membrane potential is created and maintained.*
50. *Mechanisms of action potential generation.*
51. *Explain the mechanism of synaptic transmission and its principles.*
52. *Neurotransmitters: classification, functions, formation, inactivation.*
53. *Explain the interaction of actin and myosin filaments during muscle contraction.*
54. *Explain the mechanism of muscle coupling. How is it carried out differently in smooth, striated, and cardiac muscles?*
55. *Energy supply for muscle work.*
56. *What are the features of the amino acid composition of collagen? How does it affect its structure and properties? What role does ascorbic acid play?*
57. *What are the features of the amino acid composition of elastin? How does it affect its structure and properties?*
58. *What functions does hyaluronic acid perform in the human body? What features of its chemical structure ensure these functions?*
59. *Classification of hormones by chemical nature. Give examples.*
60. *Explain the mechanism of hormone action through the adenylate cyclase system. Give an example.*
61. *Explain the mechanism of hormone action through the phosphoinositide system. Give an example.*
62. *Mechanism of action of lipophilic hormones.*
63. *Structure and biological role of catecholamines.*
64. *Structure and biological role of thyroid hormones.*
65. *Structure and biological role of pancreatic hormones.*
66. *Structure and biological role of steroid hormones.*
67. *Biological role of insulin and glucagon.*
68. *Explain the concept of vitamins and their classification.*
69. *Water-soluble vitamins. General characteristics, role in metabolism.*
70. *Fat-soluble vitamins – properties, role in metabolism, manifestations of deficiency and hypervitaminosis.*
71. *Bioantioxidant properties of water- and fat-soluble vitamins.*

Appendix 3.

For syllabus of the discipline " Biochemistry. Part 2. Biochemistry"

List of Essay Topics

1. *Storage and transmission of information in biological systems*
2. *Biochemical mechanisms of metabolic regulation*
3. *Biochemical functions of membranes*
4. *Macroergic compounds and their biological significance*
5. *Protein metabolism as a central process of living matter*
6. *Nitrogen balance*
7. *Biological value of proteins*
8. *Plasma proteins*
9. *Clinical significance of transaminase activity determination*
10. *Biological role of carbohydrates in the body*
11. *Anaerobic carbohydrate metabolism*
12. *Aerobic glucose oxidation and its significance*
13. *Lipid metabolism*
14. *Metabolic water*
15. *Cholesterol biotransformation and its biological significance*
16. *Water-soluble vitamins and their role in metabolism*
17. *Fat-soluble vitamins and their role in metabolism*
18. *Bioantioxidant properties of water- and fat-soluble vitamins*
19. *Biochemistry of connective tissue*
20. *Biochemistry of bone tissue*
21. *Biochemical functions of the liver*
22. *Chemical basis of mediator processes*
23. *Mechanism of action and biological role of steroid hormones*
24. *Mechanism of action and biological role of protein-peptide hormones*
25. *Mechanism of action and biological role of amino acid–derived hormones*
26. *Biotransformation of xenobiotics and endogenous toxins*
27. *Molecular mechanism of muscle contraction*
28. *Biological nanomotors*
29. *Molecular chaperones*
30. *Prions and prion infections*
31. *Folding diseases*
32. *Voltage-gated ion channels: structure and functions*
33. *Protein digestion*
34. *Biochemistry of cellular recognition*
35. *Mechanisms of signal transduction*
36. *G-protein coupled receptors (GPCR) and their role in visual, olfactory, and taste signal perception*
37. *Biochemistry of visual reception*
38. *Regulation of the cell cycle*
39. *Molecular mechanisms of apoptosis*
40. *Oncogenes and tumor suppressor genes, and their role in carcinogenesis*
41. *Chemical carcinogenesis*

42. *Antinociceptive system: biochemical basis of pain relief*
43. *Molecular basis of memory*
44. *Biochemistry of sleep and wakefulness*
45. *Biochemistry of the immune response*
46. *Mitochondrial transport systems*
47. *Reactive oxygen species: benefits and risks*
48. *Pharmacogenetic algorithms*

Students may also propose their own topic upon agreement with the instructor.