

# SYLLABUS

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INTERNATIONAL EUROPEAN  
UNIVERSITY



SCHOOL OF  
MEDICINE

BIOLOGIC AND BIOORGANIC  
CHEMISTRY

2023



# SYLLABUS



Discipline				
		Biological and bioorganic chemistry		
Teacher(s)				
		Candidate of Chemical Sciences, Associate Professor Golodaeva Olena Anatoliivna; Doctor of Medical Sciences, Professor Gaiova Lyudmila Volodymyrivna		
Profile of the teacher(s)				
		<a href="https://medicine.ieu.edu.ua/pro-yemsh/kafedry/kafedra-fundamentalnykh-dystsyplin">https://medicine.ieu.edu.ua/pro-yemsh/kafedry/kafedra-fundamentalnykh-dystsyplin</a>		
Consultations				
Face-to-face consultations		Second Thursday of the month from 15:00 to 16:00		
Online consultations		Third Friday of the month from 15:00 to 16:00		
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Discipline page				
		<a href="https://medicine.ieu.edu.ua/pro-yemsh/kafedry/kafedra-fundamentalnykh-dystsyplin">https://medicine.ieu.edu.ua/pro-yemsh/kafedry/kafedra-fundamentalnykh-dystsyplin</a>		
Form of final control		test	differentiated test	exam
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>



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## 1 Brief annotation of the discipline

The discipline "Biological and bioorganic chemistry" studies the structure and reactivity of various classes of organic substances, and on their basis, the most important biologically active substances that are part of living organisms - low molecular weight biomolecules, biopolymers (proteins, nucleic acids, polysaccharides), natural and synthetic physiologically active compounds (hormones, vitamins, drugs, toxic substances, etc.). The tasks of bioorganic chemistry are to determine the structure of biomolecules, natural and synthetic bioregulators, to identify the relationship between their molecular and electronic structure and physiological, in particular pharmacological, effects, to identify patterns of their transformations. It lays the foundation for the formation of the following programmatic learning outcomes in accordance with the Standard of Higher Education of Ukraine for undergraduate training of specialists of the second (master's) level of the specialty "Medicine".

## 2 Prerequisite for studying the discipline

The discipline is based on such subjects as Chemistry, General Biology, and Human Biology previously studied by students in secondary school. "Biological and Bioorganic Chemistry" lays the foundation for the study of medical biology, biophysics, medical chemistry (bioinorganic, physical chemistry), morphological disciplines and integrates with these disciplines; lays the foundation for students to study molecular biology, genetics, physiology, pathology, general and molecular pharmacology, toxicology and propaedeutics of clinical disciplines.

## 3 Purpose and objectives of the discipline

**The purpose** of teaching the discipline "Biological and Bioorganic Chemistry" is to study biomolecules and molecular organization of cellular structures, general laws of enzymatic catalysis and biochemical dynamics of transformation of the main classes of biomolecules (amino acids, carbohydrates, lipids, nucleotides, etc, porphyrins, etc.), molecular biology and genetics of informational macromolecules (proteins and nucleic acids), i.e. molecular mechanisms of heredity and realization of genetic information, hormonal regulation of metabolism and biological functions of cells, biochemistry of special physiological functions.

### Objectives:

- to teach students the general principles of evaluating the chemical properties of organic compounds;
- to provide knowledge of the structure of substances that make up groups (proteins, carbohydrates, nucleic acids, lipids, vitamins, enzymes, hormones) based on knowledge of classes of compounds.
- to teach students to investigate and identify certain classes of biological compounds in the laboratory based on the properties of their functional groups;
- to carry out qualitative and quantitative reactions and evaluate indicators in laboratory biochemical research.

## 4 Learning Outcomes

<b>PLO 1</b>	Have a thorough knowledge of the structure of professional activity. Be able to carry out professional activities that require updating and integration of knowledge. Be responsible for professional development, the ability to further professional training with a high level of autonomy
<b>PLO 2</b>	Understanding and knowledge of basic and clinical biomedical sciences, at a level sufficient to solve professional problems in the field of health care



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<b>PLO 21</b>	Search for necessary information in professional literature and databases of other sources, analyze, evaluate and apply this information
<b>PLO 22</b>	Apply modern digital technologies, specialized software, statistical methods of data analysis to solve complex healthcare problems.

## 5 ECTS Credits

8 ECTS credits / 240 academic hours, including lectures - 24, practical - 104, independent work - 112.

## 6 Structure of the discipline

Topic Name	Audit			
	Total	L.	Pr.	I.

### Section 1. Biologically important classes of bioorganic compounds. Biopolymers and their structural components

Content section 1. Theoretical basis of the structure and reactivity of bioorganic compounds.

Topic 1: Classification, nomenclature and isomerism of bioorganic compounds. Classification of chemical reactions. Reactivity of alkanes, alkenes, arenes. The nature of chemical bonding.	7	1	3	3
Topic 2. Classification, nomenclature and isomerism of bioorganic compounds. The nature of chemical bonding.	6	-	3	3
Topic 3. Reactivity of alcohols, phenols, and amines.	6	-	3	3
Topic 4. Structure and chemical properties of aldehydes and ketones.	7	1	3	3
Topic 5. Structure, properties and biological significance of carboxylic acids and their functional derivatives.	7	1	3	3
Topic 6: Higher fatty acids. Lipids. Phospholipids.	7	1	3	3
Topic 7. Structure, reactivity and biological significance of importance of heterofunctional compounds ( $\alpha$ -, $\beta$ -, $\gamma$ -hydroxy acids, keto acids and pheno acids).	6	-	3	3

Content section 2. Structure and biological functions of carbohydrates.

Topic 8: Carbohydrates. Structure and chemical properties of monosaccharides.	7	1	3	3
Topic 9: Structure and functions of disaccharides and polysaccharides.	7	1	3	3

Content section 3. Biologically active heterocyclic compounds.



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## Structure of the discipline

Topic 10. Classification, structure and importance of biologically important heterocyclic compounds.	7	1	3	3
Topic 11. Structure and biochemical functions of nucleosides and nucleotides.	6	-	3	3
Topic 12: Structure and biological role of nucleic acids.	6	-	3	3
<b>Content section 4. <math>\alpha</math>-Amino acids. Peptides. Proteins.</b>				
Topic 13. Amino acid composition of proteins and peptides. Structural organization of proteins.	5	-	2	3
Topic 14: Physical and chemical properties of proteins. Protein precipitation reactions. Denaturation.	6	1	2	3
Total for section 1	90	8	40	42

## Chapter 2. General laws of metabolism. Metabolism of carbohydrates, lipids, proteins and its regulation.

### Content section 5. The role of enzymes and vitamins in metabolism

Topic 15. Subject and tasks of biochemistry. Study of the structure and physicochemical properties of enzymes. proteins. Quantitative determination of protein by the biuret method. Proof of the protein nature of enzymes.	8	1	3	4
Topic 16. Study of the structure and physicochemical properties of proteins.	7	-	3	4
Topic 17: Determination of enzyme activity, study of enzyme catalysis kinetics and the effect of activators and inhibitors.	8	1	3	4
Topic 18: Study of the role of cofactors and coenzyme forms of vitamins in the catalytic activity of enzymes. Study of the participation of vitamins and coenzyme forms of vitamins in various biological processes. forms of vitamins in various biochemical processes.	9	2	3	4

### Content section 6. Metabolism and energy.

Topic 19. Investigation of oxidative phosphorylation and ATP synthesis, inhibitors and uncouplers of oxidative phosphorylation. Metabolism and energy. Study of the functioning of the tricarboxylic acid cycle	9	2	3	4
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### Content section 7. Carbohydrate metabolism and its regulation

Topic 20: Study of the peculiarities of carbohydrate digestion. Biosynthesis and catabolism of glycogen. Conversion of other monosaccharides to glucose.	8	1	3	4
Topic 21: Study of anaerobic oxidation of glucose. Glucose biosynthesis - gluconeogenesis. Study of aerobic oxidation of glucose.	8	1	3	4
Topic 22. Study of aerobic oxidation of glucose. Pentose phosphate pathway of glucose conversion.	7	-	3	4

### Content section 8. Lipid metabolism and its regulation.



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## Structure of the discipline

Topic 23. Structure and function of cell membranes. Study of the features of lipid digestion. Disorders of lipid digestion and transport in the blood of exogenous lipids.	9	2	3	4
Topic 24. Study of fatty acid metabolism and ketone bodies. Beta-oxidation of fatty acids. Biosynthesis and biotransformation of cholesterol. Study of the biosynthesis of fatty acids, triacyl glycerols and phosphoglycerides. Disorders of lipid metabolism: obesity and fatty infiltration of the liver.	9	2	3	4
<b>Content section 9. Metabolism of amino acids. Enzymopathies of amino acid metabolism.</b>				
Topic 25. Study of the chemical composition of gastric juice. Features of protein digestion. Study of amino acid transformations (transamination, deamination, decarboxylation). Studies of ammonia detoxification and urea biosynthesis. Specialized pathways of metabolism of individual amino acids. Creatine biosynthesis. Disorders of amino acid metabolism.	8	4	2	2
<b>Total for section 2</b>	<b>90</b>	<b>16</b>	<b>32</b>	<b>42</b>
<b>Chapter 3. Molecular biology. Biochemistry of intercellular of intercellular communications. Biochemistry of tissues and physiological functions.</b>				
<b>Content section 10. Fundamentals of molecular biology.</b>				
Theme 26. Study of biosynthesis and catabolism of purine nucleotides. Determination of the end products of their metabolism.	7	-	3	4
Topic 27: Study of pyrimidine nucleotide metabolism. Study of the composition of nucleic acids.	6	-	3	3
Topic 28. Studies of DNA replication. Analysis of the mechanisms of mutation and DNA repair. Transcription of RNA. Protein biosynthesis in ribosomes. Stages and mechanism of translation, regulation of translation. Antibiotics - inhibitors of transcription and translation.	7	-	3	4
<b>Chapter 11. Molecular mechanisms of hormone action on target cells and biochemistry of hormone regulation.</b>				
Topic 29: Investigation of molecular and cellular mechanisms of hormone action on target cells. Hormones of the pituitary gland and hypothalamus. Study of the action of pancreatic and gastrointestinal hormones. Mechanism of metabolic disorders in diabetes mellitus.	6	-	3	3
Topic 30. Hormonal regulation of blood glucose levels. Construction of sugar curves. Hormones of the adrenal glands. Hormonal regulation of calcium metabolism. Study of iodine in the thyroid gland. Physiologically active eicosanoids	5	-	3	2



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Topic 31. Steroid hormones of the gonads. Hormonal regulation of biochemical transformations of substances during nutrition. Regulation of metabolism during fasting. Interrelation of all types of metabolism and its regulation.	5	-	3	2
Content section 12. Biochemistry and pathobiochemistry of blood				
Topic 32. Study of the chemical composition and acid-base state of blood. Determination of residual nitrogen of blood. Study of coagulation, anti-coagulation and fibrinolytic blood systems.	6	-	3	3
Topic 33. Study of the chemical composition of red blood cells. Normal and pathological forms of hemoglobins. Study of the end products of heme catabolism. Pathobiochemistry of jaundice.	6	-	2 3	3
Chapter 13. Biochemistry of tissues and organs.				
Topic 34. Biochemistry of the liver. Microsomal oxidation, cytochrome P-450. Study of types of biological oxidation. The role of fat-soluble vitamins in the functioning of tissues and organs. Study of normal and pathological components of urine	5	-	3	2
Topic 35. Biochemistry of connective tissue.	5	-	3	3
Topic 36. Biochemistry of nervous tissue.	4	-	2	2
Total for section 3	60	-	32	28
In total, for all sections of the discipline	240	24	104	112

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## List of mandatory tasks

**Section 1.** Biologically important classes of bioorganic compounds. Biopolymers and their structural components

1. Classification, nomenclature and isomerism of bioorganic compounds. The nature of chemical bonding. Classification of chemical reactions. Reactivity of alkanes, alkenes, arenes.
2. Reactivity of alcohols, phenols, amines. Structure and chemical properties of aldehydes, ketones. Structure, properties and biological significance of carboxylic acids and their functional derivatives. Higher fatty acids. Lipids. Phospholipids.
3. Structure, reactivity and biological significance of heterofunctional compounds ( $\alpha$ -,  $\beta$ -,  $\gamma$ -hydroxy acids, keto acids and pheno acids).
4. Carbohydrates. Structure and chemical properties of monosaccharides. Structure and functions of disaccharides and polysaccharides.
5. Classification, structure and importance of biologically important heterocyclic compounds. Structure and biochemical functions of nucleosides and nucleotides.
6. Structure and biological role of nucleic acids.
7. Amino acid composition of proteins and peptides. Structural organization of proteins. Physical and chemical properties of proteins. Protein precipitation reactions. Denaturation.

**Section 2.** General laws of metabolism. Metabolism of carbohydrates, lipids, proteins and its regulation.

1. Subject and objectives of biochemistry. Study of the structure and physicochemical properties of proteins. Quantitative determination of protein by the biuret method. Proof of the protein nature of enzymes.
2. Study of the structure and physicochemical properties of enzymes.
3. Determination of enzyme activity, study of the kinetics of enzymatic catalysis and the effect of activators and inhibitors.



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## List of mandatory tasks

4. Study of the role of cofactors and coenzyme forms of vitamins in the catalytic activity of enzymes. Study of the participation of vitamins and coenzyme forms of vitamins in various biochemical processes.
5. Studies of oxidative phosphorylation and ATP synthesis, inhibitors and uncouplers of oxidative phosphorylation. Metabolism and energy. Study of the functioning of the tricarboxylic acid cycle. Study of the peculiarities of carbohydrate digestion. Biosynthesis and catabolism of glycogen. Conversion of other monosaccharides to glucose.
6. Study of anaerobic oxidation of glucose. Biosynthesis of glucose - gluconeogenesis. Study of aerobic oxidation of glucose. Pentose phosphate pathway of glucose conversion.
7. Structure and function of cell membranes. Study of the features of lipid digestion. Disorders of lipid digestion and transport of exogenous lipids in the blood. Beta-oxidation of fatty acids. Biosynthesis and biotransformation of cholesterol. Studies of the biosynthesis of fatty acids, triacylglycerols and phosphoglycerides. Lipid metabolism disorders: obesity and fatty liver infiltration.
8. Study of the chemical composition of gastric juice. Features of protein digestion. Study of amino acid transformations (transamination, deamination, decarboxylation). Studies of ammonia detoxification and urea biosynthesis. Specialized metabolic pathways of individual amino acids. Creatine biosynthesis. Disorders of amino acid metabolism.

**Section 3.** Molecular biology. Biochemistry of intercellular communications. Biochemistry of tissues and physiological functions.

1. Study of biosynthesis and catabolism of purine nucleotides. Determination of the end products of their metabolism.
2. Study of the metabolism of pyrimidine nucleotides. Study of the composition of nucleic acids. Study of DNA replication. Analysis of the mechanisms of mutations and DNA repair. RNA transcription. Protein biosynthesis in ribosomes. Stages and mechanism of translation, regulation of translation. Antibiotics - inhibitors of transcription and translation.
3. Study of molecular and cellular mechanisms of hormone action on target cells. Pituitary and hypothalamic hormones. Study of the action of pancreatic and gastrointestinal hormones. Mechanism of metabolic disorders in diabetes mellitus.
4. Hormonal regulation of blood glucose levels. Construction of sugar curves. Hormones of the adrenal glands. Hormonal regulation of calcium metabolism. Study of iodine in the thyroid gland. Physiologically active eicosanoids.
5. Steroid hormones of the gonads. Hormonal regulation of biochemical transformations of substances during nutrition. Regulation of metabolism during fasting. Interrelation of all types of metabolism and its regulation.
6. Study of chemical composition and acid-base state of blood. Determination of residual blood nitrogen. Study of coagulation, anti-coagulation and fibrinolytic blood systems.
7. Study of the chemical composition of red blood cells. Normal and pathological forms of hemoglobins. Study of the end products of heme catabolism. Pathobiochemistry of jaundice.
8. Biochemistry of the liver. Microsomal oxidation, cytochromes P-450. Study of types of biological oxidation. The role of fat-soluble vitamins in the functioning of tissues and organs. Study of normal and pathological components of urine.
9. Biochemistry of connective tissue. Biochemistry of nervous tissue.

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## Selective tasks

1. Create multimedia presentations on the topics of practical classes
  2. Creating chemical crosswords
  3. Making tables
  4. Participation in the work of the scientific and student circle
  5. Participation in the student olympiad in the discipline
  6. Participation in scientific and practical conferences
  7. Organization and visiting of thematic museums
  8. Publication of abstracts of scientific conference reports in co-authorship with a teacher
- For completing selective tasks, 12 points are added to the student's academic rating





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## 9 Signs of discipline

Term of Teaching	Semestr	International disciplinary integration	Course (year of study)	Cycles: general training/ vocational training/ free choice
2 semestr	II, III	Yes	1st, 2st	Vocational training

## 10 Grading System and Requirements

**The current** performance of students is assessed on a 4-point scale (2; 3; 4; 5) at each practical, taking into account the approved evaluation criteria for the relevant discipline. The student must receive a grade for each topic for further conversion of grades into points on a multi-point (200-point) scale.

**Criteria for assessing** current academic performance:

Excellent ("5") - the student answered 90-100% of the questions correctly. Solves situational problems of increased complexity, is able to summarize the material.

Good ("4") - the student answered 70-89% of the questions correctly. Possesses the necessary practical skills and techniques for their implementation in excess of the required minimum.

Satisfactory ("3") - the student answered 50-69% of the questions correctly. Has only the required minimum of research methods.

Unsatisfactory ("2") - the student answered 50% of the questions correctly. When answering and demonstrating practical skills, he/she makes significant, gross mistakes.

Evaluation of students' independent work in preparation for classroom practical classes is carried out during the **current control of the topic at the relevant classroom**.

**The semester credit** is evaluated on a two-point scale (passed/not passed) and a 200-point scale by determining the arithmetic mean of current grades for each practical lesson on a 4-point scale and its subsequent conversion to 200-point scale. The minimum number of points that a student must score is 120.

The final control of knowledge in the discipline "Biological and Bioinorganic Chemistry" is carried out in the form of an exam. The exam in the discipline is conducted in the form of an oral survey and test work in accordance with the questions compiled in accordance with the material covered.

<https://ieu.edu.ua/docs/rate-of-study.pdf>

## 11 Conditions of admission to the final control

Students who have completed all types of work, tasks provided for in the curriculum for the semester in accordance with the discipline, attended all classes provided for in the curriculum, written and submitted a medical history and have an average score for current academic activities of at least "3" (72 points on a 120-point scale) are allowed to take part in the semester final control.

<https://ieu.edu.ua/docs/rate-of-study.pdf>

## 12 Discipline Policy

In order to achieve the learning objectives and successfully complete the course, you must actively engage in the work from the first day, attend lectures regularly, prepare for practical classes in advance, not be late or miss classes, come to class dressed in a medical gown, perform all necessary tasks and work on self-improvement every day, be able to work with a partner or as part of a group, ask for help and receive it when you need it.

In the classroom, students should exclude the possibility of using a mobile phone, tablet or other mobile devices, not resort to cheating and plagiarism, adhere to the cooperation and solidarity of the teacher and students, contact the teacher to help organize and consult on scientific, search and research work, participate



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in scientific circles; The teacher, in turn, must ensure the full implementation of the curriculum is mandatory, not to be late for lectures, practical (seminar) classes, objective It is important to prevent any manifestations of corruption. First of all, the teacher should monitor the chemical classrooms, pay special attention to students in practical classes when working with chemical equipment and reagents. And it is important to avoid prejudice and discrimination regardless of race, ethnicity, or religious beliefs.

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## Policy on missing classes and completing assignments late

A student who, for valid reasons, confirmed by documentary evidence, was not subject to current control has the right to undergo current control within two weeks after returning to study.

A student who was absent from classes without valid reasons, did not participate in current control activities, did not eliminate academic debt, is not allowed to take the final semester control of knowledge in this discipline, and on the day of the exam, the academic staff member assigns a grade of "not admitted" in the examination record. Retaking a differentiated test in the discipline is assigned subject to the completion of all types of educational, independent (individual) work provided for by the working curriculum of the discipline and is carried out in accordance with the schedule of liquidation of academic debt approved by the directorate.

<https://ieu.edu.ua/docs/050.pdf>

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## Academic integrity policy

Participants in the educational process are guided by the principles of academic integrity

<https://ieu.edu.ua/docs/011.pdf>

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## Recommended sources of information

### Main literature:

1. Biological and bioorganic chemistry: in 2 books: textbook. Book 1. Biological chemistry / B.S. Zimenkovsky, V.A. Muzychenko, I.V. Nizhenkovska, G.O. Syrova; edited by B.S. Zimenkovsky, I.V. Nizhenkovska - 2nd ed.
2. Biological and bioorganic chemistry: in 2 books: textbook. Book 2. Biological chemistry / Y.I. Gubsky, I.V. Nizhenkovska, M.M. Korda et al. eds.
3. Bioorganic Chemistry: textbook / Yu. Gubskiy. - 2nd ed. - Vinnitsa: Nova Knyha, 2019/ - 224p.
4. Biological chemistry = Biological chemistry: textbook / edited by Yu. Gubskiy. - 3rd edition. - Vinnytsia: Nova Knyha, 2020. - 488p.

### Supporting literature

1. Biochemistry: a textbook / edited by Prof. A.L. Zahayko, Prof. K.V. Aleksandrova - Kh.
2. Biological and bioorganic chemistry: in 2 books: textbook. Book 1. Bioorganic chemistry (IV year of study) / edited by B.S. Zimenkovsky, I.V. Nizhenkovska - VVV "Medicine" - 2014. - 272 p.
3. Gonsky Y.I., Maksymchuk TP, Kalynsky M.I. Human biochemistry. Textbook. - Ternopil: Ukrmedkniga. - 2013. - 744 p.
4. Biological and bioorganic chemistry [Text]: a textbook for students of higher educational institutions / O.O. Mardashko, L.M. Mironovych, H.F. Stepanov. - Odesa: Odesa Medical University. - 2011. - 235 p.
5. Functional biochemistry: a textbook for students of higher pharmaceutical educational institutions. IV level of accreditation / A.L. Zagayko [et al.
6. Role of science and education for sustainable development: Collective monograph / Edited by Magdalena Wierzbik-Strońska and Iryna Ostopolets / Publishing House of University of Technology. - Katowice, 2021. -p.168-176
7. Bobrova M. S., Holodaieva O.A., Koval S.Yu. The effect of hypothermia on the state of the prooxidant-antioxidant system of plants // REVISTA DE LA UNIVERSIDAD DEL ZULIA. 3ª época. Año 12 N° 33, 2021. DOI : <http://dx.doi.org/10.46925//rdluz.33.07> (Web of Science, Italy, article in English)



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## Information resources:

1. <http://guides.lib.vt.edu/oer/chemistry> - Books on chemistry.
2. [www.ncbi.nlm.nih.gov/PubMed](http://www.ncbi.nlm.nih.gov/PubMed) - free access to the database of scientific data in the field of biomedical sciences.
3. <https://pubchem.ncbi.nlm.nih.gov/> - free access to the database of scientific data in the field of biomedical sciences.
4. [www.biochemistry.org.ua](http://www.biochemistry.org.ua) - official website of the Palladin Institute of Biochemistry of the National Academy of Sciences of Ukraine.
5. [www.bpci.kiev.ua](http://www.bpci.kiev.ua) - the official website of the Institute of Bioorganic Chemistry and Petrochemistry of the National Academy of Sciences of Ukraine.
6. [www.xumuk.ru](http://www.xumuk.ru) - articles on biochemistry in free access.
7. [www.pereplet.ru/cgi/soros/readdb.cgi](http://www.pereplet.ru/cgi/soros/readdb.cgi) - Soros Educational Journal - free access to popular science articles on biochemistry, biology and chemistry.
8. <https://ojs.tdmu.edu.ua/index.php/ijmr> - International Journal of Medicine and Medical Research
9. <https://ojs.tdmu.edu.ua/index.php/bmb> - Journal of Medical and Biological Research

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## Tips for successful studying on the course

To be successful in learning and self-study, prepare yourself for it by developing the following habits:  
Take responsibility for yourself. Responsibility is the realization that in order to succeed, you must set your own priorities, allocate time and resources.  
Focus on your values and principles. Don't let friends and acquaintances tell you what is important to you.  
Put the most important things first. Don't let others distract you from your goal. Identify the time and place where you are most productive. Prioritize your work according to the complexity of the material.  
Show your best side.  
First understand others, and then try to be understood. Look for the best solution to the problem.  
Be demanding of yourself.  
I wish you perseverance, determination and motivation to learn. And then success will come to you! See you in class!  
Don't forget your medical gowns!