SYLLABUS
Fall semester 2020-2021 academic years
on the educational program "Chemical Technology of Organic Substances"

Discipline's code	Discipline's title	Independent work of students (IWS)	No. of hours per week			Number of credits	Independent work of student with teacher (IWST)
			Lectures (L)	Practical training (PT)	Laboratory (Lab)		
BH 3218	Bioorganic chemistry	68	15	-	60	5	7

Academic course information					
Form of education	**Type of course**	**Types of lectures**	**Types of practical training**	**Number of IWS**	**Form of final control**
Online / Combined	Theoretical and practical	Problematic, analytical lecture	Solving problems and exercises, situational tasks	5	
Lecturer	Gulnaz A. Seitimova, PhD				
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Academic presentation of the course		
Aim of course	**Expected Learning Outcomes (LO)** *As a result of studying the discipline the undergraduate will be able to:*	**Indicators of LO achievement (ID)** (for each LO at least 2 indicators)
To form the ability to classify the most important biological molecules (biomolecules) of a living organism, to analyze their structure, production technologies, physicochemical properties and physiological role.	1. Explain the classification, nomenclature, structure, and physical and chemical properties of biological molecules (biomolecules) that make up a living organism: amino acids, peptides, proteins, enzymes, hormones, coenzymes, vitamins, lipids, carbohydrates, and nucleic acids.	ID 1.1 – explains the principles of classification and nomenclature of biomolecules; ID 1.2 – sets the structure of biomolecules, their most favorable conformation and configuration; ID 1.3 – explains the characteristic physical and chemical properties of biomolecules.
	2. Explain the technology of isolation of biomolecules from natural raw materials and using biotechnological methods, as well as their synthetic production.	ID 2.1 – describes the technology of isolation of biomolecules from natural raw materials and using biotechnological methods; ID 2.2 – explains the synthetic production of biomolecules.
	3. Identify oligo- and polymer biomolecules and their monomeric units.	ID 3.1 – establishes the identity of simple and complex protein molecules (polypeptides, proteins, enzymes) by several criteria of their homogeneity; ID 3.2 – identifies carbohydrates, lipids, and nucleic acids by hydrolysis, qualitative analysis, and chromatography on paper (PC) with standard samples and chemical transformations;

		ID 3.3 – identifies amino acids, hormones, vitamins, oxy-, oxo-carboxylic acids, heterocycles by obtaining derivatives, using qualitative analysis and PC methods.
	4. Evaluate the presence of a chirality center and reaction centers in monomeric, oligo- and polymer biomolecules and, accordingly, evaluate their chemical and biological properties.	ID 4.1 – determines the structure, chirality centers of Monomeric biomolecules, their reactivity and biological activity; ID 4.2 – determines the structure and chirality centers of oligomeric biomolecules, their chemical and biological properties; ID 4.3 – analyzes the structure, chirality centers of polymer biomolecules, their chemical properties and physiological role in the body.
	5. Establish the relationship of biomolecules of a living organism at the level of their structure, chemical and biological properties, and features of metabolism.	ID 5.1-shows the relationship in the structure of biomolecules, their chemical and biological properties; ID 5.2-evaluates the relationship of biomolecules at the level of their cleavage in the body; ID 5.3-evaluates the relationship of biomolecules at the level of their biosynthesis.
Prerequisites	Organic Chemistry of Aliphatic Compounds, Organic Chemistry of Cyclic Compounds	
Post requisites	Chemistry and Technology of Natural Compounds, Chemical Technology of Processing Plant Raw Materials	
Information resources	*Literature:* 1. John McMurry, Mary E. Castellion, Mary E Castellion. *Fundamentals of General, Organic, and Biological Chemistry*, 4th Edition. – 2002. – 880 p. 2. Fromm, Herbert J., Hargrove, Mark. *Essentials of Biochemistry*. – Springer-Verlag Berlin Heidelberg, 2012. – 364 p. 3. Hunter, Graeme K. *Vital Forces: The Discovery of the Molecular Basis of Life*. Academic Press, 2000. – 364 p. 4. N.A. Tyukavkina, Y.I. Baukov. *Bioorganic Chemistry. – 2014. – 416 p. [in Russian]* 5. Y.A. Ovchinnikov. *Bioorganic Chemistry. – 1987. – 815 p. [in Russian]* 6. Francis Rouessac, Annick Rouessac. *Chemical analysis*: *modern instrumentation methods and techniques*. – John Wiley, 2007. – 574 p. 7. Jeffery G.H., Bassett J., Mendham J., Denney R.C. *Vogel's Textbook of Quantitative Chemical Analysis.* – Longman: John Wiley & Sons Inc.; 5th edition, 1989. – 980 p. *Internet resources:* 1. Reference list of medicines https://www.vidal.ru/; 2. American chemical society – https://www.acs.org; 3. http://www.biochemistry.org/Publications.aspx	
Academic policy of the course in the context of university	**Academic Behavior Rules:** All students have to register at the MOOC. The deadlines for completing the modules of the online course must be strictly observed in accordance with the discipline study schedule.	

moral and ethical values	ATTENTION! Non-compliance with deadlines leads to loss of points! The deadline of each task is indicated in the calendar (schedule) of implementation of the content of the curriculum, as well as in the MOOC. **Academic values:** - Practical trainings/laboratories, IWS should be independent, creative. - Plagiarism, forgery, cheating at all stages of control are unacceptable. - Students with disabilities can receive counseling at e-mail gulnaz.seitimova@gmail.com.
Evaluation and attestation policy	**Criteria-based evaluation:** assessment of learning outcomes in relation to descriptors (verification of the formation of competencies in midterm control and exams). **Summative evaluation:** assessment of work activity in an audience (at a webinar); assessment of the completed task.

CALENDAR (SCHEDULE) THE IMPLEMENTATION OF THE COURSE CONTENT:

Weeks	Topic name	LO	ID	Amount of hours	Maximum score	Form of Knowledge Assessment	The form of the lesson / platform
Module 1. The hydrocarbons of the fatty and aromatic series							
1	**Lecture 1 (L1).** Main tasks of Bioorganic chemistry. Physiological role of biomolecules and trace elements in the body. Amino acids, their characteristics, the difference between α-, β- and γ-amino acids. Classification of natural α-amino acids, their chirality, configuration, isoelectric point, bipolar ion, chemical and biological properties.	LO 1	ID 1.1 ID 1.2 ID 1.3	1			Video lecture in MS Teams
	Practical training (PT). Safety precautions, equipment and utensils for obtaining biomolecules and studying their chemical properties, cleaning them and determining physicochemical constants.	LO 2 LO 3	ID 2.1 ID 2.2 ID 3.1 ID 3.2 ID 3.3	4	8	Analysis	Webinar in MS Teams
2	**L2.** The key role of hormones in the body, their classification, methods of isolation and identification. Amino acids and peptides related to hormones and used in hormone therapy.	LO 1	ID 1.1 ID 1.2 ID 1.3	1			Video lecture in MS Teams
	PT. Chromatography of amino acids by BC and TLC using standard samples.	LO 2 LO 3	ID 2.1 ID 2.2 ID 3.3 ID 4.1	4	7	Analysis	Webinar in MS Teams
	Tests				2	Analysis	
	IWSP 1. Consultation on the implementation of IWS 1				5		Webinar in MS Teams

3	**L3.** Methodology for creating a peptide bond for the design of peptides similar to natural ones. Solid-phase method for peptide synthesis.	LO 1	ID 1.1 ID 1.2 ID 1.3	1			Video lecture in MS Teams
	PT. Comparative analysis of determination of amino acid content in plant raw materials and in substances. Chemical properties of amino acids.	LO 2 LO 3 LO 4	ID 2.1 ID 2.2 ID 3.3 ID 4.1	4	8	Analysis	Webinar in MS Teams
	IWS 1. The structure of a living cell. Human vital organs. α-amino acids, their production, chemical and biological properties. Creation of a peptide bond.	LO 5	ID 5.1 ID 5.2 ID 5.3		18	Logic task	
4	**L4.** Proteins and polypeptides, their structures, biological significance. Methodology for establishing their amino acid sequence.	LO 1	ID 1.1 ID 1.2 ID 1.3	1			Video lecture in MS Teams
	PT. Precipitation of proteins with concentrated mineral acids, heavy metal salts. Protein denaturation with phenol and formalin. Protein breakdown by alkali.	LO 2 LO 3 LO 4	ID 2.1 ID 2.2 ID 3.1 ID 4.2 ID 4.3	4	6	Analysis	Webinar in MS Teams
	Tests				3	Analysis	
	IWSP 2. Consultation on the implementation of IWS 2				5		Webinar in MS Teams
5	**L5.** Enzymes. Classification, structure, physiological role.	LO 1	ID 1.1 ID 1.2 ID 1.3	1			Video lecture in MS Teams
	PT. The ratio of proteins to acids and alkalis, coagulation of gelatin with alcohol, buffer properties of a protein solution. Biuret reaction of proteins. Xanthoprotein reaction of proteins.	LO 2 LO 3 LO 4	ID 2.1 ID 2.2 ID 3.1 ID 4.2 ID 4.3	4	8	Analysis	Webinar in MS Teams
	IWS 2. Determination of the amino acid sequence of the protein. Analysis of monographs of α-amino acids, hormones and peptides in the State Pharmacopoeia of the Republic of Kazakhstan (SP RK).	LO 5	ID 5.1 ID 5.2 ID 5.3		20	Logic task	
	Make a structural and logical diagram of the read material	LO 4 LO 5	ID 4.1 ID 4.2 ID 4.3 ID 5.1 ID 5.2 ID 5.3		10		
	MT 1				100		
Module 2. Coenzymes, vitamins, carbohydrates, oxy-, oxoacids, lipids, nucleic acids							
6	**L6.** Coenzymes. Chemical structure, properties and physiological role in the body	LO 1	ID 1.1 ID 1.2 ID 1.3	1			Video lecture in MS Teams

	PT. Salting out proteins from solutions, protein dialysis, protein coagulation when heated.	LO 2 LO 3 LO 4	ID 2.1 ID 2.2 ID 3.1 ID 4.2 ID 4.3	4	7	Analysis	Webinar in MS Teams
7	**L7.** Water-soluble and fat-soluble vitamins. The mechanism of action of vitamins.	LO 1	ID 1.1 ID 1.2 ID 1.3	1			Video lecture in MS Teams
	PT. Establishing the authenticity of water-soluble and fat-soluble vitamins.	LO 2 LO 3 LO 4	ID 2.1 ID 2.2 ID 3.3 ID 4.1	4	7	Analysis	Webinar in MS Teams
	IWSP 3. Consultation on the implementation of IWS 3				5		Webinar in MS Teams
8	**L8**. Classification of carbohydrates. Genetic series of aldoses and ketoses. Stereochemistry of monosaccharides, their mutarotation.	LO 1	ID 1.1 ID 1.2 ID 1.3	1			Video lecture in MS Teams
	PT. Detection of carbohydrates in medicinal plant raw materials. Qualitative reactions to monosaccharides.	LO 2 LO 3 LO 4	ID 2.1 ID 2.2 ID 3.2 ID 4.1	4	7	Analysis	Webinar in MS Teams
	IWS 3. Coenzymes. Water-soluble and fat-soluble vitamins. B vitamins as active substances of coenzymes (NAD+, NAD*H, FAD, FAD*H2).	LO 5	ID 5.1 ID 5.2 ID 5.3		18	Logic task	
9	**L9.** Glycolysis of glucose	LO 1	ID 1.1 ID 1.2 ID 1.3	1			Video lecture in MS Teams
	PT. Technology for extracting starch and pectin from natural sources.	LO 2 LO 3 LO 4	ID 2.1 ID 3.2 ID 4.2 ID 4.3	4	8	Analysis	Webinar in MS Teams
	Tests				3	Analysis	
	IWSP 4. Consultation on the implementation of IWS 4				5		Webinar in MS Teams
10	**L10.** Di-, oligo- and polysaccharides. Classification, structure, preparation, chemical properties, physiological role.	LO 1	ID 1.1 ID 1.2 ID 1.3	1			Video lecture in MS Teams
	PT. Qualitative reactions to starch, pectin and cellulose, their hydrolysis.	LO 2 LO 3 LO 4	ID 2.1 ID 3.2 ID 4.1 ID 4.2 ID 4.3	4	8	Analysis	
	IWS 4. Carbohydrates. Examination of monographs in the SP RK on pharmacopoeial samples of monosaccharides, disaccharides and polysaccharides.	LO 5	ID 5.1 ID 5.2 ID 5.3		17	Problem task	

	IWSP 5. Consultation on the implementation of CW				5		Webinar in MS Teams
	CW	LO 4 LO 5	ID 4.1 ID 4.2 ID 4.3 ID 5.1 ID 5.2 ID 5.3		10		
	MT (Midterm Exam)				100		
11	**L11.** Hydroxy and oxoacids. Classification, distribution, application, physiological role of hydroxy and oxoacids, their preparation and chemical properties. Keto-enol tautomerism of oxoacids.	LO 1	ID 1.1 ID 1.2 ID 1.3	1			Video lecture in MS Teams
	PT. Proof of the presence of two carboxyl groups in tartaric acid and its complexing properties. Decomposition of citric acid. Ketone cleavage of acetoacetic ether.	LO 2 LO 3 LO 4	ID 2.1 ID 2.2 ID 3.3 ID 4.1	4	8	Analysis	Webinar in MS Teams
	Tests				3	Analysis	
	IWSP 6. Consultation on the implementation of IWS 5				5		Webinar in MS Teams
12	**L12.** Saponifiable and unsaponifiable lipids. Their classification. Features of the structure of neutral lipids (fats, oils), their structure and chemical properties.	LO 1	ID 1.1 ID 1.2 ID 1.3	1			Video lecture in MS Teams
	PT. Vegetable oils and solid fats. Detection, isolation and hydrolysis. Qualitative reactions to higher fatty carboxylic acids. Assessment of the degree of unsaturation of fats.	LO 2 LO 3 LO 4	ID 2.1 ID 2.2 ID 3.2 ID 4.1	4	8	Analysis	Webinar in MS Teams
	IWS 5. Pharmacopoeial samples of amino acids, hydroxy acids and oxo acids; fats and oils. Their quality indicators are in accordance with the requirements of the State Fund of the Republic of Kazakhstan.	LO 5	ID 5.1 ID 5.2 ID 5.3		20	Problem task	
13	**L13.** Phospholipids. Their classification, structure, chemical properties. Physiological role. Unsaponifiable lipids (terpenes, steroids). Their classification, structure, chemical properties. Physiological role.	LO 1	ID 1.1 ID 1.2 ID 1.3	1			Video lecture in MS Teams
	PT. Qualitative reactions to higher fatty carboxylic acids, which are part of lipids and phospholipids, and determine their physiological role.	LO 2 LO 3 LO 4	ID 2.1 ID 2.2 ID 3.3 ID 4.1	4	8	Analysis	Webinar in MS Teams
	Tests				3		Webinar in MS Teams

14	**L14.** Deoxyribonucleic acids (DNA). DNA organization levels. Physiological role. Nucleotides and DNA nucleosides, their structure, chemical properties. Pyrimidine and purine bases of nucleosides and nucleotides, their tautomeric transformations.	LO 1	ID 1.1 ID 1.2 ID 1.3	1			Video lecture in MS Teams
	PT. Obtaining furfural and its qualitative reactions	LO 2 LO 3 LO 4	ID 2.1 ID 2.2 ID 3.3 ID 4.1	4	8	Analysis	Webinar in MS Teams
	IWSP 7. Consultation on the implementation of CW				5		
15	**L15.** Ribonucleic acids (RNA). RNA classification, their structure and physiological role. RNA nucleotides and nucleosides, their structure, chemical properties. Tautomeric transformations of heterocyclic bases that make up nucleosides and RNA nucleotides.	LO 1	ID 1.1 ID 1.2 ID 1.3	1			Video lecture in MS Teams
	PT. Comparative analysis of the relationship between structures, chemical and biological properties of a number of obtained natural biologically active compounds.	LO 4 LO 5	ID 4.1 ID 4.2 ID 4.3 ID 5.1 ID 5.2 ID 5.3	4	8	Analysis	Webinar in MS Teams
	CW	LO 4 LO 5	ID 4.1 ID 4.2 ID 4.3 ID 5.1 ID 5.2 ID 5.3		10		
	Make a structural and logical diagram of the read material				14		
	MT 2				100		

[Abbreviations: QS - questions for self-examination; TK - typical tasks; IT - individual tasks; CW - control work; MT - midterm.
Comments:
- Form of L and PT: webinar in MS Teams / Zoom (presentation of video materials for 10-15 minutes, then its discussion / consolidation in the form of a discussion / problem solving / ...)
- Form of carrying out the CW: webinar (at the end of the course, the students pass screenshots of the work to the monitor, he/she sends them to the teacher) / test in the Moodle DLS.
- All course materials (L, QS, TK, IT, etc.) see here (see Literature and Resources, p. 6).
- Tasks for the next week open after each deadline.
- CW assignments are given by the teacher at the beginning of the webinar.]

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