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**Federal State Autonomous Educational Institution of Higher Education
«Peoples' Friendship University of Russia named after Patrice Lumumba»**

Agrarian and Technological Institute

(name of the main educational division (MED)-developer of the EP of HE)

WORKING PROGRAMME OF DISCIPLINE

BIOLOGICAL CHEMISTRY

(name of discipline/module)

Recommended by the MCSD for the direction of training/ specialty:

36.05.01 Veterinary medicine

(code and name of the training area/specialty)

Mastering of the discipline / practice is carried out within the framework of the implementation of the main professional educational program (EP of HE)

Veterinary medicine

(name (profile/ specialty) EP HE)

1. 1. THE PURPOSE OF MASTERING THE DISCIPLINE

The purpose of mastering the discipline "**Biological Chemistry**" is the formation of professional knowledge about the biochemical processes occurring in the body of animals, the basics of metabolism and energy supply of the body, as well as the acquisition of skills for conducting laboratory biochemical analyses for use in practice. This is necessary for the veterinarian to correctly apply his knowledge during the appointment and treatment of animals.

2. REQUIREMENTS FOR THE RESULTS OF MASTERING THE DISCIPLINE

The development of the discipline "**Biological Chemistry**" is aimed at the formation of the following competencies (parts of competencies) in students:

Table 2.1. List of competencies formed by students during the development of the discipline (results of the development of the discipline)

Code	Competence	Indicators of competence achievement (within the framework of this discipline)
GPC-4	Ability to use methods of solving problems using modern equipment in the development of new technologies and use modern professional methodology for conducting experimental research and interpreting their results in his professional activity	GPC-4.1 Has the conceptual and methodological apparatus of basic natural sciences at a level sufficient for full-fledged professional activity at the modern level
		GPC-4.3 is ready to use modern methodology in the development and conduct of experimental research
		GPC-4.4 Uses modern professional methodology in interpreting research results

3. THE PLACE OF DISCIPLINE IN THE STRUCTURE OF THE OP IN

The discipline "**Biological chemistry**" refers to the basic part of the block B1 of the EP of HE.

Within the framework of the educational program, students also master other disciplines and/or practices that contribute to achieving the planned results of mastering the discipline "**Biological Chemistry**".

Table 3.1. The list of the components of the educational program that contribute to the achievement of the planned results of the development of the discipline

Code	Name of the competence	Previous disciplines/modules, practices	Following disciplines/modules, practices
GPC-4	Ability to use methods of solving problems using modern equipment in the development of new technologies and use	Mathematics Inorganic and analytical chemistry Organic Chemistry Biological physics Physical and colloidal chemistry	Immunology

	modern professional methodology for conducting experimental research and interpreting their results in his professional activity		
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* filled in in accordance with the matrix of competencies and SUP EP of HE

4. SCOPE OF DISCIPLINE AND TYPES OF ACADEMIC WORK

The total labor intensity of the discipline "**Biological Chemistry**" is 3 credits.

Table 4.1. Types of educational work by periods of mastering the GP of HE in FULL-time education

Type of educational work	Total, ac.h.	Semester(s)				
		1	2	3	4	
Contact work, ac.h.	51	-	-	51	-	
including:						
Lectures (LC)	17	-	-	17	-	
Laboratory work (LW)	34	-	-	34	-	
Practical/seminar classes (SC)	-	-	-	-	-	
Independent work of students, ac.h.	37	-	-	37	-	
Control (exam / test with assessment), ac.h.	20	-	-	20	-	
Total labor intensity of the discipline	ac.h	108	-	-	108	-
	credits	3	-	-	3	-

5. CONTENT OF THE DISCIPLINE

Table 5.1 Content of the discipline (module) by type of academic work

Name of the discipline section	Content of the section (topics)	Type of educational work
Section 1. Proteins, simple and complex, enzymes, vitamins, coenzymes	Topic 1.1 The subject of biological chemistry. The main stages of the development of biochemistry. The most important problems of modern biochemistry. The place of biochemistry among the biological sciences. Using the achievements of biochemistry in veterinary medicine. The main chemical components of living systems. The concept of the structure of proteins	LC, SC

	<p>1.2. Proteins: structure, properties, functions.</p> <p>Proteins are the basis of the structure and function of living organisms. The biological role of proteins. Methods of isolation and purification of proteins. Amino acid composition of proteins. Classification of amino acids. Structure and physico-chemical properties of amino acids. Biologically active peptides. Structural and functional diversity of proteins.</p> <p>Physico-chemical properties of proteins. Methods of studying proteins. Levels of structural organization of proteins. Monomers and oligomers. Folding protein. The concept of chaperones. The structure of domains. The relationship between the structure and function of proteins. Classification of proteins (simple and complex proteins).</p> <p>Complex proteins: chromoproteins, nucleoproteins, glycoproteins, lipoproteins, phosphoproteins, metalloproteins. Features of their chemical structure and biological role.</p>	LC, LW, SC
	<p>1.3. Enzymes.</p> <p>Biological catalysts: ribozymes and enzymes. Chemical structure of enzymes. The active center, its adsorption and catalytic sites. Coenzymes – the concept of their functional role and chemical diversity.</p> <p>Classification and nomenclature of enzymes. Enzyme activity, its units of measurement. Kinetics of enzymatic catalysis. Regulation of enzymatic activity. Enzyme inhibitors: irreversible and reversible; competitive and non-competitive (allosteric). The use of inhibitors in medicine and veterinary medicine. Reversible enzyme inhibition as the mechanism of action of most drugs. Isoenzymes, their role in enzyme diagnostics. Immobilized enzymes. The use of enzymes in medicine, veterinary medicine and agriculture.</p>	LC, LW, SC
	<p>1.4. Vitamins.</p> <p>Vitamins are essential factors of human and animal nutrition. Distribution of vitamins in nature. The chemical nature of vitamins, the patterns of hypo - and</p>	LC, LW, SC

	<p>hypervitaminosis in the body. Classification of vitamins. The concept of anti-vitamins. Characteristics and formulas of individual water-soluble vitamins B1, B2, pantothenic acid, PP, B6, B12, H (biotin), folic acid, C. Coenzymes are derivatives of vitamins. The functional role of coenzymes.</p>	
Section 2. Hormones, metabolism and energy, carbohydrate metabolism.	<p>Topic 2.1 Hormones. The general concept of hormones. The role of the central nervous system in regulating the activity of the endocrine glands. Hormones are the coordinators of biochemical processes. Subordination of endocrine organs. Classification of hormones by chemical nature: hormones of peptide and protein nature, amino acid derivatives, steroid hormones, prostaglandins. Methods for determining hormones.</p> <p>The biological role of hormones as regulators of metabolism. Mechanisms of action of hormones. The use of hormones and their synthetic analogues in animal husbandry and veterinary medicine.</p>	LC, LW, SC
	<p>Topic 2.2. Metabolism and energy in living organisms. General concepts of metabolism and energy. Anabolism and catabolism are the main metabolic processes. Methods of studying metabolism in animals. Basic principles of regulation of metabolism.</p> <p>Biological oxidation (tissue respiration) as a set of oxidation-reduction processes involving oxygen. Mitochondrial oxidation (respiratory chain) is the main method of oxygen utilization in the body. Components of the respiratory chain. Coenzyme functions of vitamins PP and B2. Decomposition of oxidation and phosphorylation.</p> <p>Nicotinamide and flavin dehydrogenases as the initial links of the respiratory chain. Substrates and energy efficiency of these systems. Substrate phosphorylation.</p> <p>The tricarboxylic acid cycle (CPC, citric acid cycle) as the final stage of the catabolism of acetyl fragments formed during the breakdown of carbohydrates, lipids and amino acids. Microsomal xenobiotic oxidation system.</p>	LC, LW, SC

	<p>Topic 2.3. Carbohydrate metabolism. The biological role of carbohydrates. Classification of carbohydrates. Conversion of feed carbohydrates in the gastrointestinal tract of farm animals, enzymes involved in the digestion of carbohydrates. The role of carbohydrates in metabolism, energy storage. The central role of glucose in carbohydrate metabolism. Possible ways of conversion of glucose-6-phosphate. Anaerobic conversion of glucose (glycolysis). Substrate phosphorylation. Regulation and energy output of glycolysis. Glycogen breakdown (glycogenolysis). Energy output of glycogenolysis. Glycogen synthesis (glycogenesis). Hormonal regulation of glycogen breakdown and synthesis. The role of cAMP in glycogenolysis. Features of carbohydrate metabolism in muscles and liver. Gluconeogenesis. Sources of glucose synthesis. Stages of gluconeogenesis and its regulation, Energy costs of gluconeogenesis. The Measles cycle. Aerobic carbohydrate metabolism. The Pasteur effect. Oxidative decarboxylation of pyruvic acid. The Krebs tricarboxylic acid cycle and its relation to biological oxidation. Regulation of aerobic glucose oxidation and energy output. The biological role of substrate cycles. The pentose phosphate pathway of glucose oxidation in different tissues. The consequences of thiamine deficiency in the body. Features of carbohydrate metabolism in erythrocytes. Glucose-6-phosphate dehydrogenase, NADPH, glutathione and drug hemolytic anemia. Disorders of carbohydrate metabolism.</p>	<p>LC, LW, SC</p>
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<p>Section 3. Lipid metabolism, protein metabolism, nucleoproteins and chromoproteins.</p>	<p>Topic 3.1. Lipid metabolism. Lipid metabolism. Digestion, absorption and transport of lipids in the digestive tract of animals. Decomposition and resynthesis of triacylglycerols. Transformations of glycerin. β-oxidation of fatty acids in mitochondria. Oxidation of fatty acids with an odd number of carbon atoms. Energy effect of fatty acid oxidation. Biosynthesis of fatty acids and phospholipids in various tissues. Acetone bodies and their biological role. Molecular mechanisms of ketosis occurrence in farm animals. Cholesterol biosynthesis. Serum lipoproteins. The relationship of fat and carbohydrate metabolism. The central role of CoA in lipid metabolism. Regulation and pathology of lipid metabolism in animals.</p>	<p>LC, LW, SC</p>
	<p>Topic 3.2. Protein catabolism. Protein metabolism. The biological value of proteins, essential and interchangeable amino acids. Types of pathology in animals associated with the lack of adequate protein nutrition. The quantity and quality of proteins in animal feed. Digestion of proteins in the gastrointestinal tract. Features of protein metabolism in ruminants. Microbial synthesis in the pancreas, caecum and colon. Absorption of protein breakdown products. Putrefaction of proteins in the intestine under the influence of microorganisms and mechanisms of neutralization of toxic products. Pathology of protein metabolism in animals. Features of protein metabolism in birds.</p>	<p>LC, LW, SC</p>

	<p>Topic 3.3. Amino acid metabolism. Amino acid catabolism: transamination of amino acids, deamination of amino acids; (direct and indirect), decarboxylation of amino acids; biogenic amines, their physiological and pharmacological action; hydroxylation of amino acids; the mechanism of this process. Ammonia neutralization in cells: sources of ammonia, mechanism of toxic action of ammonia, binding (neutralization) of ammonia: ornithine cycle of urea formation, formation of glutamine (in urine) and asparagine, reductive amination of α-ketoglutarate, creatine synthesis, formation and excretion of ammonium salts through the kidneys. Transformations of nitrogen-free amino acid residue. Glycogenic and ketogenic amino acids. Specific pathways of the metabolism of individual amino acids.</p>	LC, LW, SC
	<p>Topic 3.4. Chemistry and metabolism of nucleic acids. Chromoproteins. Ideas about the chemical structure and biological role of nucleic acids. Biological functions of mononucleotides, the nature of their binding in nucleic acids. Features of the structure and spatial organization of various types of RNA and DNA molecules. Features of complex protein metabolism. Cleavage and absorption of nucleic acids in the gastrointestinal tract of animals. Decay and synthesis of nucleotides in the body. The end products of the decomposition of purine and pyrimidine nucleotides in different animal species. Violations of the metabolism of purine bases.</p> <p>Biosynthesis of nucleic acids and proteins. Replication, repair, transcription. The role of biochemical research in veterinary medicine.</p> <p>Chromoproteins. Synthesis and decay of heme. Porphyria.</p> <p>The relationship of metabolic processes in the body.</p>	LC, LW, SC

* - filled in only by FULL-time study: LC – lectures; LW – laboratory work; SC – seminar classes.

6. MATERIAL AND TECHNICAL SUPPORT OF THE DISCIPLINE

Table 6.1. Material and technical support of the discipline

Audience type	Equipping the audience	Specialized educational/laboratory equipment, software and materials for the development of the discipline (if necessary)
Lecture hall	Hall No. 1, Hall No. 2 Lecture-type classroom equipped with a set of specialized furniture; a blackboard (screen) and multimedia presentation equipment	
Laboratory	An auditorium for laboratory work, individual consultations, routine monitoring and interim certification, equipped with a set of specialized furniture and equipment (auditoriums 201, 316, 318, 319, 339).	multimedia projectors and motorized screens NEC V 260X Projector, Motorized Screen for the Master Control 203X203 projector. laboratory equipment: Exhaust hood, CENTRIFUGE OPN-8, KFK-3-01 photoelectrocolorimeter, Electric drying cabinet SNOL 67/350, Thermoblock PE-4030 36 gn. d-23*45mm, Spectrophotometer Specord M -40, Computer HP 280 G2 MT V7 Q81E Intel Pentium Dual-Core G4400
Seminary	An auditorium for conducting seminar-type classes, group and individual consultations, ongoing monitoring and interim certification, equipped with a set of specialized furniture and multimedia presentation equipment (auditoriums 203, 329, 334, 336)	Pestle microbiological homogenizer Vilitex DY89-II, pestles and containers to it for 3, 5, 10, 20 and 50 ml. NANODROP 2000C Thermo Fisher Microspectrophotometer Camera for horizontal electrophoresis Sub-Cell GT, 15x15 cm, combs for 15 and 20 holes (1 piece each), with stops for filling Bio-Rad 1704402 - 2 pieces Camera for vertical electrophoresis Mini-PROTEAN® Tetra Bio-Rad 165800 - 2 pcs PowerPack Basic Power Supply Power supply for 4 electrophoretic chambers with output voltage up to 300 V. Bio-Rad 1645050 SM - 6M desktop centrifuge with 6M rotor (12 tubes x12ml) Elmi Transilluminator TCP-20.MC wavelength 312 and 254 nm, screen size 20 x 20 cm. Vilber Lourmat VL 2161 2017 1 Desktop pH Meter Series Starter 5000 Ohaus, Ohaus ST5000, pH meter MettlerToledo Microcentrifuge 5420 Microcentrifuge with rotation speed up to 15060 rpm, with the ability to work with standard test tubes on 0,2/0,5/0,6/1,5 and 2 ml and PCR strips. Epp 5420 000.318, Eppendorf Evolution™ 201/220 UV-Visible Spectrophotometer 840-210600, Thermo Fisher Multimodal reader ClarioStar Omega BMG LABTECH 415-10 Thermoshaker TS-100C, BS-010143-AAI, BioSan Liebherr GNP 3056 freezer, Biryusa-6 refrigerator, Minsk-17 Freezer. Laboratory medical centrifuge ProfMT, Refrigerator ATLANT XM 6026-031, Freezer Minsk-17, Electronic scales AR0640 Ohaus Europe, Spectrophotometer Hitachi F-2700,

Audience type	Equipping the audience	Specialized educational/laboratory equipment, software and materials for the development of the discipline (if necessary)
Lecture hall	Hall No. 1, Hall No. 2 Lecture-type classroom equipped with a set of specialized furniture; a blackboard (screen) and multimedia presentation equipment	
		Distiller GTL-200, Thermostat, Thermoblock PE-4030 36 gn. d-23*45mm, Bi-beam Spectrophotometer U-2900, Centrifuge L7-55 HP 280 G2 MT V7 Q81E Intel Pentium Dual-Core G4400 Computer There is an Internet connection Electrophoretic chamber, 1mm, Analytical scales EP214C, Laboratory washing table 985*610*900 . Microcentrifuge Eppendorf Minispin Vortex V-1 plus Flow cytometer MACSQuant Analyzer 10, Fume hood, Thermoblock PE-4030 36 gn. d-23*45mm, Spectrophotometer Specord M -40, HP 280 G2 MT V7 Q81E Intel Pentium Dual-Core G4400 Computer
Computer class	A computer classroom for conducting classes, group and individual consultations, ongoing monitoring and intermediate certification, equipped with personal computers (in the amount of _15 .), a blackboard (screen) and multimedia presentation technical means.	HP 280 G2 MT V7 Q81E Intel Pentium Dual-Core G4400 Computer
For independent work of students	An auditorium for independent work of students (can be used for laboratory classes and consultations), equipped with a set of specialized furniture, computers with access to EIOS (auditorium 203, 339)	A set of specialized furniture, Software: Microsoft products (OS, office application package, including MS Office/ Office 365, Teams), Drying cabinet, Specord M-40 spectrophotometer, dry-air thermostat

* - the audience for independent work of students is MANDATORY!

7. EDUCATIONAL, METHODOLOGICAL AND INFORMATIONAL SUPPORT OF THE DISCIPLINE

Basic literature:

- 1) Medical biochemistry / J. W. Baynes. - 5 ed. - 2019
- 2) Voet D., Voet J. - Fundamentals of Biochemistry Life at the Molecular Level. - 5th Edition, 2016

Additional literature:

- 3) Principles of Biochemistry 6th ed./ Lehninger, A.L., Nelson, D.L., Cox, M.M.- Worth Publishing, 2016.
- 4) Principles of Medical Biochemistry 2nd ed./ Gerhard Meisenberg, William H. Simmons. – Mosby Elsevier, 2006

Resources of the Internet information and telecommunication network:

1. ELS RUDN and third-party EBS, to which university students have access on the basis of concluded contracts:

- Electronic library system of RUDN - EBS RUDN <http://lib.rudn.ru/MegaPro/Web>
- ELS "University Library online" <http://www.biblioclub.ru>
- ELS Yurayt <http://www.biblio-online.ru>
- ELS "Student Consultant" www.studentlibrary.ru
- ELS "Doe" <http://eZlanbook.com/>
- ELS "Trinity Bridge" <http://www.trmost.com/>

2. Databases and search engines:

- electronic Fund of legal and normative-technical documentation <http://docs.cntd.ru/>
- search engine Yandex <https://www.yandex.ru/>
- Google search engine <https://www.google.ru/>
- bibliographic database SCOPUS
- <http://www.elsevierscience.ru/products/scopus/>
- <http://login.webofknowledge.com/>

Educational and methodological materials for independent work of students during the development of the discipline/ module*:

1. A course of lectures on the discipline "Biological chemistry".
2. Laboratory workshop on the discipline "Biological chemistry".

* - all teaching materials for independent work of students are placed in accordance with the current procedure on the discipline page in the telecommunication system (TUIS)!

8. ASSESMENT TOOLS AND A POINT-RATING SYSTEM FOR ASSESSING THE LEVEL OF COMPETENCE FORMATION IN THE DISCIPLINE

Evaluation materials and a point-rating system* for assessing the level of competence formation (part of competencies) based on the results of mastering the discipline "Biological Chemistry" are presented in the Appendix to this Work Program of the discipline.

* - OM and PRS are formed on the basis of the requirements of the relevant local regulatory act of the RUDN.

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