Federal State Autonomous Educational Institution for Higher Education
PEOPLES' FRIENDSHIP UNIVERSITY OF RUSSIA

Agrarian and Technological Institute

WORKING COURSE SYLLABUS

Biological Chemistry

Recommended by the Methodological Council for the Education Field:

36.05.01 Veterinary medicine

2022 г.

1. GOALS AND OBJECTIVES OF THE DISCIPLINE

The aim of mastering the discipline "**Biological Chemistry**" is to form a system knowledge of the students about the molecular mechanisms of the functioning of biological systems.

2. REQUIREMENTS FOR THE RESULTS OF MASTERING THE DISCIPLINE

The development of the discipline "**Biological Chemistry**" is aimed at creating the following competencies (parts of competencies) for 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 accomplishment (within the discipline)
UK -8	The ability to create and maintain safe living conditions in everyday life and in professional activities for the preservation of the natural environment, ensuring the sustainable development of society, including in the event of a threat and occurrence of emergencies and military conflicts.	UK-8.1 Analyzes the factors of harmful influence on the vital activity of elements of the habitat. (technical means, technological processes, materials, buildings and structures, natural and social phenomena);
		UK -8.2 Identifies dangerous and harmful factors within the scope of the task being performed;
		UK-8.3 Identifies and eliminates problems related to safety violations in the workplace;
		UK-8.4 Explains measures to prevent emergencies;
		UK -8.5 "Explains the rules of conduct in the event of emergencies of natural and man-made origin, as well as in the event of military conflicts;"
		UK-8.6 Provides first aid, participates in recovery activities.
GPC -4	The ability to use methods of solving problems using modern equipment in the development of new technologies in professional activity and to use modern professional methodology for conducting experimental research and interpreting their results.	GPC-4.1 Possesses the conceptual and methodological apparatus of basic natural sciences at a level sufficient for full-fledged professional activity at the modern level.
		GPC-4.2 He knows the methods of solving problems using modern equipment.
		GPC-4.3 He 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.
PC -3	Ability to develop animal research programs using special (instrumental) and laboratory methods.	PC-3.1 He is able to develop individual animal research programs, including the use of special (instrumental) and laboratory methods to detect deviations from the physiological norm of the state of a living organism, conduct differential diagnosis of the detected pathology or control the course of the disease and the effectiveness of the prescribed treatment.
		PC-3.2 Capable of developing mass comprehensive animal research programs (medical examination programs) of animals, taking into account their type and purpose, both general and special.
PC -4	The ability to conduct clinical studies of animals using special (instrumental) and laboratory methods to clarify the diagnosis.	PC-4.1 Able to conduct additional animal studies using laboratory methods to clarify the diagnosis.
		PC-4.2 Able to conduct additional animal studies using special (instrumental) methods to clarify the diagnosis.
PC -7	The ability to choose the necessary drugs of chemical and biological nature for the treatment of animals, taking into account their combined pharmacological effect on the body.	PC -7.1 He is able to choose medicines of chemical and biological nature necessary for the treatment of animals, guided by the principles of evidence-based medicine, taking into account their combined pharmacological effect on the body.
		PC-7.2 He is able to justify the prescription of a drug in a certain clinical case or the impossibility of using this drug in the situation under consideration.
		PC-7.3 He is able to calculate the dose, frequency and duration of the course of application of the drug to the patient, taking into account the form of release and the characteristics of the administration of the drug to the patient.
		PC-7.4 He is able to take into account drug interactions when prescribing a course of treatment to an animal already receiving medications and biologically active additives due to the presence of diseases identified earlier.
		PC-7.5 He is able to take into account economic, species and age characteristics, as well as the results of laboratory studies

		of the patient when choosing drugs for the treatment of the patient.

3. COURSE IN HIGHER EDUCATION

The discipline "**Biological Chemistry**" refers to the mandatory part of block B1 of the Educational Program of Higher Education.

As part of the Educational Program of Higher Education, students also master other disciplines and /or practices that contribute to achieving the planned results of mastering the discipline "**Biological Chemistry**".

Table 3.1. List of Higher Education Program components disciplines that contribute to expected learning outcomes

Competence code	Competence	Previous Disciplines (Modules)	Subsequent Disciplines (Modules)
UK -8	The ability to create and maintain safe living conditions in everyday life and in professional activities for the preservation of the natural environment, ensuring the sustainable development of society, including in the event of a threat and occurrence of emergencies and military conflicts.	History Inorganic and analytical chemistry Organic chemistry Biological physics Physical and Colloidal Chemistry Life safety	Veterinary Microbiology and Mycology Virology and biotechnology Veterinary radiobiology Parasitology and invasive diseases Epizootology and infectious diseases Organization of veterinary affairs General and Veterinary Ecology Veterinary sanitation Veterinary deontology Laboratory diagnostics of infectious and invasive diseases Organization of state veterinary supervision
GPC -4	The ability to use methods of solving problems using modern equipment in the development of new technologies in	Inorganic and analytical chemistry Organic chemistry Biological physics Computer science	Veterinary Microbiology and Mycology Virology and biotechnology

	professional activity and to use modern professional methodology for conducting experimental research and interpreting their results.	Physical and Colloidal Chemistry Cytology, Histology and Embryology	Physiology and ethology of animals Breeding with the basics of private animal husbandry Pathological physiology Veterinary radiobiology Clinical diagnostics Pathological anatomy Operative surgery with topographic anatomy Instrumental diagnostic methods Toxicology Obstetrics, gynecology and andrology Internal diseases General surgery Private Veterinary Surgery Parasitology and invasive diseases Epizootology and infectious diseases Maths Immunology Veterinary sanitation Processing technology for livestock products Medicinal and poisonous plants Fodder plants The basics of intellectual work Personality psychology and professional self-determination Clinical laboratory diagnostics Laboratory diagnostics of

			infectious and invasive diseases Horse diseases Diseases of Productive Animals Diseases of small pets Болезни мелких домашних животных Diseases of bees and entomophages Fish pathology and aquaculture Diseases of exotic animals Anesthesiology, resuscitation and intensive care Dermatology Cardiology Endocrinology Nephrology Reconstructive surgery Veterinary ophthalmology Animal Dentistry
PC -3	Ability to develop animal research programs using special (instrumental) and laboratory methods.	Animal anatomy Organic chemistry Biological physics Physical and Colloidal Chemistry	Veterinary Microbiology and Mycology Virology and biotechnology Physiology and ethology of animals Pathological physiology Clinical diagnostics Pathological anatomy Instrumental diagnostic methods Toxicology Obstetrics, gynecology and andrology Internal diseases General surgery

			Private Veterinary Surgery Parasitology and invasive diseases Epizootology and infectious diseases Immunology Veterinary deontology Clinical laboratory diagnostics Laboratory diagnostics of infectious and invasive diseases Veterinary and industrial laboratories with design basics Horse diseases Diseases of Productive Animals Diseases of small pets Болезни мелких домашних животных Diseases of bees and entomophages Fish pathology and aquaculture Diseases of exotic animals Anesthesiology, resuscitation and intensive care Dermatology Cardiology Endocrinology Nephrology Reconstructive surgery Veterinary ophthalmology Animal Dentistry
PC -4	The ability to conduct clinical studies of animals using special	Animal anatomy Biological physics	Veterinary Microbiology and Mycology

	(instrumental) and laboratory methods to clarify the diagnosis.	Cytology, Histology and Embryology	Virology and biotechnology Physiology and ethology of animals Pathological physiology Clinical diagnostics Pathological anatomy Instrumental diagnostic methods Obstetrics, gynecology and andrology Internal diseases General surgery Private Veterinary Surgery Parasitology and invasive diseases Epizootology and infectious diseases Clinical laboratory diagnostics Laboratory diagnostics of infectious and invasive diseases Horse diseases Diseases of Productive Animals Diseases of small pets Болезни мелких домашних животных Diseases of exotic animals Anesthesiology, resuscitation and intensive care Dermatology Cardiology Endocrinology Nephrology Veterinary ophthalmology Animal Dentistry

PC -7	The ability to choose the necessary drugs of chemical and biological nature for the treatment of animals, taking into account their combined pharmacological effect on the body.	Inorganic and analytical chemistry Organic chemistry Physical and Colloidal Chemistry	Veterinary Microbiology and Mycology Virology and biotechnology Pathological physiology Veterinary pharmacology Toxicology Obstetrics, gynecology and andrology Internal diseases General surgery Private Veterinary Surgery Parasitology and invasive diseases Epizootology and infectious diseases Medicinal and poisonous plants Horse diseases Diseases of Productive Animals Diseases of small pets Болезни мелких домашних животных Diseases of bees and entomophages Fish pathology and aquaculture Diseases of exotic animals Anesthesiology, resuscitation and intensive care Dermatology Cardiology Endocrinology Nephrology Veterinary ophthalmology Animal Dentistry

4. COURSE WORKLOAD AND TRAINING ACTIVITIES

Course workload of the discipline "**Biological Chemistry**" is 3 credits.

*Table 4.1. Types of academic activities during the period of the HE program mastering for **full-time** study*

Types of academic activities		**HOURS**	**Semesters**			
			3	**-**	**-**	**-**
Contact academic hours		54	54	**-**	-	-
including						
Lectures		18	18	**-**	-	-
Lab work		36	36	**-**	-	-
Seminars (workshops/tutorials)		-	-	-	-	-
Self-study		38	38	**-**	-	-
Evaluation and assessment (exam/pass/fail grading)		16	16	**-**	-	-
Course workload	Academic hour	**108**	**108**	**-**	**-**	-
	Credit unit	**3**	**3**	**-**	**-**	-

*Table 4.2. Types of academic activities during the period of the HE program mastering for **part-time** study*

Types of academic activities		**HOURS**	**Semesters**			
			3	**-**	-	**-**
Contact academic hours		18	18	-	-	-
including						
Lectures		-	-	-	-	-
Lab work		18	18	-	-	-
Seminars (workshops/tutorials)		-	-	-	-	-
Self-study		80	80	-	-	-
Evaluation and assessment (exam/pass/fail grading)		10	10	-	-	-
Course workload	Academic hour	**108**	**108**	-	-	-
	Credit unit	**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)*	**Types of academic activities**
Section 1. Introducing into Biological chemistry	Topic 1.1. A subject of biological chemistry. The main stages of the development of Biological chemistry. The most important problems of modern Biological chemistry. The place of Biological chemistry among biological sciences. Using the achievements of Biological chemistry in veterinary. The main chemical components of living systems. The concept of the structure of proteins.	Lectures, Lab work.
Section 2. Proteins: the structure, its own, functions.	Topic 2.1. Proteins are the basis of the structure and function of living organisms. Biological role of proteins. Methods for the 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. Physico-chemical properties of proteins. Methods of studying proteins. Levels of the structural organization of proteins. Monomers and oligomers. Folding the squirrel.	Lectures, Lab work.
Section 3. Enzymes.	Topic 3.1. 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. Classification and nomenclature of enzymes. Enzyme activity, units of its measurement. Kinetics of enzymatic catalysis. Regulation of enzymatic activity. Enzyme inhibitors: irreversible and reversible; competitive and noncompetitive (allosteric).	Lectures, Lab work.

Section 4. Vitamins.	Topic 4.1. Vitamins are essential factors of human and animal nutrition. Distribution of vitamins in nature. The chemical nature of vitamins, pictures of hypo - and hypervitaminosis in the body. Classification of vitamins. The concept of antivitamins. Characteristics and formulas of individual water-soluble vitamins B1, B2, pantothenic acid, PP, B6, B12, H (biotin), folic acid, C. Coenzymes - derivatives of vitamins. The functional role of coenzymes. Fat-soluble vitamins A, D, E, K. Biological role of vitamins. Specific signs of diseases of animals and birds in beriberi. The need for vitamins of different species of animals and birds.	Lectures, Lab work.
Section 5. Hormones.	Topic 5.1. The general concept of hormones. The role of the central nervous system in the regulation of the activity of endocrine glands. Hormones are coordinators of biochemical processes. Subordination of endocrine organs. Classification of hormones chemical nature: hormones, peptide and protein nature, amino acid derivatives, steroid hormones natural prostaglandins. Methods for determining hormones. Biological role of hormones as metabolism regulators. Mechanisms of action of hormones. The use of hormones and their synthetic analogues in livestock and veterinary medicine.	Lectures, Lab work.
Section 6. Metabolism of carbohydrates.	Topic 6.1. Biological role of carbohydrates. Classification of carbohydrates. Conversion of carbohydrate feeds in the gastrointestinal tract of farm animals, enzymes inHElved in the digestion of carbohydrates. The role of carbohydrates in the metabolism, the accumulation of energy. The central role of glucose in carbohydrate metabolism. Possible ways of conversion of glucose-6-phosphate. Anaerobic transformation of glucose (glycolysis). Substrate phosphorylation. Regulation and energy output of glycolysis.	Lectures, Lab work.

Section 7. Metabolism of lipids.	Topic 7.1. Metabolism of lipids. Digestion, absorption and transport of lipids in the digestive tract of animals. Decomposition and resynthesis of triacylglycerols. Transformations of glycerol. -oxidation of fatty acids in mitochondria. Oxidation of fatty acids with an odd number of carbon atoms. Energy effect of oxidation of fatty acids. Biosynthesis of fatty acids and phospholipids in various tissues. Acetone bodies and their biological role. Molecular mechanisms of ketosis in farm animals. Biosynthesis of cholesterol. Lipoproteins of blood serum. Relationship of the metabolism of fats and carbohydrates. The central role of CoA in the metabolism of lipids.	Lectures, Lab work.
Section 8. Metabolism of proteins.	Topic 8.1. Metabolism of proteins. Biological value of proteins, essential and non-essential amino acids. Types of pathology in animals associated with the lack of high-grade protein nutrition. The quantity and quality of proteins in animal feed. Digestion of proteins in the gastrointestinal tract. Features of protein metabolism in ruminant animals. Microbial synthesis in the pancreatic, caecum and thick intestine. Absorption of protein decay products. Putrefaction of proteins in the intestines under the influence of microorganisms and mechanisms for neutralizing toxic products. Pathology of protein metabolism in animals. Features of protein metabolism in birds	Lectures, Lab work.
Section 9. Metabolism of amino acids.	Topic 9.1. Ammonia in cells: ammonia sources, ammonia toxic action mechanism, ammonia binding: an ornithine urea synthesis cycle, formation of glutamine (in urine) and asparagine, reductive amination of α-ketoglutarate, synthesis of creatine, formation and excretion of ammonium salts through the kidneys. Transformations of the nitrogen-free residue of amino acids. Glycogen and ketogenic amino acids. Specific pathways for the metabolism of individual amino acids.	Lectures, Lab work.

Section 10. Chemistry and metabolism of nucleic acids.	Topic 10.1. Representations of the chemical structure and the 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 different types of RNA molecules and DNA. Peculiarities of the complex protein metabolism. Splitting and absorption of nucleic acids in the gastrointestinal tract of animals. Degradation and synthesis of nucleotides in the body. The final products of the decay of purine and pyrimidine nucleotides in different animal species. Violations of the metabolism of purine bases. Biosynthesis of nucleic acids and proteins. Replication, repair, transcription.	Lectures, Lab work.
Section 11. Mineral and water metabolism.	Topic 11.1. The value of water for the animal body. Water, as one of the final products of metabolism in the body. The content of minerals in organs and tissues. Mac and microelements, their biological role. Regulation of the metabolism of water and minerals. Importance of some chemical elements in the animal body.	Lectures, Lab work.
Section 12. Biological chemistry of blood.	Topic 12.1. Blood is the integrating part of the internal environment of the body. Protein spectrum of plasma. Methods of quantitative analysis of protein fractions of blood, their informativeness. Plasma enzymes. Non-protein organic components of plasma. Mineral components of blood. Age and Specific Features of the Chemical Composition of Blood in Animals Chemical composition of lymph and liquor. Blood coagulation system. Participation of blood components in mechanisms of immune defense. Regulation of vascular tone through vasoactive peptides. Respiratory function of blood. Buffer systems of blood plasma.	Lectures, Lab work.

Section 13. Biological chemistry of muscle tissue.	Topic 13.1. Transformation of chemical energy into energy of mechanical motion. Proteins of myofibrils. Sarcoplasmic proteins; the role of myoglobin. Mechanisms of muscle contraction and relaxation. Biochemical changes in muscles in pathology. Biological chemistry of meat production: the influence of genetic factors, feeding and keeping animals.	Lectures, Lab work.
Section 14. Biological chemistry of nervous tissue.	Topic 14.1. Cellular elements of the nervous tissue; a brief description of neurons, neuroglia and microglia. The most important neurotransmitter mediators and their receptors; neuropeptides.	Lectures, Lab work.
Section 15. Biological chemistry of connective tissue of the skin, bone and wool.	Topic 15.1. Variety of connective tissues. Elastic fibers. Metabolism of collagen and elastin. Cartilage as a special variant of connective tissue. Collagen. Elastin. Proteoglycans. Glycosaminoglycans. Cellular elements of bone tissue. Composition of collagen fibers of bone tissue.	Lectures, Lab work.
Section 16. Biological chemistry of kidney and urine	Topic 16.1. Kidneys as the main organ of excretion of terminal metabolites. Clearance (clearance) of the blood plasma component as an indicator of the effectiveness of its excretion by the kidneys. The process of urine formation. Criteria for assessing glomerular filtration. Molecular mechanisms of reabsorption and secretion in the renal tubules. Normal and pathological components of blood and urine.	Lectures, Lab work.
Section 17. Chemical composition of milk and regulation of its formation.	Topic 17.1. Protein and amino acid composition of milk, mineral composition of milk. Some features of the milk composition of different farm animals. The nutritional value of milk. The chemical composition of egg yolk, the chemical composition of egg white, the chemical composition of the shell. The nutritional value of eggs.	Lectures, Lab work.

6. CLASSROOM INFRASTRUCTURE AND TECHNOLOGY SUPPORT REQUIREMENTS

Table 6.1. Material and technical support of the discipline

Classroom for Academic Activity Type	*Equipping the classroom*	**Specialized educational/laboratory equipment, software and materials for the development of the discipline** (if necessary)
Lecture	An auditorium for conducting lecture-type classes, equipped with a set of specialized furniture; a board (screen) and technical means of multimedia presentations.	- *Centrifuges* - *Thermostats* - *Water baths* - *Spectrophotometers* - *Drying cabinets* - *Electronic and analytical scales* - *Computers, multimedia projectors, projection devices* - *Multimedia equipment.* - *Laboratory utensils for conducting experimental work*
Laboratory	An auditorium for laboratory work, individual consultations, routine monitoring and interim certification, equipped with a set of specialized furniture and equipment.	- *Centrifuges* - *Thermostats* - *Water baths* - *Spectrophotometers* - *Drying cabinets* - *Electronic and analytical scales* - *Computers, multimedia projectors, projection devices* - *Multimedia equipment.* - *Laboratory utensils for conducting experimental work*
Self-studies	An auditorium for independent work of students (can be used for seminars and consultations), equipped with a set of specialized furniture and computers with access to an electronic information and educational environment.	-

7. RECOMMENDED SOURCES FOR COURSE STUDIES

Main reading:

1. Berezov TT, Korovkin BF Biological chemistry: TextboGC. - 4 th ed. processing. and additional .- M .: Medicine, 2007.
2. Biological chemistry. TextboGC / Ed. ES Severin. - 5 th ed. - Moscow: GEOTAR-Media, 2008.
3. Smirnova IP, Chernov NN, Kuznetsova OM and others. // Collection of tests on Biological chemistry. Tutorial. 2014g. M. Publishing house "Orgservice-2000",
4. Smirnova IP, Chernov NN, Lobayeva TA, Kuznetsova OM, and others. The guide to practical training in Biological chemistry for the specialty "Veterinary Medicine". Educational allowance 2015, Moscow, Publishing House of Peoples' Friendship University

of Russia Usl. p.ch.5,12,
5. Smirnova IP, Lobayeva TA, Golomazova KA. Metabolism of carbohydrates. - Tutorial.The printing house of the PFUR, Usl.pech.- 2016
6. Smirnova IP, Syatkin SP, Skorik AS Dialogue with a student: proteins and enzymes. Tutorial. Printing house of the Peoples' Friendship University of Russia. – 2016.
7. Tests in biochemistry for students of the Agrarian-technological institute, specialty "Veterinary medicine". Neborak E.V., Smirnova I.P. - Moscow, Printing house of the Peoples' Friendship University of Russia, 2018
8. Voet D., Voet J. - Fundamentals of Biochemistry Life at the Molecular Level 5th Edition, 2016
9. Medical biochemistry / J. W. Baynes. - 5 ed. – 2019

Additional Reading:

1. Principles of Biochemistry 4nd ed./ Lehninger, A.L., Nelson, D.L., Cox, M.M..- Worth Publishing, 2004.
2. Principles of Medical Biochemistry 2nd ed./ Gerhard Meisenberg, William H. Simmons. – Mosby Elsevier, 2006
3. Lobaeva TA, Kuznetsova OM, Chernov NN. Basic terms and formulas for Biological chemistry for students of medical specialties. TextboGC / M .: Orgservice -2000, 2016.

Resources of the Internet information and telecommunication network:

1. Electronic library system of RUDN and third-party Electronic library systems to which university students have access on the basis of concluded contracts:
- Electronic library system of RUDN - ELS 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 "Lan"http://eZlanbook.com/
- ELS "Trinity Bridge"http://www.trmost.com/

2. Databases and search engines:
- electronic fund of legal and regulatory and technical documentation http://docs.cntd.ru/
- search engine Yandex https://www.yandex.ru/
- search engine Google https://www.google.ru/
- abstract database SCOPUS http://www.elsevierscience.ru/products/scopus/

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 educational and methodological materials for independent work of students are placed in accordance with the current procedure on the discipline page in the **Telecommunication educational and Information System!**

8. MID-TERM ASSESSMENT

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.

* - Assessment Materials and a Point Rating System are formed based on the requirements of the relevant local regulatory act of the RUDN.

DEVELOPER:

Associate professor of Biological chemistry department		Neborak E.V.
Position, Basic curriculum	Signature	Full name.

HEAD OF THE DEPARTMENT:

Department of Biochemistry named after Acad. T.T. Berezov		Pokrovskiy V.S.
Name Basic Curriculum	Signature	Full name.

HEAD OF THE HIGHER EDUCATION PROGRAM:

Director of the Department of Veterinary Medicine		Vatnikov Yu.A.
Position, Basic curriculum	Signature	Full name