Federal State Autonomous Educational Institution of Higher Education "Peoples' Friendship University of Russia"

Medical Institute

(name of Educational Division developing the postgraduate program)

Department of Biochemistry named after academician T.T. Berezov

(name of the Educational Department developing the postgraduate program)

WORKING PROGRAM OF THE DISCIPLINE

Biochemistry Molecular mechanisms of cancer

(name of the discipline)

Scientific specialty:

1.5.4. Biochemistry

(code and name of the scientific specialty)

Practical training of students is carried out within the framework of the postgraduate education program:

Biochemistry Molecular mechanisms of cancer

(name of the postgraduate program)

2023 г.

1. THE PURPOSE OF MASTERING THE DISCIPLINE

The purpose of mastering the discipline "Biochemistry Molecular mechanisms of cancer" is to prepare for candidate exams, as well as the development of in-depth knowledge and the acquisition of professional competencies of a researcher in the field of Biochemistry Molecular mechanisms of cancer.

Objectives of the discipline:

- in-depth study of theoretical, methodological, clinical foundations of biochemistry;
- formation and improvement of professional training of a biochemist-researcher with systemic thinking, well-versed in complex molecular and biochemical processes of a living organism, having in-depth knowledge of related disciplines;
- formation of skills in mastering the latest molecular biological technologies and techniques;
- formation of skills and abilities of independent research and teaching activities in the field of Biochemistry Molecular mechanisms of cancer.

2. REQUIREMENTS TO DISCIPLINE OUTCOMES

Mastering the discipline "Biochemistry Molecular mechanisms of cancer" is aimed at preparing for candidate exams.

As a result of studying the discipline, a graduate student should:

Know:

- basic theories, concepts and principles in the chosen field of activity;
- methodology of biochemistry, expanding general professional, fundamental training;
- regulatory documents regulating the organization and methodology of scientific research;

Be able to:

- to use fundamental biological concepts in the field of professional activity for setting and solving new tasks

to design and carry out comprehensive research, including interdisciplinary, based on a holistic systematic scientific worldview using knowledge in the field of history and philosophy of science;

independently analyze the available information, set the purpose and objectives of the study and propose methods to solve them

- professionally draw up, present and report the results of scientific research according to approved forms;

Own:

- the ability to independently carry out research activities in the relevant professional field using modern research methods and information and communication technologies
- skills to plan and solve problems of their own professional and personal development
- the skills of forming educational material, lecturing, readiness to

teach in higher education and leadership of research works (R&D) of students, the ability to present educational material in oral, written and graphic form for various contingents of listeners.

3. SCOPE OF THE DISCIPLINE

The total workload of scientific research is 4 credits.

Table 4.1. Types of academic activities by periods of mastering the postgraduate program

Type of activity		**Total,** academic hours	**Course**			
			1	**2**	**3**	
In-class learning (total, hours)		*60*		*60*		
Including:						
Lectures (L)		30		30		
Laboratory tasks (LT)		30		30		
Practical classes (PC)/ Seminars (S)						
Self-study, academic hours		*48*		*48*		
Control (exam/pass credit), academic hours		*36*		*36*		
Total workload	*academic hours*	**144**		**144**		
	credits	**4**		**4**		

5. CONTENTS OF THE DISCIPLINE

Table 5.1. The content of the discipline (module) by types of academic work

Name of the discipline section	**Contents of the section**	**Type of study activity***
Section 1. Introduction to Biochemistry.	Topic 1.1. Introductory conversation. The subject, tasks and main directions of biological chemistry. The history of the development of biochemistry in Russia and in the world.	L, LT
	Topic 1.2. Basic chemical components of living systems. Structures and properties of chemical compounds. Structure and functions of the main classes of biomolecules.	L, LT
Section 2. Proteins: structure, properties, functions.	Topic 2.1. The concept of the structure of proteins. Amino acids are monomers of protein molecules and peptides. Proteinogenic amino acids. Classification of amino acids. Structure and physico-chemical properties of amino acids. Biologically active peptides	L, LT
	Topic 2.2. Structural and functional diversity of proteins. The structure of proteins. Chaperones and protein folding. Degradation of proteins. Site-directed mutagenesis. Physico-chemical properties of proteins. Methods of protein research. Classification of proteins (simple and complex proteins). The relationship of the structure of proteins with their function. Simple proteins. Structural features of connective tissue proteins	L, LT
	Topic 2.3. Conjugated (complex) proteins: nucleoproteins, chromoproteins,	L, LT

	phosphoproteins, glycoproteins, proteoglycans, lipoproteins, metalloproteins, complex proteins-enzymes. Features of their chemical structure and biological role.	
Section 3. Nucleic acids. Nucleoproteins: their role in the phenomena of heredity.	Topic 3.1. General characteristics of protein and polynucleotide components. The structure, 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. The biological role of nucleotides. Structure and functions of ATP	L, LT
	Topic 3.2. Nucleoproteins: levels of structural organization, role in the phenomena of heredity.	L, LT
Section 4. Enzymes and biological catalysis	Topic 4.1. Fundamentals of biocatalysis. Features of enzymes as biocatalysts. The active center, its structure. Coenzymes-the concept of their functional role and chemical diversity. Classification and nomenclature of enzymes.	L, LT
	Topic 4.2. 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. Reversible inhibition of enzymes as a mechanism of action of most drugs. The use of enzymes in medicine. Isoenzymes, their role in enzyme diagnostics. Immobilized enzymes. Multi-enzyme complexes.	L, LT
Section 5. Trace elements and vitamins	Topic 5.1. Exchange of trace elements. Features of the exchange of iron, copper, zinc, magnesium, manganese, molybdenum, chromium, cobalt, iodine, selenium, fluorine and silicon.	L, LT
	Topic 5.2. Vitamins as important factors of human nutrition. Sources of vitamins in nature. The chemical nature of vitamins, the patterns of hypo - and hypervitaminosis in the body. Classification and daily requirement for 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. Fat-soluble vitamins: A, D, E, K. The functional role of coenzymes.	L, LT
Section 6. Molecular mechanisms of regulation and self-	Topic 6.1. Ways of signal transmission in a cell. Receptors. Secondary intermediaries. Hormones are the coordinators of biochemical processes. Subordination of the endocrine	L, LT

regulation	organs. The chemical structure of hormones, their physiological effect. The main approaches to the classification of hormones. The mechanism of hormonal signal transmission to cells. The effect of hormones on metabolism. Chemical classification of hormones.	
	Topic 6.2. The effect of hormones on metabolism. Chemical classification of hormones. Hormones are derivatives of amino acids (formulas and characteristics). Adrenaline, norepinephrine, thyroxine, triiodothyronine. Synthesis of iodothyronines. Peptide hormones. adrenocorticotropic hormone (ACTH), somatotropic hormone (STH), thyroid-stimulating hormone (TSH), lactotropic hormone (prolactin, PLH), luteinizing hormone (LH), follicle-stimulating hormone (FSH), melanocyte-stimulating hormone (MSH), antidiuretic hormone (ADH, vasopressin), oxytocin, calcitonin, parathyroid hormone, insulin, glucagon.	L, LT
	Topic 6.3. Steroid hormones (formulas and characteristics). Cortisol, aldosterone, estradiol, progesterone, testosterone, calcitriol. Features of the synthesis of steroid hormones. Disorders of hormonal metabolism. Diabetes insipidus. Syndrome of inadequate secretion of ADH. Pituitary nanism. Acromegaly. Osteoporosis. Hypothyroidism, hyperthyroidism. Hypoparathyroidism, hyperparathyroidism. States of excess and deficiency of insulin. States of excess and deficiency of catecholamines. Addison's disease and Nelson's syndrome. Itsenko-Cushing syndrome. Adrenal insufficiency. Conn's syndrome. Hypogonadism. Deficiency and excess of androgens and estrogens.	L, LT
Section 7. Carbohydrate metabolism	Topic 7.1. The biological role of carbohydrates. Classification of carbohydrates. Digestion of carbohydrates in the gastrointestinal tract; 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). Regulation and output of glycolysis energy.	L, LT
	Topic 7.2. Glycogen breakdown (glycogenolysis). Glycogenolysis energy output. Glycogen synthesis (glycogenesis).	L, LT

	Hormonal regulation of glycogen breakdown and synthesis. The role of cAMP in glycogenolysis. Features of carbohydrate metabolism in muscles and liver.	
	Topic 7.3. Gluconeogenesis. Sources for glucose synthesis. Stages of gluconeogenesis and its regulation, energy costs of gluconeogenesis. The Measles cycle. Aerobic carbohydrate metabolism. The Pasteur Effect	L, LT
	Topic 7.4. Aerobic oxidation of glucose. Oxidative decarboxylation of pyruvic acid. The Krebs tricarboxylic acid cycle and its relation to biological oxidation. A multi-enzyme complex of oxidative decarboxylation of α-keto acids. Regulation of aerobic glucose oxidation and energy production.	L, LT
	Topic 7.5. Biological oxidation Basic principles and regulation of metabolism. Common pathways of catabolism. Sources of pyruvate and ways of its use. Oxidative decarboxylation of pyruvate. The central role of acetyl-CoA in metabolic processes. Biological oxidation (tissue respiration) as a set of redox processes involving oxygen. Respiratory chain. Coenzyme functions of vitamins PP and B2. Nicotinamide and flavin dehydrogenases as the initial links of the respiratory chain. Shuttle transfer of hydrogen to mitochondria: glycerophosphate and malate-aspartate systems. Separation of respiration and phosphorylation. Substrates and energy efficiency of these systems. Substrate phosphorylation. Respiratory control.	L, LT
	Topic 7.6. The pentose phosphate pathway of glucose oxidation in various tissues. The consequences of thiamine deficiency in the body. Features of carbohydrate metabolism in erythrocytes. Glucose-6-phosphate dehydrogenase, NADPH, glutathione and medicinal hemolytic anemia. Disorders of carbohydrate metabolism. Disorders of glycogen metabolism (glycogenoses), disorders of fructose and galactose metabolism. Diabetes mellitus.	L, LT
Section 8. Lipid metabolism	Topic 8.1. Lipids: structure, properties, functions. Biological membranes Classification of lipids. The main representatives of various classes of lipids. Glycerolipids. Sphingolipids. Cholesterol and its derivatives. Fat-soluble vitamins and their transport. Arachidonic acid and its derivatives	L, LT

	(eicosanoids). Prostaglandins, prostacyclines, leukotrienes and thromboxanes. Biological cell membranes. Lipids of cell membranes.	
	Topic 8.2. Lipid metabolism. Digestion, features of lipid absorption and transport. Cleavage and resynthesis of triacylglycerols. Transformations of glycerin. Lipoproteins: functions and role in the development of atherosclerosis.	L, LT
	Topic 8.3. β-oxidation of fatty acids in mitochondria. Ketone bodies. Biosynthesis of fatty acids and phospholipids in various tissues.	L, LT
	Topic 8.4. Cholesterol biosynthesis. The central role of CoA in lipid metabolism. The relationship between fat and carbohydrate metabolism. Regulation and pathology of lipid metabolism. Bioeffective role of various representatives of the lipid class. Quantitative determination of cholesterol in blood serum.	L, LT
	Topic 8.5. Microsomal lipid oxidation. The role of cytochrome P450 in the neutralization of xenobiotics. The system of microsomal oxidation of xenobiotics. Reactive oxygen species. The sources of their formation and their role in metabolic processes. The role of lipid peroxidation as a factor initiating the renewal of hydrophobic cellular structures. A brief description of the enzymatic (catalase, peroxidase, superoxide dismutase) and non-enzymatic links of antioxidant protection.	L, LT
Section 9. Metabolism of simple proteins and amino acids.	Topic 9.1. Biochemical significance of proteins. The usefulness of protein nutrition. Norms of protein in the diet. Exogenous and endogenous pools of amino acids. The rate of renewal of individual body proteins. Digestion of proteins in the gastrointestinal tract; enzymes involved in the digestion of proteins. Proteolysis. General characteristics and classification of proteinases. Diagnostic value of the analysis of the contents of gastric juice and duodenum.	L, LT
	Topic 9.2. Catabolism of amino acids: 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.	L, LT

	Topic 9.3. Neutralization of ammonia 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	L, LT
	Topic 9.4. Specific ways of exchanging individual amino acids: glycine and serine metabolism, exchange of sulfur-containing amino acids: exchange of cysteine, methionine, phenylalanine and tyrosine, tryptophan exchange, histidine exchange, exchange of dicarboxylic amino acids and their amides, exchange of branched chain amino acids. Transformations of nitrogen-free amino acid residue. Glycogenic and ketogenic amino acids. Pathology of protein and amino acid metabolism: homocystinuria, phenylketonuria types I and II, alkaptonuria, albinism, Hartnup's disease, histidinemia, maple syrup disease.	L, LT
Section 10. Exchange of complex proteins	Topic 10.1. Synthesis and decay of heme. Iron metabolism. Bilirubin is the main human bile pigment.	L, LT
	Topic 10.2. Cleavage and synthesis of nucleotides in the body. The role of xanthine oxidase. Uric acid as the final product of the breakdown of purine nucleotides. Violation of purine nucleotide metabolism (gout, Lesh-Nihan syndrome).	L, LT
	Topic 10.3. Biosynthesis of nucleic acids and proteins. Replication, recovery, transcription. The role of biochemical research in medicine and the use of DNA technologies.	L, LT
Section 11. Biochemistry of tissues and organs	Topic 11.1. Blood biochemistry Blood as an 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 enzyme. Non-protein organic plasma components. Mineral components of blood. The blood clotting system. The participation of blood components in the mechanisms of immune defense. Regulation of vascular tone by vasoactive peptides. Respiratory function of the blood. Blood plasma buffer systems.	L, LT
	Topic 11.2. Liver biochemistry. Features of the metabolism of carbohydrates, lipids and proteins in hepatocytes. Neutralizing liver	L, LT

	function. Biotransformation of xenobiotics.	
	Topic 11.3. Biochemistry of connective tissue A variety of connective tissue. Elastic fibers. Catabolism of collagen and elastin. Cartilage as a special variant of connective tissue. Biochemistry of mineralized tissues Cellular elements of bone tissue. The composition of collagen fibers of bone tissue.	L, LT
	Topic 11.4. Biochemistry of nervous tissue Cellular elements of nervous tissue; brief description of neurons, neuroglia and microglia. The most important mediators of nerve impulses and their receptors are neuropeptides. pathology.	L, LT
	Topic 11.5. Biochemistry of muscles Transformation of chemical energy into energy of mechanical movement. Proteins of myofibrils. Sarcoplasmic proteins; the role of myoglobin. Mechanisms of muscle contraction and relaxation.	L, LT
	Topic 11.6. Biochemistry of kidneys and urine Kidneys as the main organ of excretion of final metabolites. Clearance (purification) of the blood plasma component as an indicator of the effectiveness of its excretion by the kidneys. The process of urine formation. Criteria for evaluating glomerular filtration. Molecular mechanisms of reabsorption and secretion in renal tubules. Normal and pathological components of blood and urine	L, LT
	Topic 11.7. Fundamentals of clinical biochemistry and medical enzymology Fundamentals of clinical laboratory diagnostics. Biochemical diagnostics of bone tissue diseases, myocardial infarction, liver diseases, etc. Methods of studying the hemostasis system.	L, LT

6. MATERIAL AND TECHNICAL SUPPORT OF THE DISCIPLINE

Table 6.1. Material and technical support of the discipline

Auditorium type	**Equipment the audience**	**Specialized educational/laboratory equipment, software and materials for the development of the discipline (if necessary)**
Lecture hall	An auditorium for conducting lecture-type classes, equipped with a set of specialized furniture; a board (screen) and technical means of multimedia	A set of specialized furniture; technical means: a multimedia projector, a computer, a white magnetic board, a set of markers for the board, a set of educational

Auditorium type	Equipment the audience	Specialized educational/laboratory equipment, software and materials for the development of the discipline (if necessary)
	presentations. Hall No. 1 for 300 seats, Hall No. 2 for 300 seats, Hall No. 3 for 50 seats, RUDN Medical Institute, 117198, Moscow, Miklukho-Maklaya str., 8	presentations, educational posters and tables. Software: Microsoft products (OS, office application package, including MS Office/ Office 365, Teams, Skype.
Specialized audience	An auditorium for laboratory work, individual consultations, routine monitoring and interim certification, equipped with a set of specialized furniture and equipment. Auditoriums 329, 334, 336, RUDN Medical Institute, 117198, Moscow, Miklukho-Maklaya str., 8.	Multimedia projectors and motorized screens NEC V 260X Projector, Motorized Screen for Master Control Projector 203X203. 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
Educational and Scientific Laboratory	Laboratory of Molecular Biological and Biochemical Research Methods. Audiences 201, 316, 318, 319, 339, RUDN Medical Institute, 117198, Moscow, Miklukho-Maklaya str., 8	Pestle microbiological homogenizer Vilitek 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 x12ml vials) 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

Auditorium type	Equipment the audience	Specialized educational/laboratory equipment, software and materials for the development of the discipline (if necessary)
		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, 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

Auditorium type	Equipment the audience	Specialized educational/laboratory equipment, software and materials for the development of the discipline (if necessary)
		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. Auditorium 203, 339, RUDN Medical Institute, 117198, Moscow, Miklukho-Maklaya str., 8	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

7. EDUCATIONAL, METHODOLOGICAL AND INFORMATIONAL SUPPORT OF THE DISCIPLINE

Basic literature:

1. Berezov T.T., Korovkin B.F. Biological chemistry: Textbook for universities. - 3rd ed., stereotype. - M. : Medicine, 2012, 2008, 2004. - 704 p

. 2. Biochemistry with exercises and tasks [Electronic resource]: Textbook for universities. - Edited by E.S. Severin. - M. : GEOTAR-Media, 2010. - 384 p.

3. Biochemistry with exercises and tasks [Electronic resource]: Textbook. – Edited by A.I. Glukhov, E.S. Severin. – M. : GEOTAR-Media, 2019. - 384 p.

4. Biochemistry [Electronic resource]: Textbook. - Edited by E.S. Severin. - 5th ed., ispr. and add. - M. : GEOTAR-Media, 2016. - 768 p.

5. Severin S.E., Aleynikova T.L. Biological chemistry: Textbook for universities. - 3rd ed., ispr. - M. : Medical Information Agency, 2017. - 496 p

. 6. Biochemistry [Text/electronic resource]: A workshop for students of the specialties "Medicine" and "Pharmacy". - N.N. Chernov, T.T. Berezov, E.V. Lukasheva, etc. - Rostov-on-Don : Phoenix, 2017. - 205 p.

7. Lukasheva E.V., Chernov N.N. Enzymes: An educational and methodological guide for students of medical universities. - M. : Publishing House of RUDN, 2011. - 37 p.

8. Biochemistry: A guide to practical classes [Text/electronic resource]: Textbook for universities / Edited by N.N.Chernov. - M. : GEOTAR-Media, 2009. - 240 p.

9. Baynes J.W., Dominiczac M.H. Medical Biochemistry. - Fifth Edition ; Book in English. - London : Elsevier, 2019. - 682 p.

10. Finkelstein, A.V. Physics of protein molecules / A.V. Finkelstein. - Moscow ; Izhevsk : Izhevsk Institute of Computer Research, 2014. - 423 p. - ISBN 978-5-4344-0193-7 ; The same [Electronic resource]. - URL: http://biblioclub.ru/index.php?page=book&id=469608 (17.09.2018)

11. Medical enzymology : practicum / author-comp. S.F. Andrusenko, E.V. Denisova ; Ministry of Education and Science of the Russian Federation, Federal State Autonomous Educational Institution of Higher Education "North Caucasus Federal University". -

Stavropol : NCFU, 2018. - 145 p. : ill. - Bibliogr. in the book; The same [Electronic resource]. - URL: http://biblioclub.ru/index.php?page=book&id=563155 (07.08.2019).
12. Clinical biochemistry/ Edited by V.A. Tkachuk.- 3rd ed. - Moscow: GEOTAR-Media, 2008.- 512 p..
13. Clinical Biochemistry [Electronic resource] // Journal of Grodno State Medical University. 2018. No.16:16. ISSN 22218785 URL: http://search.ebscohost.com/login.aspx?direct=true&db=asn&AN=128927341&site=eds-live
14. Mikhailov, S.S. Biochemistry of motor activity : textbook / S.S. Mikhailov. - 6th ed., supplement. - Moscow : Sport, 2016. - 296 p. : ill. - ISBN 978-5-906839-41-1 ; The same [Electronic resource]. - URL: http://biblioclub.ru/index.php?page=book&id=454250 (16.02.2019).
15. Shautsukova L. Z. System of blood group AB0. Genetics, Biochemistry, Physiology // News of higher educational institutions. The North Caucasus region. Natural sciences. 2010. Issue 2, pp.131-133
16. Plakunov, V.K. Fundamentals of dynamic biochemistry : textbook / V.K. Plakunov, Yu.A. Nikolaev. - Moscow: Logos, 2010. - 216 p. - (New University Library). - ISBN 978-5-98704-493-3 ; The same [Electronic resource]. - URL: http://biblioclub.ru/index.php?page=book&id=84985 (17.09.2018).
17. Biochemistry and molecular biology : educational and methodological manual / Ministry of Education and Science of the Russian Federation, Federal State Autonomous Educational Institution of Higher Professional Education "North Caucasus Federal University" ; author-comp. S.F. Andrusenko, E.V. Denisenko. - Stavropol : NCFU, 2015. - 94 p. : Table. - Bibliogr. in the book; The same [Electronic resource]. - URL: http://biblioclub.ru/index.php?page=book&id=457873 (17.09.2018).
18. Kanyukov, V.N. Vitamins : textbook / V.N. Kanyukov, A.D. Strekalovskaya, T.A. Saneeva ; Ministry of Education and Science of the Russian Federation. - Orenburg : Orenburg State University, 2012. - 108 p. : ill., tab. - Bibliogr. in the book; The same [Electronic resource]. - URL: http://biblioclub.ru/index.php?page=book&id=258836 (17.09.2018)
19. Grishchenkova, T.N. Nucleic acids : textbook / T.N. Grishchenkova, T.V. Chuikova, E.A. Shcherbakova ; Ministry of Education and Science of the Russian Federation, Kemerovo State University. - Kemerovo : Kemerovo State University, 2009. - 90 p. - ISBN 978-5-8353-0903-0 ; The same [Electronic resource]. - URL: http://biblioclub.ru/index.php?page=book&id=232492 (16.01.2019).
20. Biological chemistry : textbook / A.D. Taganovich, E.I. Oletsky, N.Yu. Konevalova, V.V. Lelevich ; ed. A.D. Taganovich. - 2nd ed., ispr. - Minsk : Higher School, 2016. - 672 p. : ill. - Bibliogr.: p. 654. - ISBN 978-985-06-2703-2 ; The same [Electronic resource]. - URL: http://biblioclub.ru/index.php?page=book&id=235731 (28.06.2019).
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https://dspace.cuni.cz/bitstream/handle/20.500.11956/111493/Clinical_biochemistry-pdf.pdf
25. 978-953-51-3967-6. Evolutionary Physiology and Biochemistry - Advances and Perspectives [Electronic resource] 2018. 1 p. ISBN 9789535138570 URL:
https://www.intechopen.com/books/evolutionary-physiology-and-biochemistry-advances-and-perspectives
26. Viduranga Waisundara. Biochemistry and Health Benefits of Fatty Acids [Electronic resource] 2018. 1 p. ISBN 9781789848724 URL:
https://www.intechopen.com/books/biochemistry-and-health-benefits-of-fatty-acids
27. Biochemistry Laboratory Manual For Undergraduates : An Inquiry-Based Approach [Electronic resource] / Timea Gerczei Fernandez [et al.]. 2015. ISBN 9783110411324 URL:
http://search.ebscohost.com/login.aspx?direct=true&db=e001mww&AN=1805212&site=eds-live
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Additional literature:

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2. 13. Principles of Medical Biochemistry 2nd ed./ Gerhard Meisenberg, William H. Simmons. - Mosby Elsevier, 2006.
3. 14. Biochemistry 8th ed./ J. M. Berg, J. L. Tymoczko, G. J. Gatto, Jr. L. Stryer. - W. H. Freeman and Company, 2015.
4. 15. Harper's Illustrated Biochemistry 30th ed./ Victor W. Rodwell, David A. Bender, Kathleen M. Botham, Peter J. Kennelly, P. Anthony Weil / McGraw-Hill Education, 2015.r, Kathleen M. Botham, Peter J. Kennelly, P. Anthony Weil / McGraw-Hill Education, 2015.
5. Novikov V. E., Katunina N. P. Pharmacology and biochemistry of hypoxia // Reviews on clinical pharmacology and drug therapy. 2002. Issue 2 Volume 1, pp.73-87
6. Rusova Tatiana Vasilyevna, Baytov Vladislav Sergeevich Biochemistry of synovial fluid proteoglycans in the dynamics of osteoarthritis development // Genius of orthopedics. 2009. Issue 3, pp.41-44
7. Fomina, M.V. Pharmaceutical biochemistry. Educational and methodical manual : textbook / M.V. Fomina, E.V. Bibartseva, O.Ya. Sokolova ; Ministry of Education and Science of the Russian Federation. - Orenburg : OSU, 2015. - 109 p. : Table. - Bibliogr.: p. 99. - ISBN 978-5-7410-1303-8 ; The same [Electronic resource]. - URL: http://biblioclub.ru/index.php?page=book&id=438993 (17.09.2018).
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Resources of the Internet information and telecommunication network:

1. EBS 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
- EBS "University Library online" http://www.biblioclub.ru

- ABS Yurayt http://www.biblio-online.ru
- EBS "Student Consultant" www.studentlibrary.ru
- EBS "Doe" http://e.lanbook.com/
- EBS "Trinity Bridge"

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/

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

1. A course of lectures on the discipline "Biochemistry Molecular mechanisms of cancer".
2. Methodological guidelines for performing practical tasks in the discipline "Molecular mechanisms of cancer".
3. Methodological guidelines for independent work in the discipline "Biochemistry Molecular mechanisms of cancer".

** - all teaching materials for independent work of students are placed in accordance with the current procedure on the discipline page in the TEIS!*

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

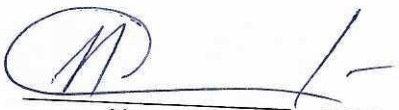
Evaluation materials and a score-rating system for assessing the development of the discipline Biochemistry Molecular mechanisms of cancer are presented in the Appendix to this Work Program of the discipline.

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

DEVELOPERS:

Head of the Department of Biochemistry		V.S. Pokrovsky
Post, Department	Signature	Name
Associate Professor of the Department of Biochemistry		E.V. Neborak
Post, Department	Signature	Name

HEAD OF THE DEPARTMENT:

Department of Biochemistry		V.S. Pokrovsky
Name of the Department	Signature	Name