Federal State Autonomous Educational Institution of Higher Education
PEOPLES' FRIENDSHIP UNIVERSITY OF RUSSIA
NAMED AFTER PATRICE LUMUMBA
RUDN University

Institute of Medicine

educational division (faculty/institute/academy) as higher education programme developer

COURSE SYLLABUS

BIOORGANIC CHEMISTRY

course title

Recommended by the Didactic Council for the Education Field:

31.05.01 General Medicine

field of studies / speciality code and title

The course instruction is implemented within the professional education programme of higher education:

General medicine

higher education programme profile/specialisation title

2026

1. COURSE GOAL(s)

The discipline “Bioorganic chemistry” is included in the program of the specialty “General Medicine” in the direction 31.05.01 “General Medicine” and is studied in the 2nd semester of the 1st year. The discipline is implemented by the Department of Organic Chemistry. The discipline consists of 5 sections and 14 topics and is aimed at studying the structure and reactivity of the main classes of organic compounds involved in biochemical processes.

The course goal is to form a system of knowledge about the laws in the chemical behavior of the main classes of organic compounds in relation to their structure in order to use this knowledge as a basis for study at the molecular level, the processes occurring in the living organisms.

2. REQUIREMENTS FOR LEARNING OUTCOMES

Mastering the discipline "Bioorganic Chemistry" is aimed at developing the following competencies (parts of competencies) among students: GC-1, GPC-3, GPC-4, GPC-5

Table 2.1. List of competences that students acquire during the course

Competence code	**Competence descriptor**	**Competence formation indicators** (within this course)
GC-1	Ability to carry out a critical analysis of problematic situations based on a systematic approach, develop a strategy for action	GC-1.1. Ability to analyze scientific and technical literature and regulatory documentation of medical organizations;
GPC-3	Ability to counter doping in sports and fight against it	GPC-3.2 Ability to analyze biochemical, physical and chemical, and molecular and biological mechanisms of the development of pathological processes in the cells of the athlete’s body tissues when taking prohibited drugs; defining the principles of the biochemical processes when taking illegal drugs.
GPC-4	Ability to use medical devices provided for in the order of medical care, as well as to conduct examinations of the patient in order to establish a diagnosis	GPC-4.2. Ability to evaluate the effectiveness and safety of the use of medical devices
GPC-5	Ability to assess morphofunctional, physiological conditions and pathological processes in the human body to solve professional problems	GPC-5.2. Ability to evaluate the results of clinical, laboratory and functional diagnostics in solving professional tasks

3.COURSE IN HIGHER EDUCATION PROGRAMME STRUCTURE

The course refers to the core/variable/elective component of (B1) block of the higher educational programme curriculum.*

- \- Underline whatever applicable.

Within the higher education programme students also master other (modules) and / or internships that contribute to the achievement of the expected learning outcomes as results of the course study.

Table 3.1. The list of the higher education programme components/disciplines that contribute to the achievement of the expected learning outcomes as the course study results

Competence code	Competence descriptor	Previous courses/modules*	Subsequent courses/modules*
GC-1	Ability to carry out a critical analysis of problematic situations based on a systematic approach, develop a strategy for action	Philosophy Mathematics Chemistry Physics	Hygiene; Public health and healthcare, economics of health care; Epidemiology; Propaedeutics of internal diseases; Evidence-based medicine; History of medicine; Clinical Pharmacology; Economy
GPC-3	Ability to counter doping in sports and fight against it	Chemistry; Applied physical education;	Medical rehabilitation; Pharmacology; Clinical Pharmacology; Physical Culture; Applied physical education;

GPC-4	Ability to use medical devices provided for in the order of medical care, as well as to conduct examinations of the patient in order to establish a diagnosis	Physics; Chemistry; Introductory practice for obtaining primary professional skills: patient care (simulation center); Introductory practice on obtaining primary professional skills: patient care;	General Surgery; Neurology, medical genetics, neurosurgery; Endocrinology; Anesthesiology, resuscitation, intensive care; Radiation diagnostics; Traumatology, orthopedics; General medical skills; Urgent conditions; Biotechnology; Topographic anatomy and operative surgery; Hospital surgery, pediatric surgery; Oncology, radiation therapy; Experimental oncology; Pharmacology; The practice of emergency medical procedures (simulation center);

Competence code	Competence descriptor	Previous courses/modules, internships*	Subsequent courses/modules, internships*
			Practice of diagnostic profile: assistant ward nurse; The practice of obtaining Primary professional skills and Professional experience: assistant to a procedural nurse;
GPC-5	Ability to assess morphofunctional, physiological conditions and pathological processes in the human body to solve professional problems	Chemistry	Biochemistry; Normal physiology; General Surgery; Obstetrics and gynecology; Biology; Microbiology, virology; Oncology, radiation therapy; Pathophysiology, clinical pathophysiology; Molecular genetic methods; Methods of microbiological diagnosis; Propaedeutics of internal diseases; Immunology; Pathological anatomy, clinical pathological anatomy; Radiation diagnostics; Medical Elementology; Phthisiology; Anesthesiology, intensive care, intensive care; Ophthalmology; Methods of cell biology and histology; Pharmacology; Anatomy; Histology, embryology, cytology; Topographic anatomy and operative surgery; Forensic medicine; Maxillofacial surgery; Medical forensics; Otorhinolaryngology; Pediatrics; Sectional course

* To be filled in according with the competence matrix of the higher education programme.

4. COURSE WORKLOAD AND ACADEMIC ACTIVITIES

The total workload of the course is 2 credits (72 academic hours).

Table 4.1. Types of academic activities during the periods of higher education

*programme mastering (**full-time training**)**

Type of academic activities		Total academic hours	Semesters/training modules			
			2			
Contact work ac.h.		*68*	***68***			
including:						
Lectures (**LC**)		-	**-**			
Lab Works (**LW**)		68	**68**			
Seminars (**S**)		-	**-**			
Self-study, *ac.h.*		*4*	***4***			
Evaluation and assessment (exam or pass/fail grading), ac.h.		-	**-**			
Total labor intensity	**ac.h.**	**72**	**72**			
	credit	**2**	**2**			

5. COURSE CONTENTS

Table 5.1. The course content by type of academic programme

Course module title	**Course module contents (topics)**	**Academic activities types**
Section 1. Introduction. Hydrocarbons.	1.1. Introduction. Setting goals for the study of Bioorganic chemistry. Demonstration of the interdisciplinary nature of the discipline being studied, formed on the scientific basis of organic chemistry and biology. Familiarization with the basics of the structure and reactivity of organic compounds: the structure of the carbon atom, hybridization of orbitals, the concept of a covalent chemical bond, the properties of a chemical bond, the mutual influence of atoms in a molecule. Familiarization with the classification and nomenclature of organic substances. Formation of skills for applying the rules of nomenclature.	LW
	1.2. Familiarization with the reactivity of hydrocarbons - alkanes, alkenes, alkynes, dienes and arenes. Radical substitution reactions in alkanes. Electrophilic addition reactions in alkenes, alkynes and dienes. Oxidation reactions. The acidity of terminal alkynes. Polymerization reactions. Electrophilic substitution reactions in arenes. Reactivity of substituted benzenes. Formation of practical skills for detecting multiple bonds in an analyzed object. Practical demonstration of the chemical stability of alkanes and	LW

Course module title	Course module contents (topics)	Academic activities types
Section 2. Functional classes of organic compounds.	arenes.	
	2.1. Familiarization with the chemical properties of alcohols (monoatomic and polyatomic), phenols and thiols. The effect of hydrogen bonding on the physical properties of substances. Demonstration of acidic, nucleophilic properties of these classes of compounds (preparation of alcoholates, phenolates, thiolates, esters and ethers, sulfides, thioesters, sulfonium salts). Reactions of electrophilic aromatic substitution of phenols. The biological role of sulfonium salts and thioesters. The use of alcohols to produce halogen derivatives, alkenes. Oxidation of alcohols and thiols, with emphasis on the biological significance of such processes. Formation of practical skills in detecting alcohols and phenols by chemical methods, obtaining esters, practical demonstration of the acidic properties of alcohols and phenols, demonstration of the dependence of the solubility of alcohols on the structure.	LW
	2.2. Familiarization with the chemical properties of aliphatic and aromatic amines, amino alcohols, aminophenols and their biological properties. Demonstration of the basic and nucleophilic properties of amines – formation of ammonium salts, quaternary ammonium salts, amides. Oxidation of amines. Practical and biological significance of reactions of amines with nitrous acid, carcinogenicity of nitrosamines.	LW
	2.3 Familiarization with the chemical properties of aldehydes and ketones. Nucleophilic addition, formation of Schiff bases, oximes, hydrazones, semicarbazones, oxidation, reduction (including enzymatic), reactions at the α-position. Formation of practical skills in detecting aldehydes and ketones by chemical methods.	LW

Course module title	Course module contents (topics)	Academic activities types
	2.4. Familiarization with the structure and chemical properties of carboxylic acids. Dissociation of carboxylic acids. Formation of derivatives of carboxylic acids: salts, halogen anhydrides, anhydrides, amides, nitriles and esters, studying their properties. Biologically significant dibasic carboxylic acids: oxalic, malonic, succinic, glutaric and adipic, the behavior of these acids when heated. Fumaric and maleic acids. Formation of practical skills for the detection of oxalic acid in the form of calcium oxalate.	LW
	2.5. Lipids – classification, structure, physical properties, biological role. Simple and complex lipids, steroids. Practical study of the structure of fats and oils by hydrolysis and the use of previously acquired skills to identify hydrolysis products. The use of previously acquired practical skills to prove the unsaturated nature of biologically significant fatty acids. The study of the solubility of fats and oils.	LW
	2.6. Fundamentals of stereochemistry. Demonstration of the basic concepts of stereochemistry – asymmetric carbon atom, configuration, chirality, chiral center, enantiomers, optical activity, specific rotation, racemate. Formation of practical skills in depicting structural formulas of chiral molecules on a plane using Fischer projection formulas and stereochemical wedge-shaped projections, as well as establishing absolute and relative configurations by R-S and D-L systems.	LW
	2.7. Familiarization with the structure and chemical properties of hydroxy acids, participants of metabolism – lactic, malic, β-hydroxybutyric, citric acid and isocitric acid. Salicylic acid and its biologically active derivatives. Formation of practical skills in the detection of lactic acid by chemical method. The use of previously acquired skills to study the structure and properties of salicylic acid, as well as its derivatives. Practical study of the chemical properties of tartaric acid and the establishment of the structure of citric acid.	LW

Course module title	Course module contents (topics)	Academic activities types
Section 3. Biopolymers (proteins, carbohydrates) and their structural components.	2.8. Familiarization with the chemical properties of aldehyde- and ketoacids. The structure and properties of ketoacids, participants in metabolism - pyruvic, α-ketoglutaric, oxalic acid, acetoacetic acid. Formation of ketoacids in the body from amino acids (elimination-dehydration, oxidative deamination) and hydroxy acids.	LW
	3.1. Familiarization with the structure and chemical properties of amino acids. Optical isomerism of amino acids. Biologically important reactions: deamination, decarboxylation, (formation of colamine, histamine, tryptamine). Peptides and proteins. Hydrolysis of peptides. Chemical synthesis of dipeptides. The concept of complex proteins: glycoproteins, lipoproteins, nucleoproteins, phosphoproteins. Practical demonstration of the amphoteric nature of amino acids. Formation of practical skills in the detection of amino acids and proteins by chemical methods.	LW
	3.2. Familiarization with the structure and chemical properties of monosaccharides (glucose, mannose, galactose, fructose, ribose, 2-deoxyribose). Oxidation and reduction reactions, production of glycosides. Types of glycosides, biological role. Acylation and alkylation reactions. The practical importance of obtaining ozones. Formation of the practical skill of depicting the structural formulas of carbohydrates using Fischer projection formulas and perspective Haworth presentation. Stereochemistry of carbohydrates, the concept of mutarotation. Establishing spatial relationships between different types of stereoisomers monosaccharides – demonstration of the concepts of enantiomer, diastereomer, epimer, anomer. Familiarization with the chemical properties and structure of disaccharides using the example of maltose, lactose, cellobiose and sucrose. The dependence of the properties of disaccharides on the type of bond between monosaccharide residues. Hydrolysis of disaccharides. Familiarization with the chemical properties and structure of polysaccharides using the example of starch and cellulose. The biological significance of	LW

Course module title	Course module contents (topics)	Academic activities types
	carbohydrates. Formation of practical skills for the detection of reducing sugars, starch. Familiarization with the structure and biological functions of heteropolysaccharides: chondroitin sulfate, heparin, hyaluronic acid.	
Section 4. Biologically important heterocycles	4.1. Familiarization with the main classes of biologically significant heterocyclic compounds: five-membered heterocycles with one (pyrrole, thiophene, furan) and two heteroatoms (imidazole, pyrazole, thiazole); six-membered heterocycles with one and two heteroatoms (pyridine, pyrimidine); fused heterocycles (indole, purine, pteridine, isoalloxazine, flavin). The structure of porphine and heme. Basic and nucleophilic properties of pyridine. Pyridine derivatives - nicotinic acid and its amide (vitamin PP). Isonicotinic acid, pyridoxal. Tautomerism of imidazole. Keto-enol and lactim-lactam tautomerism on the example of uracil, thymine, cytosine, guanine, uric acid. Practical demonstration of the chemical properties of pyridine and uric acid. Practical study of the solubility of uric acid salts.	LW
Section 5. Nucleic acids and nucleotide coenzymes	5.1. Familiarization with the structure of nucleic acid monomers. Nucleosides, hydrolysis. Nucleotides, hydrolysis. RNA and DNA. The primary structure of nucleic acids. Hydrolysis. Nucleotide coenzymes of ATP, NAD^+(NADH), $NADP^+$ (NADPH), S-adenosyl methionine, acetyl coenzyme A, FAD, $FADH_2$ and their transformations in the body - phosphorylation, oxidation, reduction, methylation, acylation. The structure of cAMP, cGMP, PAPS, UDP-galactose.	LW

* - to be filled in only for **full** -time training: *LC - lectures; LW - lab work; S - seminars.*

6. CLASSROOM EQUIPMENT AND TECHNOLOGY SUPPORT REQUIREMENTS

Table 6.1. Classroom Equipment and Technology Support Requirements

Classroom for Academic Activity Type	Auditorium equipment	Specialized educational / laboratory equipment, software and materials for mastering the discipline (if necessary)

Lab-work	Auditorium for laboratory work, individual consultations, ongoing monitoring and intermediate certification, equipped with a set of specialized furniture and equipment	fume hood ШВП-4 (6 pcs.), rotary evaporator Heivalue digital G3B, rotary evaporator IKA, digital devices for determining the melting point SMP10, electronic laboratory scales AND EK-610, flask heaters MK-M of different volumes, drying cabinet PE-4610, magnetic stirrer MRHei-Mix S, magnetic stirrer with heating MRHei-Standart, refractometer, combined laboratory bath BKL, vacuum chemical station RS3001 VARIO-pro. vane-rotary vacuum pump RZ2.5, membrane chemical vacuum pump MZ2CNT, heat blower Steinel, UV lamp Spectroline EB-280C, chemical glassware, refrigerator; WI-FI

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 the EIOS.	**Faculty of Science Reading Room** Ordzhonikidze, 3. Coworking area Monday - Friday 10.00 – 22.00 **Reading room of the main building of the RUDN** Coworking area Monday - Saturday 9.00 - 23.00 Hall No. 2 Monday - Thursday 10.00 - 17.45 Friday 10.00 - 16.45 Hall No. 6 Monday - Thursday 10.00 - 17.45 Friday 10.00 - 16.45

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

7. RECOMMENDED SOURCES FOR COURSE STUDIES

Main readings:

1. Tyukavkina N.A. Organic chemistry : учебник / N.A. Tyukavkin. - Электронные текстовые данные. - Москва : ГЭОТАР-Медиа, 2022. - 592 с. - Книга на английском языке. https://lib.rudn.ru:443/MegaPro/UserEntry?Action=Link_FindDoc&id=508876&idb=0

2. Zurabyan S.E.
Fundamentals of bioorganic: textbook for medical students / S.E. Zurabyan. -. -

Moscow : GEOTAR-Media, 2019. - 304 p. : ill.. - ISBN 978-5-9704-4990-5. http://lib.rudn.ru/MegaPro/UserEntry?Action=Rudn_FindDoc&id=464603&idb=0

3. URL:
https://lib.rudn.ru/MegaPro/UserEntry?Action=Link_FindDoc&id=508876&idb=0
L. G. Voskressenky, A. V. Listratova, A. V. Varlamov. “Bioorganic Chemistry for Medicine Students. Lectures”, Moscow, Peoples’ Friendship University of Russia, 2015

Additional readings:

1. Reinhard Bruckner “Advanced Organic Chemistry” Academic Press.

2. Francis A. Carey, Richard J. Sundberg “Advanced Organic Chemistry” Springer, 2008

Internet sources:

1. Electronic libraries (EL) of RUDN University and other institutions, to which

university students have access on the basis of concluded agreements:

- RUDN Electronic Library System (RUDN ELS) http://lib.rudn.ru/MegaPro/Web
- EL "University Library Online" http://www.biblioclub.ru
- EL "Yurayt" http://www.biblio-online.ru
- EL "Student Consultant" www.studentlibrary.ru
- EL "Trinity Bridge"

2. Databases and search engines:

- electronic foundation of legal and normative-technical documentation http://docs.cntd.ru/
- Yandex search engine https:// www .yandex.ru/
- Google search engine https://www.google.ru/
- Scopus abstract database http://www.elsevierscience.ru/products/scopus/
- educational materials on bioorganic chemistry of the Chemistry Department of Moscow State University http://www.chem.msu.ru/rus/teaching/org.html

*Learning toolkits for self-studies in the RUDN LMS TUIS *:*

1. The set of lectures on the course «Bioorganic Chemistry».
2. Guidelines for laboratory works on the discipline «Bioorganic Chemistry»

* - all educational and methodological materials for independent work of students are placed in accordance with the current procedure on the page of the discipline in TUIS!

8. ASSESSMENT TOOLKIT AND GRADING SYSTEM* FOR EVALUATION OF STUDENTS' COMPETENCES LEVEL AS COURSE RESULTS

Evaluation materials and a point-rating system* to evaluate the level of competences (competences in part) formation as the course "Bioorganic Chemistry" results are presented in the Appendix to the course syllabus.

* The assessment toolkit and the grading system are formed on the basis of the requirements of the relevant local normative act of RUDN University (regulations / order).

DEVELOPERS:

Assistant of the Organic Chemistry Department		**Golubenkova A.S.**
Position, Department	Signature	Full name
The Head of Organic Chemistry Department		**Voskressensky L. G.**
Name of Department	Signature	Full name

HEAD OF EP HE:

The Head of Department of General Medical Practice		**Sturov N.V.**
Position, Department	Signature	Full name