Federal State Autonomous Educational Institution of Higher Education

PEOPLES' FRIENDSHIP UNIVERSITY OF RUSSIA

RUDN University

Medical Institute

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

COURSE SYLLABUS

CHEMISTRY

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course title

Recommended by the Didactic Council for the Education Field:

31.05.03 Dentistry

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field of studies / speciality code and title

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

Dentistry

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higher education programme profile/specialisation title

2024 г.

1. Course GOAL(s)

The course goal of the course “Chemistry” is to form of systemic knowledge about the patterns of chemical behavior of the main classes of organic compounds necessary in the study of processes occurring in a living organism at the molecular level, and the main materials used in dental practice.

2. REQUIREMENTS FOR LEARNING OUTCOMES

Mastering the discipline "Chemistry" is aimed at developing the following competencies (parts of competencies) among students:

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

Competence code	**Competence descriptor**	**Competence formation indicators** (within this course)
GC-6	Ability to identify and implement the priorities of their own activities and ways to improve them based on self-assessment and lifelong learning	GC-6.1. Ability to evaluate and control their resources and their limits (personal, situational, temporary), uses them optimally for the successful completion of the assigned task
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.

3. COURSE IN HIGHER EDUCATION PROGRAMME STRUCTURE

The course “Chemistry” refers to the variable component of (B1) block of the higher educational programme curriculum.

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

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

Competence code	Competence descriptor	Previous courses/modules, internships*	Subsequent courses/modules, internships*
GC-6	Ability to identify and implement the priorities of their own activities and ways to improve them based on self-	Chemistry of biogenic elements	Biological Chemistry Oral Biochemistry Pharmacology
Competence code	**Competence descriptor**	**Previous courses/modules, internships***	**Subsequent courses/modules, internships***
	assessment and lifelong learning		
GPC-3	Ability to counter doping in sports and fight against it	Chemistry of biogenic elements	Pharmacology

* 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 "Chemistry" is __3_ credits (_108_ academic hours).

*Table 4.1. Types of educational work by periods of mastering EP VO for **FULL-TIME EDUCATION***

Types of academic activities		Total ac.h,	Semester 2
Contact work ac.h.		*54*	*54*
Lectures (**LC**)		18	18
Lab Works (**LW**)		36	36
Seminars (**PC**)			
Self-study, *ac.h.*		*48*	*48*
Evaluation and assessment (exam or pass/fail grading), ac.h.		*6*	*6*
Total labor intensity	**ac.h.**	**108**	**108**
	ac.h.	**3**	**3**

5. COURSE CONTENTS

Table 5.1. The course content by type of academic program

Section name	Section content	Types of academic activities *

Module 1. Introduction Hydrocarbons.	Topic 1.1. Goals for studying chemistry. Demonstration of the interdisciplinary nature of the discipline under study, formed on the scientific basis of organic chemistry and biology. Acquaintance 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. Acquaintance with the classification and nomenclature of organic substances. Formation of skills in applying the rules of nomenclature.	LC
	Topic 1.2. Familiarization with the reactivity of hydrocarbons - alkanes, alkenes, alkynes, dienes and arenes. Radical substitution reactions in alkanes. Electrophilic addition reactions in alkenes,	LC, LW

Section name	**Section content**	**Types of academic activities ***
	alkynes and dienes. Oxidation reactions. Acidity of terminal alkynes. polymerization reactions. Electrophilic substitution reactions in arenes. Reactivity of substituted benzenes. Formation of practical skills for detecting multiple bonds in the analyzed object. Practical demonstration of the chemical stability of alkanes and arenes.	
Module 2. Functional organic compounds	Topic 2.1. Familiarization with the chemical properties of alcohols (monatomic 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 (obtaining alcoholates, phenolates, thiolates, esters and ethers, sulfides, thioethers, sulfonium salts). Reactions of electrophilic aromatic substitution of phenols. The biological role of sulfonium salts and thioethers. The use of alcohols to obtain halogen derivatives, alkenes. Oxidation of alcohols and thiols, with emphasis on the biological significance of such processes. Formation of practical skills for 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.	LC, LW

	Topic 2.2. Familiarization with reactivity of aliphatic and aromatic amines, aminoalcohols and their biological significance, aminophenols. Demonstration of basic and nucleophilic properties of amines – formation of ammonium salts, quaternary ammonium salts, amides. Practical and biological significance of reactions amines with nitrous acid, carcinogenicity of nitrosoamines	LC, LW
	Topic 2.3. Familiarization with reactivity of aldehydes and ketones. Nucleophilic addition, reaction with nitrogen nucleophiles, oxidation, reduction (including enzymatic), reaction via αposition Formation of practical skills for the detection of aldehydes and ketones by chemical methods.	LC, LW
	Topic 2.4. Familiarization with reactivity of carboxylic acids. Preparation of carboxylic acid derivatives and study of their properties. Biological role of carboxylic acid derivatives on the example of lipids. Biologically important dicarboxylic acids: oxalic, malonic, succinic, glutaric and adipic acids, their behavior under the heating. Practical study of structures of fats and oils via hydrolysis and the use of previously acquired skills for identification of	LC, LW

Section name	**Section content**	**Types of academic activities ***
	hydrolysis products. Formation of practical skills for the detection of oxalic acid in the form of calcium oxalates. Lipids - classification, structure, biological role. Practical study of the structure of fats and oils by hydrolysis and the application of previously acquired skills to identify hydrolysis products. Application of previously acquired practical skills to prove the non-limiting nature of biologically significant fatty acids. The study of the solubility of fats and oils.	

	Topic 2.5. Familiarization with the chemical properties of hydroxy acids. The structure and chemical transformations of hydroxy acids, participants in metabolism - lactic, malic, citric acids. Demonstration of the basic concepts of stereochemistry – asymmetric (chiral) carbon atom, configuration, chirality, chiral center, enantiomers, optical activity, specific rotation, racemate. Formation of practical skills in depicting the structural formulas of chiral molecules on a plane using Fisher projection formulas and stereochemical wedge-shaped projections, as well as establishing the absolute and relative configuration in R-S and D-L systems. Biological activity of salicylic acid and its derivatives. Formation of practical skills for the detection of lactic acid by a chemical method. Application 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.	LC, LW
	Topic 2.6. Familiarization with the chemical properties of aldehyde and keto acids. The structure and properties of keto acids, participants in metabolism - pyruvic, α-ketoglutaric, oxaloacetic acid. The formation of keto acids in the body from amino acids (cleavage-dehydration, oxidative deamination) and hydroxy acids.	LC
Module 3. Bio-polymers (proteins and carbohydrates) and their components.	Topic 3.1. Familiarization with the structure and chemical properties of proteinogenic 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. A practical demonstration of the amphoteric character of	LC, LW

Section name	**Section content**	**Types of academic activities ***
	amino acids. Formation of practical skills for the detection of amino acids and proteins by chemical methods.	

	Topic 3.2. Familiarization with the structure and chemical properties of monosaccharides (glucose, mannose, galactose, fructose, ribose, 2-deoxyribose). Oxidation and reduction reactions, formation of glycosides. Types of glycosides, biological role. Acylation and alkylation reactions. The practical significance of obtaining ozones. Formation of a practical skill in depicting the structural formulas of carbohydrates using Fisher's projection formulas and Haworth's perspective formulas. Stereochemistry of carbohydrates, concept of mutarotation. Establishment of spatial relationships between different types of stereoisomers of monosaccharides - demonstration of the concepts of enantiomer, diastereomer, epimer, anomer. Familiarization with the chemical properties and structure of disaccharides on the example of maltose, lactose, cellobiose and sucrose. Dependence of the properties of disaccharides on the type of bond between monosaccharide residues. Hydrolysis of disaccharides. Acquaintance with the chemical properties and structure of polysaccharides on the example of starch and cellulose. The biological significance of carbohydrates. Formation of practical skills in the detection of reducing sugars, starch. Acquaintance with the structure and biological functions of heteropolysaccharides: chondroitin sulfate, heparin, hyaluronic acid.	LC, LW
Module 4. Biologically important heterocycles	Topic 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); six-membered heterocycles with one and two heteroatoms (pyridine, pyrimidine); fused heterocycles (indole, purine). Reactivity of pyrrole, furan, thiophene. Reactions of electrophilic substitution. The structure of porphin and heme. Basic and nucleophilic properties of pyridine. Electrophilic substitution reactions in pyridine. Pyridine derivatives - nicotinic acid and its amide (vitamin PP). Isonicotinic acid, pyridoxal. Tautomerism of imidazole. Keto-enol and lactimlactam tautomerism on the example of uracil, thymine, cytosine, guanine, uric acid. Practical demonstration of the chemical properties of	LC, LW
Section name	**Section content**	**Types of academic activities ***
	pyridine and uric acid. Practical study of the solubility of uric acid salts.	

Module 5.. Nucleic acids. Nucleotide coenzymes.	Topic 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 AMP, ADP, ATP, NAD+, NADP, NADH+ S-adenosylmethionine, acetylcoenzyme, FAD, $FADH_2$, their transformations in the body - phosphorylation, oxidation, reduction, methylation, acylation.	LW
Module 6. Physicochemistry of macromolecular compounds.	Topic 6.1 Polymers. The concept of medical polymers. Properties of HMS solutions. Features of the dissolution of HMS s as a consequence of their structure. The shape of macromolecules. The mechanism of swelling and dissolution of the HMS. Dependence of the swelling value on various factors. Anomalous viscosity of HMS solutions. Staudinger equation. Viscosity of blood and other biological fluids. Osmotic pressure of biopolymer solutions. Polyelectrolytes. Isoelectric point and methods for its determination. Donnan membrane equilibrium. Oncotic pressure of plasma and blood serum. Stability of biopolymer solutions. Salting out biopolymers from solution. Coacervation and its role in biological systems. Gelation of HMS solutions. Jelly properties: syneresis and thixotropy.	LW

* - filled in only for full-time education: LK - lectures; LW - laboratory work; SZ - seminars.

6. CLASSROOM EQUIPMENT AND TECHNOLOGY SUPPORT REQUIREMENTS

 Table 6.1. Classroom Equipment and Technology Support Requirements

Classroom for Academic Activity Type	**Audience equipment**	**Specialized educational / laboratory equipment, software and materials for mastering the discipline** (if necessary)
Lecture room	An room for lecture-type classes, equipped with a set of specialized furniture; board (screen) and technical means of multimedia presentations.	
Laboratory room	Educational chemical laboratory for group laboratory-type classes,	a set of specialized furniture; specialized equipment of the chemical laboratory: ventilation hood cabinet

Classroom for Academic Activity Type	Audience equipment	Specialized educational / laboratory equipment, software and materials for mastering the discipline (if necessary)
	individual consultations, monitoring, intermediate certification, independent work	SHVP-4 (4 pcs.), rotary evaporator Heivalue digital G3B, rotary evaporator IKA, digital devices for determining the melting point SMP10; electronic laboratory scales AND EK-610, MK-M mantles of different sizes, drying cabinet PE-4610, magnetic stirrer MRHei-Mix S, magnetic stirrer with heating MRHei-Standart, refractometer, combined laboratory bath BKL, vacuum chemical station PC3001 VARIO-pro , circulating cooler Rotacool Mini, rotary vane vacuum pump RZ2.5, chemical membrane vacuum pump MZ2CNT, Steinel thermal blower, Spectroline EB280C UV lamp, electronic vacuum controller with CVC3000 detect Vacuumbrand valve, chemical ware, refrigerator; there is wi-fi
room for independent work of students	An room 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.	**Reading Room of Faculty of Science** Ordzhonikidze D.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 reading:

1. 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

2. Tyukavkin, N. A. Organic chemistry : textbook / Tyukavkin N. A. - Москва : ГЭОТАР-Медиа, 2022. - 592 с. - ISBN 978-5-9704-6595-0. https://lib.rudn.ru:443/MegaPro/UserEntry?Action=Link_FindDoc&id=508876&idb=0

3. L. G. Voskressenky, A. V. Listratova, A. V. Varlamov. “Bioorganic Chemistry for Medicine Students. Lectures”, Moscow, Peoples’ Friendship University of Russia, 2015

Additional reading:

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

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

3. Organic Chemistry with a Biological Emphasis, Volume I, Timothy Soderberg https://digitalcommons.morris.umn.edu/chem_facpubs/1/
4. Organic Chemistry with a Biological Emphasis, Volume II, Timothy Soderberg 5. https://digitalcommons.morris.umn.edu/chem_facpubs/2/

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 "Lan" http://e.lanbook.com/
- 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/

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

1. The set of lectures on the course « Chemistry».
2. Guidelines for laboratory works on the discipline « 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 " 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 Professor, **Organic Chemistry Department**		**Listratova A. V.**
Position, Department	Signature	Full name
HEAD OF Organic Chemistry Department		**Voskressensky L. G.**
Name of Department	Signature	Full name

HEAD OF EP HE:
Deputy Director of IM in the direction of "Dentistry" — **Razumova S.N.**

Position, Department	Signature	Full name