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**Federal State Autonomous Educational Institution of Higher Education  
PEOPLES' FRIENDSHIP UNIVERSITY OF RUSSIA named after P. Lumumba  
(RUDN University)  
Science faculty**

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

## **COURSE SYLLABUS**

**Chemistry of natural compounds**

course title

**Recommended by the Didactic Council for the Education Field of:**

**04.04.01 «Chemistry»**

field of studies / speciality code and title

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

**«Fundamental and applied chemistry»**

higher education programme profile/specialisation title

## 1. COURSE GOAL(s)

The goal of the course of «Chemistry of natural compounds» is in:

- familiarization with the properties, structure and synthesis of molecules of organic compounds found in wildlife;
- study of the relationship of structural formulas with their biological functions;
- getting an idea about the most important classes of natural compounds that play a significant role in the life of plants and animals;
- disclosure of the fundamental mechanisms of action, biosynthesis and industrial synthesis of vitamins and hormones on the human body;
- study at the molecular level of the transmission of hereditary information (amino acids, proteins, nucleic acids);
- discussion of the most important processes occurring in plants: photosynthesis, the formation of terpenoids and alkaloids.

## 2. REQUIREMENTS FOR LEARNING OUTCOMES

Mastering the discipline "Chemistry of natural compounds" is aimed at developing the following competences (competences in part):

*Table 2.1. List of competences that students acquire through the course study*

Competence code	Competence descriptor	Competence formation indicators (within this course)
PC-1	The ability to plan work and choose adequate methods for solving research problems in the chosen field of chemistry, chemical technology or sciences related to chemistry	PC-1.1. Draws up a general research plan and detailed plans for individual stages

## 3. COURSE IN HIGHER EDUCATION PROGRAMME STRUCTURE

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

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*
PC-1	The ability to plan work and choose adequate methods for solving research problems in the chosen field of chemistry,	Methods of Organic Chemistry Fundamentals of biotechnology Molecular spectral analysis Domino reactions	Undergraduate practice

Competence code	Competence descriptor	Previous courses/modules*	Subsequent courses/modules*
	chemical technology or sciences related to chemistry	in the synthesis of heterocycles Research work Experimental methods in the chemistry NMR of organic compounds	

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

#### 4. COURSE WORKLOAD AND ACADEMIC ACTIVITIES

The total workload of the course is 3 credits

*Table 4.1. Types of academic activities during the periods of higher education programme mastering (full-time training)*

Types of academic activities		Total, ac.h.	Semester(-s)			
			1	2	3	4
<i>Contact academic hours</i>		36			36	
including:						
Lectures (LC)		36			36	
Lab works (LW)						
Seminars (workshops/tutorials) (S)						
<i>Self-studies</i>		54			54	
<i>Evaluation and assessment (exam/passing/failing grade)</i>		18			18	
<b>Course workload</b>	academic hours	<b>108</b>			<b>108</b>	
	credits	<b>3</b>			<b>3</b>	

#### 5. COURSE CONTENTS

*Table 5.1. Course contents and academic activities types*

Course module title	Course module contents (topics)	Academic activities types
Section 1. Introduction.	Theme 1.1. Organic compounds of human and animal organisms - proteins, nucleic acids, lipids; plants - carbohydrates, alkaloids. Biosphere and its development. Theoretical and practical significance of studying the chemistry of natural compounds.	LC
Section 2. Proteins.	Theme 2.1. Protein content in the body and their functions. Variety of natural proteins. The beginning of protein chemistry. Qualitative reactions of proteins. The primary structure of proteins. Secondary structure of proteins. Tertiary structure of a proteins. Polypeptide synthesis.	LC
Section 3. Nucleic acids.	Theme 3.1. Deoxyribose nucleic acid is the human genome. The structure of the macromolecule, DNA, gene and other parts. DNA is the primary template for the synthesis of	LC

	<p>proteins in each individual. Cell plasma is matrix ribose nucleic acid, mRNA. Protein synthesis. One gene, one protein. Discovery of DNA (I. Miter). The structure of a section of DNA - a gene. Nucleotides, nucleosides, D - 2 - deoxyribose furanose, D - ribose furanose, purine and pyrimidine bases. Primary structure of NC. Nucleotide sequence. A triplet of nucleotides is the code of a - amino acids. Secondary structure of DNA. Double helix of nucleotide chains with antiparallel orientation.</p>	
Section 4. Enzymes (enzymes).	<p>Theme 4.1. Enzymes are biocatalysts. Biochemical enzymatic processes - baking, alcoholic fermentation (yeast). Simple enzymes. Complex proteins. Anoenzyme and coenzyme. Enzymatic reactions. Nicotinamidin dinucleotide NAD.</p>	LC
Section 5. Lipids (fats).	<p>Theme 5.1. Lipids are the building material of cell membranes and various body tissues; a source of energy that ensures the vital activity, growth and development of the body. Neutral (simple) triglycerides. Isomerism of triglycerides according to the position of acyl radicals. Targeted synthesis of triglycerides.</p>	LC
Section 6. Vitamines	<p>Theme 6.1. The biological role of vitamins. Avitaminosis and hypervitaminosis. Classification of vitamins. fat soluble vitamins. Structure and chemical synthesis. Vitamins A, D, K, E. Water-soluble vitamins. Structure, biological role and synthesis. Vitamins C, group of vitamins B, vitamin PP. Mechanisms of the biological action of vitamins.</p>	LC
Section 7. Terpenes and terpenoids.	<p>Theme 7.1. Classification, finding in nature, methods of isolation from natural sources. Synthesis and application.</p>	LC
Section 8. Hormones.	<p>Theme 8.1. Hormones, physiologically active substances - regulators of biochemical metabolic processes in the body. Hormones of a number of biogenic a-amino acids.</p> <p>Thyroxin. Synthesis of thyroxine. Thyroxine analogues: thyroidin, diiodothyrosine, betazine. Synthesis of these hormones.</p> <p>Hormones of a number of amino alcohols: Adrenaline, Serotonin, Histamine (synthesis, biosynthesis, functions).</p> <p>Nonapeptides, vasopressin and oxytocin. The difference is in the structure of the peptide chain and in the physiological action.</p> <p>Samotropin. Insulin (Structure. Biotechnological production of insulin). Steroid hormones. Pregnane derivative - cortisone. Industrial production of cortisone from sapogenin. Sex</p>	LC

	hormones. Androstan derivatives, male sex hormones: testosterone, androsterone, dehydroandrosterone. Estrane derivatives, female sex hormones: estrone, estradiol, estrol. Cholesterol is the basis for the synthesis of steroid hormones in the body. Industrial methods for obtaining steroid hormones.	
Section 9. Alkaloids.	Theme 9.1. Alkaloids are organic compounds found in various parts of a plant. Piperidine (coniine, arecoline, lobeline and its analogues), Pyridine (nicotine, anabasine), Tropane (tropine, atropine, scopolamine, cocaine, cynamylcocaine), imidazole alkaloid pilocarpine, Quinoline alkaloids. Industrial method for the synthesis of papaverine. Purine alkaloids are tea alkaloids. Industrial method for the synthesis of theophylline Caffeine is a psychotropic agent, a tonic. Quinolizidine alkaloids: lupinine, pachycarpine, cytisine. Condensed systems with a fragment of quinolizidine. Pyrrolizidine alkaloids, esters of the dihydric alcohol of platinecin - platifillin and sarracin. Polycyclic condensed alkaloids: berberine, emytine, ezerine, reserpine, morphine. Morphine derivatives: codeine and heroin. Morphine is an effective pain reliever (analgesic). Morphine and heroin are strong drugs. Acyclic alkaloids (phenethylamine): tyramine, mexalin, ephedrine. Industrial synthesis of ephedrine. The steroidal alkaloids salosidin and salonidin.	LC
Section 10. Photosynthesis.	Theme 10.1. The essence and significance of photosynthesis for the development of the Earth. History of the doctrine of photosynthesis. The scale of photosynthetic activity in the biosphere. Basic and additional photosynthetic pigments: chlorophylls, carotenoids, phycobilins. Chloroplasts and their role in photosynthesis. The structure of chloroplasts. Chlorophyll a and chlorophyll b. The porphine structure is the basis of the molecular structure of the chloroplast.	LC

\* - 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*

Type of academic activities	Classroom equipment	Specialised educational / laboratory equipment, software, and materials for course study (if necessary)
Lecture	A lecture hall for lecture-type classes,	

Type of academic activities	Classroom equipment	Specialised educational / laboratory equipment, software, and materials for course study (if necessary)
	equipped with a set of specialised furniture; board (screen) and technical means of multimedia presentations.	
Self-studies	A classroom for independent work of students (can be used for seminars and consultations), equipped with a set of specialised furniture and computers with access to the electronic information and educational environment.	

\* The premises for students' self-studies are subject to **MANDATORY** mention

## 7. RESOURCES RECOMMENDED FOR COURSE STUDY

### *Main readings:*

1. BIOCHEMISTRY 2nd ed., corrected. and additional Textbook and workshop for open source software. Scientific school: Moscow State Technical University named after N.E. Bauman (Moscow). Ershov Yu. A., Zaitseva N. I.; Ed. Schukina S.I. <https://www.biblio-online.ru/book/biohimiya-442538>
2. BIOCHEMISTRY FOR TECHNOLOGIES IN 2 H. PART 2 2nd ed. Textbook and workshop for secondary vocational education 1 Scientific school: Vologda State Dairy Academy named after NV Vereshchagin (Vologda). <https://www.biblio-online.ru/book/biohimiya-dlya-tehnologov-v-2-ch-chast-2-442534>
3. BIOLOGICAL CHEMISTRY 2nd ed., Per. and additional Textbook for bachelor's, specialist's and master's programs 2. Scientific school: Crimean Federal University named after V.I. Vernadsky (Simferopol). Dryuk V. G., Sklyar S. I., Kartsev V. G. <https://www.biblio-online.ru/book/biologicheskaya-himiya-442129>

### *Additional readings:*

1. Chemistry of natural compounds (carbohydrates, nucleides, steroids, proteins). Kochetkov N.K., Torgov I.V., Botvinik M.M. 1961. ([http://biblioclub.ru/index.php?page=book\\_view\\_red&book\\_id=430998](http://biblioclub.ru/index.php?page=book_view_red&book_id=430998))
2. Fundamentals of the chemistry of natural compounds (volumes 1 and 2). Semyonov A.A., Kartsev V.G., Moscow, 2009
3. Soldatenkov A.T., Kolyadina N.M., Shendrik. I.V. - Fundamentals of organic chemistry of medicinal substances - Chemistry, Moscow, 2003.
4. V.V. Plemenkov, Introduction to the chemistry of natural compounds. Kazan, 2001
5. Chemistry of biologically active compounds (Theory and Practice): textbook 2018 Bolotov V. M. Komarova E. V. Savvin P. N. Publisher: Voronezh State University of Engineering Technologies 85 pp. ISBN: 978-5-00032-306- 9 BBK: G2 i7 UDC: 577.15/.17 ([http://biblioclub.ru/index.php?page=book\\_red&id=487998](http://biblioclub.ru/index.php?page=book_red&id=487998) )

### *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](http://www.studentlibrary.ru)

- EL "Lan" <http://e.lanbook.com/>

- EL "Trinity Bridge"

2. Databases and search engines:

- Yandex search engine <https://www.yandex.ru/>

- Google search engine <https://www.google.ru/>

- abstract database SCOPUS <http://www.elsevierscience.ru/products/scopus/>

*Training toolkit for self- studies to master the course* \*:

1. Course of lectures on the discipline "Chemistry of Natural Compounds".
2. Guidelines for the study of the special course "Chemistry of natural compounds" Chapters 1-4. Lipids, hormones, plant protection chemicals. RUDN University, Moscow, 1987.
3. Guidelines for the study of the special course "Chemistry of natural compounds" Chapters 5-8. Protein substances, nucleic acids, photosynthesis, organic drugs. RUDN University, Moscow, 1987.
4. Varlamov A.V., Borisova T.N., Sorokina E.A., Voskressensky L.G., Nikitina E.V. Fundamentals of organic chemistry. - M.: RUDN University, 2007. - 356.

\* The training toolkit for self- studies to master the course is placed on the course page in the university telecommunication training and information system under the set procedure.

#### DEVELOPERS:

Associate Professor of the

Department of Organic

Chemistry

E.V. Nikitina

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Position, Department

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Signature

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name and surname

#### HEAD OF EDUCATIONAL DEPARTMENT:

Organic Chemistry Department

L. G. Voskressensky

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Name of Department

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signature

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#### HEAD

#### OF HIGHER EDUCATION PROGRAMME:

Dean of Science faculty,

Head of the Department of

Organic Chemistry

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