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

Stereochemistry

course title

Recommended by the Didactic Council for the Education Field:

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

2023

1. COURSE GOAL(s)

The goal of the course "Stereochemistry" is to familiarize students with the features of the spatial structure of the main classes of organic compounds, mastering the nomenclature of spatial isomers; formation on the basis of conformational analysis of the concept of the role and relationship of the configuration (conformation) of substrates (reagents) and the mechanisms of reactions of organic compounds; formation of the student's ability to correctly predict the stereochemical result of reactions.

2. REQUIREMENTS FOR LEARNING OUTCOMES

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

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

Competence code	**Competence descriptor**	**Competence formation indicators** (within this course)
M-PC-2-s	To be able to conduct patent information research in the chosen field of chemistry and/or related sciences	M-SPC-2-s-1. Searches for specialized information in patent information databases
		M-SPC-2-s-2. Analyzes and summarizes the results of a patent search on the subject of the project in the selected field of chemistry (chemical technology)

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***
M-PC-2-s	To be able to conduct patent information research in the chosen field of chemistry and/or related sciences	Methods of Organic Chemistry Theoretical organic chemistry The method of working with databases Fundamentals of biotechnology Domino reactions in the synthesis of heterocycles Research work Experimental methods in the chemistry NMR of organic compounds Molecular spectral analysis	Undergraduate practice

* 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 4 credits.

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			
			1	2	3	4
Contact academic hours		*54*			*54*	
including:						
Lectures (**LC**)		36			36	
Lab Work (**LW**)		18			18	
Seminars (workshops/tutorials) (S)						
Self-studies		*72*			*72*	
Evaluation and assessment (exam/passing/failing grade)		*18*			*18*	
Course workload	academic hours_	**144**			**144**	
	credits	**4**			**4**	

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. Basic concepts of stereochemistry	Theme 1.1. Stereochemical features of the atom of carbon, silicon, nitrogen, phosphorus, oxygen, sulfur.	LC
	Theme 1.2. Stereochemical models and formulas.	LC
	Theme 1.3. Conformation. Configuration.	LC
Section 2. Chiropractic phenomena and their structural prerequisites	Theme 2.1. Chirality. Plane polarized light. Polarimetry.	LC
	Theme 2.2. Enantiomerism and diastereomerism. Enantiotopia, diastereotopia. Types of elements of chirality.	LC
Section 3. Racemates	Theme 3.1. Racemates. Classification and properties of racemic mixtures. Methods for the cleavage of racemates.	LC, LW
	Theme 3.2. Racemization. The use of natural optically active substances for the separation of racemates.	LC, LW
Section 4. Nomenclature of spatial isomers.	Theme 4.1. Nomenclature of spatial isomers, enantiomers and diastereomers.	LC, LW
Section 5. Methods for determining the configuration of asymmetric centers.	Theme 5.1. Relative and absolute configuration. Methods for determining the absolute configuration: X-ray diffraction analysis, quasi-racemates, chemical correlation, chiroptic	LC, LW

Course module title	Course module contents (topics)	Academic activities types
Chiropractic methods.	methods (practical application).	
	Theme 5.2. Dispersion of optical rotation. Circular dichroism. Cotton effect. DOV and CD curves. Classification of chromophores.	LC, LW
Section 6. Conformations of alkanes. Stereochemistry of SN reactions	Theme 6.1. Conformation of alkanes (ethane, butane), mono- and dihaloalkanes. Conformations of diastereomers.	LC, LW
	Theme 6.2. Stereochemistry of nucleophilic substitution reactions in the series of alkanes, alkyl halides, alcohols.	LC, LW
Section 7. Stereochemistry of reactions for obtaining alkenes and processes of electrophilic addition to the double bond.	Theme 7.1. Alkene nomenclature. Stability and interconversions of stereoisomeric alkenes. Obtaining π-diastereomers.	LC, LW
	Theme 7.2. Stereochemistry of reactions of alkenes (electrophilic addition and oxidation). Addition reactions.	LC, LW
Section 8. Stereochemistry of dienes and cycloalkanes. Triple bond addition reactions.	Theme 8.1. Conjugated dienes. Diene synthesis (Diels-Alder reaction). Cumulenes (allenes, ketenimines). Cycloalkanes: cyclopropane, cyclobutane, cyclopentane, cycloheptane.	LC
	Theme 8.2. Higher cycles. Cyclization reactions, Thorp-Ingold effect. Obtaining alkynes, nucleophilic and electrophilic addition to the triple bond.	LC
Section 9. Cyclohexane and its derivatives	Theme 9.1. Cyclohexane. Cycloalkenes and cycloalkynes. Substituted cycloalkanes.	LC, LW
	Theme 9.2. Stereochemical features of reactions in six-membered cycles.	LC, LW
Section 10. Stereochemistry of carbonyl addition reactions	Theme 10.1. Cyclohexanones and their reactions. Syntheses based on carbonyl compounds.	LC, LW
	Theme 10.2. Hydrindane. Dekalin. Rule of Krum, Felkin-On.	LC, LW
Section 11. Spatial structure of bridge and frame systems	Theme 11.1. Stereochemistry of bridged, condensed and framework cyclic systems.	LC
	Theme 11.2. Propellans, rotaxanes, catenanes, Möbius strips.	LC
Section 12. Features of the conformation of saturated oxygen-containing heterocycles	Theme 12.1. Oxygen-containing heterocycles with one and two oxygen atoms.	LC
	Theme 12.2. Optically active nitrogen-containing compounds. Monosaccharides. Spatial structure.	LC
Section 13. Cyclo-chain tautomerism in mono- and disaccharides	Theme 13.1. Cyclo-chain tautomerism. Disaccharides, mutarotation.	LC, LW
Section 14. Conformation, Preparation and reactivity of derivatives with multiple C=N bonds. Saturated	Theme 14.1. Nitrogen-containing heterocycles. Piperidine and its derivatives. Decahydroquinoline.	LC
	Theme 14.2. Compounds with a C=N (N=N) bond: oximes, hydrazines, azomethines, diazo compounds.	LC

Course module title	Course module contents (topics)	Academic activities types
nitrogen-containing heterocycles	Theme 14.3. The conformation of amides and their analogues.	LC
Section 15. Stereochemical features in a series of arenes	Theme 15.1. The conformation of aromatic compounds. Optically active compounds of the biphenyl type.	LC, LW
	Theme 15.2. Atropisomerism. Cyclophanes and ansa- compounds. Helicenes. Metallocenes. Molecular propellers. Spirany.	LC, LW
Section 16. Asymmetric synthesis and catalysis. Approaches to enantio- and diastereoselective synthesis.	Theme 16.1. Asymmetric synthesis. Syntheses based on chiral starting materials. asymmetric catalysis. Syntheses in chiral media.	LC, LW
	Theme 16.2. Examples of enantio- and diastereoselective synthesis. Wittig reactions. Electrocyclic reactions. Baldwin rules. Iodolactonization.	LC, 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

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, equipped with a set of specialised furniture; board (screen) and technical means of multimedia presentations.	
Lab work	A classroom for laboratory work, individual consultations, current and mid-term assessment; equipped with a set of specialised furniture and machinery.	A set of specialized furniture; specialized chemical laboratory equipment: ShVP-4 exhaust cabinet, ShVP-2 exhaust cabinet, Hei-value digital G3B rotary evaporator, IKA rotary evaporator, SMP10 digital devices for determining the melting point; electronic laboratory scales AND EK-610, heating mantles MK-M of various sizes, drying cabinet PE-4610, magnetic stirrer MRHei-Mix S, magnetic stirrer with heating MRHei-Standart, refractometer, combined laboratory BKL bath, vacuum chemical station RS3001 VARIO-pro , Rotacool Mini circulating cooler, RZ2.5 rotary vane vacuum pump, MZ2CNT chemical diaphragm vacuum pump, Steinel thermal blower, Spectroline EB-280C UV lamp, electronic vacuum controller with CVC3000 detect Vacuumbrand valve,

Type of academic activities	Classroom equipment	Specialised educational / laboratory equipment, software, and materials for course study (if necessary)
		emergency cabin made of stainless steel SHVV, chemical glassware, fridge. To visualize the structures under study, students are given sets of Dreyding and Stuart-Brigleb molecular models. A portable saccharimeter, a photopolarimeter, and Abbe refractometers are used to study the chiropractic properties of compounds. To study samples by IR and NMR spectroscopy, the instruments of the Scientific and Educational Center for Collective Use of RUDN University are used: http://www.rudn.ru/index.php?pagec=5972, http://fizmat-rudn.ru/ckp-fhi.
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 reading:

1. Eliel E., Wylen S., Doyle M. "Fundamentals of organic stereochemistry". per. from English, ed. "Binomial. Knowledge Laboratory", Moscow, 2007

2. Nogradi M. "Stereoselective synthesis", trans. from English, ed. "Chemistry", Moscow, 1989

Additional reading:

1. Potapov V.M. "Stereochemistry", ed. "Chemistry", Moscow, 1988

2. Nogradi M. "Stereochemistry". per. from English, ed. "Chemistry", Moscow, 1984

3. V. I. Sokolov, "Introduction to Theoretical Stereochemistry." ed. Nauka, Moscow, 1982

4. Blaga K., Chervinka O., Kover Ya. "Fundamentals of stereochemistry and conformational analysis". per. from English, ed. "Chemistry", Leningrad, 1974

5. Iliel E. "Stereochemistry of carbon compounds" trans. from English, ed. Mir, Moscow, 1965

6. Buxton Sh., Roberts S. "Introduction to the stereochemistry of organic compounds". ed. Mir, Moscow, 2005

7. Prostakov N.S. "Configuration and conformation of molecules". ed. RUDN University, Moscow, 1972.

8. Iliel E. "Fundamentals of stereochemistry" trans. from English, ed. Mir, Moscow, 1971.

9. Dyadchenko V.P. "Introduction to Stereochemistry: Methodological Development". Faculty of Chemistry, Moscow State University M.V. Lomonosov, 2005

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 EBS
  http://lib.rudn.ru/MegaPro/Web
  http://lib.rudn.ru:8080/MegaPro/Web
- Databases Scopus
  https://www.scopus.com/
- Databases Web of Science
  http://apps.webofknowledge.com/WOS_GeneralSearch_input.do?product=WOS&search_mode=GeneralSearch&SID=N1cZ3JYEClUJdm14VTK&preferencesSaved=
- Organic Chemistry Portal
  http://www.organic-chemistry.org/
- The Blue Book — official IUPAC guide to nomenclature
  http://www.acdlabs.com/iupac/nomenclature/
- Databases Reaxys
  https://www.reaxys.com/reaxys/secured/search.do

2. Databases and search engines:

- electronic fund of legal and normative-technical documentation
  http://docs.cntd.ru/
- 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. The set of lectures on the course "Stereochemistry".
2. Laboratory workshop on the discipline "Stereochemistry".
3. Tests, homework.

* 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.

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

The assessment toolkit and the grading system* to evaluate the competences formation level (competences in part) upon the course study completion are specified 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:

Associate Professor of the Department of Organic Chemistry		**F. I. Zubkov**
Position, Department	Signature	name and surname

HEAD OF EDUCATIONAL DEPARTMENT:

Organic Chemistry Department		**L. G. Voskressensky**
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HEAD
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Dean of Faculty of Science, Head of the Department of Organic Chemistry		**L. G. Voskressensky**
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