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

Faculty of Science

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

COURSE SYLLABUS

Bioproducts and Biorefineries

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:

«Bioenergies and Biorefineries»

higher education programme profile/specialisation title

2024

1. COURSE GOAL

The goal of the course “Bioproducts and Biorefineries” is to provide a state of the art on (bio)chemicals and biomaterials production from biomass and waste as well as the state of the art of biorefineries as a future sustainable paradigm.

2. REQUIREMENTS FOR LEARNING OUTCOMES

Mastering the course “Bioproducts and Biorefineries” is aimed at the development of the following competences:

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

Competence code	**Competence descriptor**	**Competence formation indicators** (within this course)
GPC-2	Ability to analyze, interpret and generalize the results of experimental and computational-theoretical work in the chosen field of chemistry or related sciences.	GPC-2.1 Ability to carry out a critical analysis of the results of own experimental and computational-theoretical works and to interpret them correctly
GPC-3	Ability to use computational methods and adapt existing software products to solve problems of professional activity	GPC-3.1. Ability to use modern IT-technologies in the collection, analysis, and presentation of chemical profile information;
PC-2	Ability, based on a critical analysis of the results of research and development, to evaluate the prospects for their practical application and continuation of work in the chosen field of chemistry, chemical technology or sciences related to chemistry	PC-2.1. Ability to systematize information obtained in the course of research and development, to analyze it and compare it with literature data;
		PC-2.2. Ability to determine possible directions for the development of work and prospects for the practical application of the results obtained

3. COURSE IN HIGHER EDUCATION PROGRAMME STRUCTURE

The course “Bioproducts and Biorefineries” refers to the **variable** 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*
GPC-2	Ability to analyze, interpret and generalize the results of experimental and computational-theoretical work in the chosen field of chemistry or related sciences.	Actual problems of modern chemistry Bioenergy Modern organic synthesis and pharmacology Alternative/new tools for organic synthesis	Actual problems of modern chemistry Catalyst (nanomaterials) design and applications Catalysis: from Basic principles to applications. Homogeneous, Heterogeneous, PhotoCatalysis, Biocatalysis, Electrocatalysis Experimental lab 1: Flow synthesis and alternative technologies Experimental lab 2: Biorefineries and Bioproducts Experimental lab 3: Advanced Organic Synthesis Student Scientific-Research work Pre-graduation practical training
GPC-3	Ability to use computational methods and adapt existing software products to solve problems of professional activity	Bioenergy	Catalyst (nanomaterials) design and applications Experimental lab 3: Advanced Organic Synthesis Artificial intelligence and additive technologies in chemistry Student Scientific-Research work Pre-graduation practical training
PC-2	Ability, based on a critical analysis of the results of research and development, to evaluate the prospects for their practical application and continuation of work in the chosen field of chemistry, chemical technology or sciences related to chemistry		Catalyst (nanomaterials) design and applications Experimental lab 1: Flow synthesis and alternative technologies Experimental lab 3: Advanced Organic Synthesis Artificial intelligence and additive technologies in chemistry Student Scientific-Research work Pre-graduation practical training

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

4. COURSE WORKLOAD AND ACADEMIC ACTIVITIES

1) The total workload of the course “Bioproducts and Biorefineries” is 5 credits (180 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	Training modules			
			1	2	3	4
Contact academic hours		24		*24*		
including:						
Lectures (LC)		16		16		
Lab work (LW)		8		8		
Seminars (workshops/tutorials) (S)						
Self-studies		*120*		*120*		
Evaluation and assessment (exam/passing/failing grade)		*36*		*36*		
Course workload	academic hours	**180**		**180**		
	credits	**5**		**5**		

5. COURSE MODULES AND CONTENTS

Table 5.1. Course contents and academic activities types

Course module title	Course module contents (topics)	Academic activities types
Module 1. Introduction to Bioproducts and Biorefineries	Topic 1.1 Introduction to Bioproducts and Biorefineries. Types of Bioproducts. Biofuels Concept. Biorefineries: concept and types. Examples. Platform molecules: concept and examples. Bioproducts from biomass/waste: different platforms.	LC
Module 2. Bioproducts from biomass/waste	Topic 2.1 Oil platform. Types of bioproducts. Oleaginous feeds (fatty acids). Chemistry of fatty acids and transformations. Examples. Glycerol as platform molecule: chemistry and transformations. Examples (e.g. epichlorohydrin, Solvay). Bioproducts: chemicals, surfactants and others	LC
	Topic 2.2 Hydrocarbon platform. Carboxylic acids (succinic, fumaric, itaconic, levulinic acid and related platform molecules). Chemistries and transformations. Examples. Sorbitol as a platform molecule.	LC
	Topic 2.3 Ethanol production platform. Chemicals from ethanol. Transformations. Examples	LC
	Topic 2.4 Syngas platform. Chemicals from syngas. Transformations. Examples	LC
Module 3. Extraction of bioproducts from biomass/waste	Topic 3.1 Extraction of bioproducts from biomass/waste. Examples. Specialty Chemicals. Pharmaceuticals. Essential oils. WEEEs valorization.	LC, LW
Module 4. Materials from biomass/waste	Topic 4.1 Biopolymers (Starch, chitosan/chitin, PLA, PHAs, etc.). Extraction from biomass.	LC, LW

Course module title	Course module contents (topics)	Academic activities types
	Modification/functionalization. Examples. Applications	
	Topic 4.2 Biomaterials from biomass/waste. Biomaterials for construction. Biomaterials in the automotive sector. Biomaterials for packaging. Biomaterials for miscellaneous applications	LC, LW
Module 5. Biorefineries	Topic 5.1 Biorefinery concept. Introduction. Types of biorefineries. Type I, Type II and Type III. Key examples.	LC
	Topic 5.2 Techno-economic assessment applied to two key examples. LCA, concept and examples	LC
	Topic 5.3 Safety in biorefineries. Sustainable biorefining. Process Safety issues and process intensification. Examples.	LC
Module 6. Conclusions and prospects	Topic 6.1 Conclusions and prospects. Overview of the course. Lessons learnt. Perspectives and future of biomass/waste for useful products.	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, equipped with a set of specialised furniture; board (screen) and a set of devices for multimedia presentations.	Projector, motorized screen for projectors, wi-fi
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 equipment of the chemical laboratory: fume hood SHVP-4, fume hood SHVP-2, rotary evaporator Hei-value digital G3B, rotary evaporator IKA, digital devices for determining the melting point SMP10; electronic laboratory scales AND EK-610, MK-M flask heaters of different volumes, drying cabinet, magnetic stirrer MRHei-Mix S, magnetic stirrer with heating MRHei-Standart,

Type of academic activities	Classroom equipment	Specialised educational / laboratory equipment, software, and materials for course study (if necessary)
		refractometer, combined laboratory water bath, vacuum chemical station RS3001 VARIO-pro, circulation cooler Rotacool Mini, rotary plate pump vacuum RZ2.5, membrane vacuum chemical pump MZ2CNT, Steinel thermal air blower, Spectroline UV lamp, electronic vacuum controller with CVC3000 detect Vacuumbrand valve, stainless steel emergency cabin SHVV, chemical dishes, refrigerator; wi-fi
Self-studies	A classroom for self-studies (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.	**Faculty of Science Reading Room** 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 premises for students' self-studies are subject to **MANDATORY** mention

7. RECOMMENDED RESOURCES FOR COURSE STUDY

Main sources:

1. Biorefineries-Industrial Processes and Products: Status Quo and Future Directions, Editor(s) B. Kamm, P.R. Gruber, M. Kamm, 2006, Wiley-VCH, DOI:10.1002/9783527619849
2. Refining Biomass Residues for Sustainable Energy and Bioproducts Technology, Advances, Life Cycle Assessment, and Economics, 1st Edition -

November 1, 2019, Eds R.P. Kumar, E. Gnansounou, J. K. Raman, G. Baskar, ISBN: 9780128189962

3. Bioprocessing of Renewable Resources to Commodity Bioproducts, Eds. V. S. Bisaria, A. Kondo, 2014, Wiley-VCH, ISBN:9781118175835 DOI:10.1002/9781118845394

Additional sources:

1. Website of the American Chemical Society ACS Publications: Chemistry journals, books, and references https://pubs.acs.org/
2. http://www.thieme.com/journals-main
3. http://onlinelibrary.wiley.com/
4. http://www.springer.com/gp/products/journals
5. Server with the ability to search for methods for synthesizing compounds http://www.orgsyn.org/

Internet sources

1. Electronic libraries with access for RUDN students:
- 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/
- www.scholar.google.ru

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

1. A set of lectures on “Bioproducts and Biorefineries
2. The laboratory workshop on “Bioproducts and Biorefineries”

* 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:

Organic Chemistry Department		**Rafael Luque**
position, department	signature	name and surname
Organic Chemistry Department		**Christophe Len**
position, department	signature	name and surname

HEAD OF EDUCATIONAL DEPARTMENT:

Organic Chemistry Department		**Voskressensky L.G.**
name of department	signature	name and surname

HEAD OF HIGHER EDUCATION PROGRAMME:

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