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

Emerging contaminants: from fate to environmental remediation

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

2025

1. COURSE GOAL

The goal of the course "Emerging contaminants: from fate to environmental remediation" is to understand and comprehend the threats and involvement of emerging contaminants of different forms (micro/nanoplastics, pharmaceuticals, PFAS, etc.) in the environment including on soil, water and air as well as their speciation and distribution, including various different forms of their remediation/removal. These will include some toxicological considerations in their fate and mobility into the environment.

2. REQUIREMENTS FOR LEARNING OUTCOMES

Mastering the course "Emerging contaminants: from fate to environmental remediation" 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)
PC-1	Ability to develop a work plan and to choose adequate methods for solving research problems in the chosen field of chemistry, chemical technology or sciences related to chemistry	PC-1.1 Ability to prepare a general plan of research and detailed plans for individual stages
		PC-1.2. Ability to select experimental and calculation-theoretical methods for solving the problems based on the available material and time resources

3. COURSE IN HIGHER EDUCATION PROGRAMME STRUCTURE

The course "Emerging contaminants: from fate to environmental remediation" 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	Ability to develop a work plan and to choose adequate methods for solving research problems in the chosen field of chemistry, chemical technology or sciences related to chemistry	Modern organic synthesis and pharmacology Alternative / new tools for organic synthesis Advanced Organic Synthesis Catalyst (nanomaterials) design and applications Experimental lab 1: Flow + alternative technologies	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 "Emerging contaminants: from fate to environmental remediation" 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	Training modules			
			1	2	3	4
Contact academic hours		48				*48*
including:						
Lectures (LC)		32				32
Lab work (LW)		16				16
Seminars (workshops/tutorials) (S)						
Self-studies		*6*				*6*
Evaluation and assessment (exam/passing/failing grade)		*18*				*18*
Course workload	academic hours	**72**				**72**
	credits	**2**				**2**

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 emerging contaminants. Properties and behaviours of emerging pollutants	Topic 1.1. Introduction to emerging contaminants. Properties and behaviours of emerging pollutants	LC
Module 2. Types of emerging contaminants	Topic 2.1. Organic pollutants (dyes, etc.)	LC, LW
	Topic 2.2. Pharmaceuticals	LC, LW
	Topic 2.3. PFAS	LC, LW
	Topic 2.4. Micro and nanoplastics	LC, LW
	Topic 2.5. Nanomaterials	LC, LW
	Topic 2.6. Others (miscellaneous)	LC, LW
Module 3. Fate and mobility in the environment	Topic 3.1. Distribution and speciation (airborne, water, soil, etc.)	LC, LW
	Topic 3.2. Compounds and intermediates. Toxicity and environmental concerns	LC, LW
	Topic 3.3.	LC, LW
Module 4. Environmental remediation. Degradation and removal	Topic 4.1. Physico-chemical degradation methods	LC, LW
	Topic 4.2. Photocatalytic degradation method	LC, LW
	Topic 4.3. Biological degradation methods	LC, LW
	Topic 4.4. Others	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 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.	Rotary evaporator, bulb heater, magnetic stirrer without heating, magnetic stirrer with heating, electronic scales, vacuum pump
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 SOURCES FOR COURSE STUDIES

Main sources:

1. Nadia Morin-Crini, Eric Lichtfouse, Grégorio Crini (2022) Emerging Contaminants Vol. 1 https://doi.org/10.1007/978-3-030-69079-3
2. Nadia Morin-Crini, Eric Lichtfouse, Grégorio Crini (2022) Emerging Contaminants Vol. 2 https://doi.org/10.1007/978-3-030-69090-8

3. Aravind, Jeyaseelan and Kamaraj, Murugesan. Emerging Contaminants: Remediation Technologies, Berlin, Boston: De Gruyter, 2022. https://doi.org/10.1515/9783110751727
4. Nuro, Aurel, editor. Emerging Contaminants. IntechOpen, 2021. Crossref, doi:10.5772/intechopen.87857.
5. Sébastien Sauvé and Mélanie Desrosiers (2014) A review of what is an emerging contaminant
6. Rohitashw Kumar, Mahrukh Qureshi, Dinesh Kumar Vishwakarma, Nadhir Al-Ansari, Alban Kuriqi, Ahmed Elbeltagi, Anuj Saraswat, A review on emerging water contaminants and the application of sustainable removal technologies, Case Studies in Chemical and Environmental Engineering, Volume 6, 2022, 100219, ISSN 2666-0164, https://doi.org/10.1016/j.cscee.2022.100219
7. Prajapati, D., Shah, M., Yadav, A. *et al.* A critical review on emerging contaminants: origin, discernment, and remedies. *Sustain. Water Resour. Manag.* 9, 69 (2023). https://doi.org/10.1007/s40899-023-00853-y
8. Manivannan, Bhuvaneshwari and Nallathambi, Gobi and Devasena, Thiyagarajan (2022) Alternative methods of monitoring emerging contaminants in water: a review, Vol. 24 http://dx.doi.org/10.1039/D2EM00237J
9. Arman NZ, Salmiati S, Aris A, Salim MR, Nazifa TH, Muhamad MS, Marpongahtun M. A Review on Emerging Pollutants in the Water Environment: Existences, Health Effects and Treatment Processes. *Water*. 2021; 13(22):3258. https://doi.org/10.3390/w13223258
10. Bruce Petrie, Ruth Barden, Barbara Kasprzyk-Hordern (2015) A review on emerging contaminants in wastewaters and the environment: Current knowledge, understudied areas and recommendations for future monitoring https://doi.org/10.1016/j.watres.2014.08.053
11. Cui-Lan Bai, Liang-Ying Liu, Yi-Bin Hu, Eddy Y. Zeng, Ying Guo (2021) Microplastics: A review of analytical methods, occurrence and characteristics in food, and potential toxicities to biota https://doi.org/10.1016/j.scitotenv.2021.150263
12. Sarawut Sangkham, Orasai Faikhaw, Narongsuk Munkong, Pornpun Sakunkoo, Chumlong Arunlertaree, Murthy Chavali, Milad Mousazadeh, Ananda Tiwari (2022) A review on microplastics and nanoplastics in the environment: Their occurrence, exposure routes, toxic studies, and potential effects on human health https://doi.org/10.1016/j.marpolbul.2022.113832

Additional sources:

1. Website of the American Chemical Society ACS Publications: Chemistry journals, books, and references https://pubs.acs.org/
2. John A. Joule, Keith Mills (2010) Heterocyclic Chemistry, 5th Edition, Wiley-Blackwell

3. 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/

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

1. A set of lectures on “Emerging contaminants: from fate to environmental remediation”
2. The laboratory workshop on “Emerging contaminants: from fate to environmental remediation”

* 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:

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position, department	signature	name and surname

HEAD OF EDUCATIONAL DEPARTMENT:

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HEAD OF HIGHER EDUCATION PROGRAMME:

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

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