НАЦІОНАЛЬНИЙ УНІВЕРСИТЕТ БІОРЕСУРСІВ І ПРИРОДОКОРИСТУВАННЯ УКРАЇНИ

Кафедра загальної екології радіобіології та безпеки життєдіяльності

“ЗАТВЕРДЖУЮ”
Декан факультету захисту рослин,
біотехнологій та екології
_____ Юлія КОЛОМІЄЦЬ
Протокол № 9 від “23” 05 2024 р.

“СХВАЛЕНО”
на засіданні кафедри загальної екології,
радіобіології та БЖД
Протокол № 11 від “22” 05. 2024 р.
Завідувач кафедри
_____ Алла КЛЕПКО

”РОЗГЛЯНУТО ”
Гарант ОПП «Екологія та охорона навколишнього середовища»
Гарант ОП
_____ Віталій ГАЙЧЕНКО

РОБОЧА ПРОГРАМА НАВЧАЛЬНОЇ ДИСЦИПЛІНИ

ЕКСПЕРИМЕНТАЛЬНА РАДІОБІОЛОГІЯ

Галузь знань	10 «Природничі науки»
Спеціальність	101 «Екологія»
Освітня програма	«Екологія та охорона навколишнього середовища»
Факультет	Захисту рослин, біотехнологій та екології
Розробники:	Гудков Ігор Миколайович, доктор біологічних наук, професор кафедри загальної екології радіобіології та безпеки життєдіяльності Іллєнко Володимир Віталійович, кандидат біологічних наук, ст. викладач кафедри загальної екології радіобіології та безпеки життєдіяльності

Київ – 2024 р.

Description of the discipline

Experimental Radiobiology
(name)

Academic degree, specialty, academic programme		
Academic degree	*Master's*	
Specialty	*101 Ecology*	
Academic programme	*"Ecology and Environmental Protection"*	
Characteristics of the discipline		
Type	Compulsory	
Total number of hours	120	
Number of ECTS credits	4	
Number of modules	3	
Course project (work) (if any)	-	
Form of assessment	*Exam*	
Indicators of the course for full-time and part-time forms of study		
	Full-time form of study	Part-time form of study
Year of study (course)	1	-
Semester	2	-
Lectures	*30 hours*	*6 hours*
Practical and seminar lessons		*- hours*
Laboratory practical	*15 hours*	*2 hours*
Self-dependent work	*75 hours*	*112 hours*
Self-dependent work		*hours*
Week hours for full-time education	*3 hours*	

1. Aim, objectives, competences and expected learning outcomes of the discipline

The aim of teaching the discipline "Experimental Radiobiology" is to study the sources of ionizing radiation in the environment, migration of radioactive substances in different ecosystems, features of physicochemical forms of radionuclides and assessment of environmental impact and risks associated with radioactive contamination. Formation of abilities and skills of carrying out radioecological researches with use of radioactive isotopes, methods of radiochemical separation and modern methods of measurement.

The objective is to provide opportunities to use the acquired knowledge and skills to describe, analyze and predict the accumulation of radioactive isotopes and

their migration in the environment under conditions of limited information, as well as to perform a master's thesis.

After finishing of course students should to

know the characteristics of ionizing radiation and the physico-chemical basis of the interaction of ionizing radiation with substances, methods of radiometry and spectrometry of ionizing radiation, physical and chemical properties of natural and artificial radioactive isotopes of chemical elements, the basis of statistical processing of experimental data.

be able to:

- measure the specific, volume radioactivity for α-, β-, γ-radionuclides;
- carry out experimental research using the method of labeled atoms and compounds;
- conduct an autoradiography;
- properly describe, analyze and formalize the results of their own experimental studies;
- formulate logical conclusions.

Acquisition of competencies:

integral competence (IC): the ability to solve complex tasks and problems in the field of ecology, environmental protection and sustainable use of natural resources in the course of professional activity or in the process of study that involves research and/or innovation, and is characterised by complexity and uncertainty of conditions and requirements;

general competences (GC):

2. Ability to make informed decisions.

6. Ability to search, process and analyse information from various sources.

professional (special) competences (PC)::

12. Ability to apply new approaches to the analysis and forecasting of complex phenomena, critical thinking of problems in professional activities.

15. Ability to organise work related to environmental assessment, environmental protection and optimisation of environmental management in conditions of incomplete information and conflicting requirements.

Expected Learning Outcomes (ELO):

4. To know the legal and ethical standards for assessing professional activities, developing and implementing socially significant environmental projects in the face of conflicting requirements.

7. To be able to communicate in a foreign language in scientific, industrial, social and public spheres of activity.

2. Program and structure of the discipline for:
– complete full-time form of study

№	Topic	The topic content, recommended literature	Types of educational activity, hours.		
			lectures	practical training	independent work
	Module 1. Radionuclides in the environment				
1.1.	Consequences of the largest radiation accidents and prospects for the use of contaminated areas for research	**Know** main reasons and consequences of the largest nuclear and radiation accidents and incidents: the Kyshtym disaster (1957), Windscale fire (1957), Three Mile Island accident (1979), the Chernobyl disaster (1986), Fukushima nuclear disaster (2011) **Understand** how artificial radionuclides have affected the environment and human health	4	-	9
		Literature: 1-8			
1.2.	Biological effects of ionizing radiation. Assessing impacts of ionizing radiation to man and the environment (principles, mechanisms, biomarkers)	**Know** what is radiobiological effect. Dose/Effect curve. The main radiobiological effects in plants, animals and humans. Biomarkers that are sensitive to the dose of ionizing radiation. **Understand** models of risk from radiation exposure: no-threshold (LNT), Sub-linear, Threshold, Hormesis.	4	-	7
		Literature: 1-5, 7,8			
1.3.	Speciation of radionuclides in the environment	**Know** the concept of speciation of radionuclides. How the speciation of radionuclides influences ecosystem transfer, biological uptake and effects. **Understand** which chemical properties would influence the mobility/migration of trace elements/radionuclides in ecosystems and biological uptake in organisms.	4	2	6
		Literature: 1-5, 7,8			
		Module 2. Experiment in radioecological research			

2.1	Field sampling and statistics in radioecology	**Know** the soil sampling methods for radiation control. Requirements for sampling devices and equipment. General requirements for the selection of test sites. Gamma survey of the surveyed area. Sampling. Soil sampling in rural settlements, on agricultural lands and in natural landscapes. Sampling in case of local emergency radioactive contamination of the territory. Marking, transportation, storage and disposal of samples. **Understand** requirements for sampling devices and equipment. Determination of homogeneity of radioactive contamination. Sampling of plant products in storage places or during its transportation, in the field.	2	3	6
		Literature: 6-10			
2.2	Particularities of radionuclide contamination measurements	**Know** requirements for error in determining the density of radioactive soil contamination. Determination of the number of soil samples to estimate the median density of radioactive contamination of the soil at the elementary site. **Understand** requirements for soil sampling and preparation and measurement of radionuclide activity in them.	2	2	6
		Literature: 6-8,11			
2.3	Radioactive particles and solid state speciation	**Know** the definition: particles - colloids - LMM species. Size categories for different physico-chemical forms of radionuclides. **Understand** mobility and bioavailability of different physico-chemical forms of radionuclides.	2	2	10
		Literature: 6-8,13			
2.4.	Modeling within radioecology	**Know** models and tools that can be used: CROM, RESRAD, HOTSPOT, ERICA. **Understand** how to use different models and software (tools) to solve specific problems in assessing environmental pollution by radioactive isotopes.	4	2	10
		Literature: 1-5, 7,8			
		Module 3. Features of studying the state of radioactive isotopes under different conditions			

3.1	Distribution, main fluxes and deposits of biologically active radionuclides (^{137}Cs and ^{90}Sr) in forest ecosystems.	**Know** the cycle and redistribution of biologically mobile radionuclides in forest stands after the Chernobyl accident in 1986. **Understand** ways to measure the parameters of forest stands and estimation the stock of above-ground biomass of forests.	2	2	7
		Literature: 1-5, 7,8			
3.2.	Radioecology of fresh and salt water	**Know** the features of radionuclide migration in water bodies. Levels of natural radionuclides in the oceans, main sources of man-made radionuclides and additional sources of natural radionuclides from man-made processes. Behavior and fate of radionuclides, distribution coefficients, speciation, sedimentation, post-sedimentation processes, processes in different marine environments. **Understand** estuarine processes, the potential long-range river transport of radionuclides. Overview of marine environmental and human dose assessments, IAEA methodology.	2	2	7
		Literature: 1-5, 7,8			
3.3	Terrestrial radioecology, transfer and countermeasures	**Know** sources of radionuclides, physical transport and biological transfer, countermeasures, summarized transfer data – IAEA TRS. **Understand** data-gap filling methodology, the goal of countermeasures, countermeasures for different isotopes	4	-	7
		Literature: 1-3, 7			
		Total:	**30**	**15**	**75**

3. Topics of laboratory classes

№ s/n	Topic title	Hours
1	Sequential extraction method for isolation of physicochemical forms of radionuclides	2
2	Soil sampling methods for radiometric studies	3
3	Calculation of the required number of samples in the field study of radionuclide contaminated areas	2
4	Size and charge fractionation methods	2
5	Atmosphere dispersion. Discharge to the atmosphere $H>2.5\ H_B$ (CROM tool)	2

6	Measuring the width of annual rings and the length of needles using the free ImageJ software.	2
7	Data analisis from uptake experiment with Blue mussels.	2
	Total	15

4. Topics for self-study

№ s/n	Topic title	Hours
1	Classification and purpose of dosimetric control devices, their components. Devices of individual dosimetric control.	10
2	Preparation for operation of general dosimetric control devices - X-ray and radiometers	15
3	Units of measurement of doses and radioactivity, their relationship and conversion	10
4	Sampling of environmental objects and their preparation for radiometry	15
5	Calculation of the level of ^{137}Cs contamination of plant products	15
6	Calculation of the level of ^{137}Cs contamination of animal husbandry products	10

5. Tools for assessing expected learning outcomes:

- exam;
- module tests;
- abstracts;
- graphic design works;
- presentation of laboratory works;

6. Teaching methods:

- verbal method (lecture, discussion, interview, etc.);
- practical method (laboratory classes);
- visual method (illustration, demonstration);
- processing learning resources (note-taking,summarising, reviewing, writing an abstract);
- video method (remote, multimedia, web-based, etc.);
- self-study (completing assignments);

7. Assessment methods:

- exam;
- oral or written assessment;
- module tests;
- presentation of laboratory works;

- presentations at academic events

8. Distribution of points received by students

The assessment of students' knowledge and skills is conducted by means of a 100-point scale and is converted into national grades according to Table 1 of the current *Exam and Credit Regulations at NULES of Ukraine*.

Student's rating, points	National grading of exams and credits	
	exams	credits
90-100	excellent	pass
74-89	good	
60-73	satisfactorily	
0-59	unsatisfactorily	fail

To determine a student's rating in the discipline $\mathbf{R_{DIS}}$ (up to 100 points), the received assessment rating $\mathbf{R_A}$ (up to 30 points) is added to the academic performance raiting $\mathbf{R_{AP}}$ (up to 70 points): $\mathbf{R_{DIS}} = \mathbf{R_{AP}} + \mathbf{R_A}$.

9. Teaching and learning aids

- e-learning course of the discipline (*https://elearn.nubip.edu.ua/course/view.php?id=2682*);
- Gudkov I. M. Radiobiology and Radioecology (in English): Textbook for students of higher educational institutions. Вид. 2-е, переробл. та допов. К.: НУБіП України, Житомирська політехніка, 2019. 384 с.

10. Recommended sources of information

1. Choppin G. R., Liljenzin J.-O., Rydberg J. Radiochemistry and nuclear chemistry. 4th ed., Academic Press, 2013, 858 p.
2. Radiation biology: a handbook for teachers and students. International Atomic Energy Agency, VIENNA, 2010, 150 p.
3. Chernobyl: 30 Years of Radioactive Contamination Legacy. Report. Lead writer and coordination of report: Prof. Valerii Kashparov, Kyiv, 2016, 59 p.
4. Climate change and nuclear power. International Atomic Energy Agency, VIENNA, 2005, 112 p.
5. Natural and induced radioactivity in food. International Atomic Energy Agency, VIENNA, 2002, 136 p.

6. Gleyzes, C., Tellier, S. & Astruc, M. Fractionation studies of trace elements in contaminated soils and sediments: a review of sequential extraction procedures. Trac-Trends in Analytical Chemistry, 21 (6-7), 2002, p. 451-467.
7. International Atomic Energy Agency Safety Standards Series No. RS-G-1.8, Environmental and Source Monitoring for Purposes of Radiation Protection for protecting people and the environment, Safety Guide, IAEA, VIENNA, 2005, p.119.
8. He, Z. L. L., Yang, X. E. & Stoffella, P. J. Trace elements in agroecosystems and impacts on the environment. Journal of Trace Elements in Medicine and Biology, 19 (2-3), 2005, p. 125-140.
9. Lind, O.C., Salbu, B., Janssens, K., Proost, K., García-León, M., García-Tenorio, R. Characterization of U/Pu particles originating from the nuclear weapon accidents at Palomares, Spain, 1966 and Thule, Greenland, 1968. Science of the Total Environment, 376, 2007, p. 294–305.
10. Salbu, B. Fractionation of radionuclide species in the environment. Journal of Environmental Radioactivity, 100 (4), 2009, p. 283-289.
11. https://www.iaea.org/publications
12. https://web.archive.org/web/20110515164252/http://www-pub.iaea.org/MTCD/publications/PDF/INES-2009_web.pdf
13. https://www.who.int/news/item/05-09-2005-chernobyl-the-true-scale-of-the-accident
14. https://www.iaea.org/newscenter/news/fukushima-nuclear-accident-update-log-15
15. http://www.unscear.org/docs/reports/2008/11-80076_Report_2008_Annex_C.pdf
16. https://www.wright.edu/sites/www.wright.edu/files/page/attachments/radiation-safety-biological-effects-of-ionizing-radiation.pdf
17. https://doi.org/10.1016/j.jenvrad.2008.12.013
18. https://doi.org/10.1007/978-3-319-22171-7