

**NATIONAL UNIVERSITY OF LIFE AND ENVIRONMENTAL SCIENCES OF
UKRAINE**

Department of General Ecology, Radiobiology and Safety of Life Activity

"APPROVED"

The Faculty of Plant Protection, Biotechnologies and Ecology
“21” May 2025

**CURRICULUM OF ACADEMIC DISCIPLINE
RADIOBIOLOGY AND RADIOECOLOGY**

Field of knowledge 16 «Chemical and Bioengineering »

Specialty 162 Biotechnology and bioengineering

Academic programme "Biotechnology and bioengineering "

Faculty: Plant Protection, Biotechnologies and Ecology

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Description of the discipline **RADIOBIOLOGY AND RADIOECOLOGY**

Radiobiology, or radiation biology, is the science of the effects of ionizing radiation on living organisms and their groups. In recent decades, the objects of study of radiobiology have become not only living organisms and their groups, but also biologically important molecules, cells and cell populations, and individual metabolic processes. And a new definition of radiobiology has emerged - the science of the effects of ionizing radiation on living systems at all levels of the organization. This wording is not an alternative to the first - they are both correct.

Academic degree, specialty, academic programme		
Academic degree	Bachelor	
Specialty	162 Biotechnology and bioengineering	
Academic programme	"Biotechnology and bioengineering"	
Characteristics of the discipline		
Type	Compulsory	
Total number of hours	90	
Number of ECTS credits	3	
Number of modules	2	
Form of assessment	Exam	
Indicators of the discipline for full-time and part-time forms of university study		
	Form of obtaining higher education	
	Full-time	Part-time
Year of study	3	3
Semester	5	5
Lectures	15 hours	2 hours.
Practical classes and seminars	- hours	- hours
Laboratory classes	15 hours	6 hours
Self-study	90 hours	82 hours
Number of hours per week for full-time students	2	

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

Primary purpose of study of discipline “Radiobiology and radioecology» is a capture thorough knowledge about influence of ionizing radiations on living organisms, mastering of the applied aspects of specialty, related to radiation safety, and also practical application of knowledge, for the solving of research and applied tasks.

Acquisition of competences:

Integral competence (IC): Ability to solve complex specialized tasks and practical problems characterized by complexity and uncertainty in biotechnology and bioengineering, or in the process of learning that involves the application of biotechnology and bioengineering theories and methods.

General competencies (GC):

GC1. Ability to apply knowledge in practical situations.

GC5. Ability to learn and master modern knowledge.

GC6. Safe activity skills.

GC9. Ability to preserve and multiply moral, cultural, scientific values and achievements of society based on understanding the history and patterns of development of the subject area, its place in the general system of knowledge about nature and society and in the development of

society, technology and engineering, to use various types and forms of physical activity for active recreation and leading a healthy lifestyle.

Professional (special) competencies (SC):

Expected Learning Outcomes (ELO):

ELO4. Be able to apply the provisions of regulatory documents that regulate the procedure for product certification, production certification, requirements for the organization of quality management systems at enterprises, rules for drawing up technical documentation and maintaining a technological process, based on the knowledge gained during practical training.

ELO10. Be able to conduct experimental research to determine the influence of physicochemical and biological factors of the external environment on the vital activity of cells of living organisms.

ELO22. Be able to take into account social, environmental, ethical, economic aspects, requirements of labor protection, industrial sanitation and fire safety when forming technical solutions. Be able to use various types and forms of physical activity for active recreation and leading a healthy lifestyle.

2. Programme and structure of the discipline

Names of content modules and topics	Number of hours												
	Full-time form							Part-time form					
	weeks	total	including					total	including				
			l	p	lab	ind	self		l	p	lab	ind	self
1	2	3	4	5	6	7	8	9	10	11	12	13	14
Content Module 1. Introduction. Physical basics of radiobiology and radioecology													
Topic 1. Introduction to radiobiology. History		13	1		2	-	10	11	1		-	-	10
Topic 2. Physical basics of radiobiology		14	2		2	-	10	13	1		2	-	10
Topic 3. Sources of radioactive substances and ionizing radiation		9	2		2	-	5	10	-		-	-	10
Topic 4. Physical bases of interaction of ionizing radiations with substances of cells of living organisms		9	2		2		5	12	-		2		10
Total for content module 1		45	7		8		30	46	2		4		40
Content Module 2. Biological effects of ionizing radiation													
Topic 5. Biological effects of ionizing radiation on plants and animals		14	2		2		10	10	-				
Topic 6. Radiation protection and		14	2		2		10	12	-		2		

radiosensitization												
Topic 7. Migration of radionuclides in the environment and objects of agriculture		9	2		2		5	10			-	
Topic 8. Measures to reduce the accumulation of radionuclides into crop and livestock products		8	2		1		5	12			-	
Total for content module 2		45	8		7	30		43	1		2	40
Total hours		90	15		15	60		90	2		6	82

3. Topics of lections

№	Topic title	Hours
1	Introduction to radiobiology. History	1
2	Physical basics of radiobiology	2
3	Sources of radioactive substances and ionizing radiation	2
4	Physical bases of interaction of ionizing radiations with substances of cells of living organisms	2
5	Biological effects of ionizing radiation on plants and animals	2
6	Radiation protection and radiosensitization	2
7	Migration of radionuclides in the environment and objects of agriculture	2
8	Measures to reduce the accumulation of radionuclides into crop and livestock products	2

4. Topics of laboratory classes

№	Topic title	Number of hours
1	Rules for working with ionizing radiation sources in radiological laboratories	2
2	Determination of the dose rate of γ -radiation created by the reference source ^{137}Cs through protective materials	2
3	Determination of the flow of β -particles from the radiation source	2
4	Measurement of the γ -background in the premises and on the territory using the SRP-68-01 radiometer	2
5	Measurement of the specific and volume activity of β -emitting radionuclides using the "Beta" radiometer	2
6	Determination of the β -radiation half-attenuation layer	2
7	Express determination by γ -radiation of cesium radionuclides in water, soil, food and agricultural products using the RUB-01-P6 radiometer	2
8	Determination of the content of ^{137}Cs in the human body using the RUB-01-P6 radiometer	1
	In total	15

5. Topics for self-study

№	Topic title	Number of hours
1	Ionizing radiation and the history of radiobiology	10
2	Nuclear fission reactions	10
3	Biological effects of ionizing radiation on living organisms and biocenoses	5
4	Forecasting environmental pollution in cases of radiation accidents	5
5	Sampling of soil, forest litter, herbaceous vegetation, shrubs, trees	10
6	Preparation of selected samples for laboratory testing	10
7	Determination of ^{137}Cs content in soil, forest litter, herbaceous vegetation, bushes and	5

	trees using the RUB-01-P6 radiometer and assessment of its migration ability in forest ecosystems	
8	Assessment of the state and quality of natural and anthropogenically modified ecosystems	5
	In total	60

6. Tools for assessing expected learning outcomes:

- oral or written questioning;
- interview;
- testing;
- defence of laboratory, calculation/graphic works, projects;
- peer assessment, self-assessment.

7. Teaching methods:

- the method of problem-based learning;
- method of practice-oriented learning;
- case method;
- method of learning through research;
- method of educational discussions and debates;
- method of teamwork, brainstorming.

8. Assessment of learning outcomes:

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

8.1. Distribution of points received by students

Topic	Hours (lectures/ practical works)	Results of study	Task	Evaluation
Module 1. Introduction. Physical foundations of radiobiology and radioecology				
Delivery of all practical works and performance of independent works takes place including in the elearn platform				
Topic 1 Introduction. Radiobiology and radioecology as a continuous science	1/2	Know the main stages of development of world and domestic radiobiology	Assess the contribution of Ukrainian radiobiologists to world radiobiology and radioecology	8
Topic 2. Radioactivity, types of ionizing radiation and their dosimetry	2/2	Understand the basic physical processes of interaction of ionizing radiation with substances of living cells	Solving problems on the translation of radioactivity units and doses in the SI system and non-system units	7
Topic 3. Sources of radioactive substances and ionizing radiation	2/2	Distinguish between natural and artificial radionuclides; family-forming and non-family	Analyze the contribution of various sources in the formation of the radiation background of the environment	7
Topic 4. Physical bases of interaction of ionizing radiations with substances of cells of living	2/2	Analyze radiobiological effects, distinguish between somatic and genetic, near and far,	Justify the stochasticity of certain radiobiological effects	8

organisms		deterministic and stochastic		
Total module 1				30
Module 2. Effect of ionizing radiation on living organisms and production in radionuclide-contaminated areas				
Delivery of all practical works and performance of independent works takes place including in the elearn platform				
Topic 5. Biological effects of ionizing radiation on plants and animals. Radiosensitivity of plants, animals and other organisms	2/2	Analyze radiobiological effects, distinguish between somatic and genetic, near and far, deterministic and stochastic. Know the levels of semi-lethal doses for different species of organisms: plants and animals, humans, protozoa, bacteria and viruses	Justify the stochasticity of certain radiobiological effects. Give examples of calculation of LD50 and LD100	7
Topic 6. Radiation protection and radiosensitization	2/2	Understand and know the basic means of physical and chemical-pharmacological means of radiation protection	Evaluate the comparative contribution of individual pathways of post-radiation recovery to the overall recovery of higher plants and animals	8
Topic 7. Atmosphere and soil as starting points of radionuclide migration in the natural environment. Receipt of radionuclides from the soil into plants and animals, biological action of incorporated radionuclides	2/2	Know the migration routes of radionuclides in the environment. Factors influencing the accumulation of radionuclides by living organisms	Calculate the projected level of contamination of livestock and crop products at a certain level of radionuclide contamination of the territory	8
Topic 8. Measures to reduce the inflow of radionuclides into crop and livestock products and its purification from radionuclides by primary technological processing	2/1	Understand the possibilities of various countermeasures to reduce the entry of radionuclides into products. Know how to process radionuclide-contaminated products	Assess the suitability of products for consumption by the level of radionuclide contamination	8
Total module 2				30
Total for the semester				70
Exam				30
Total for the course				100

8.2. Scale for assessing students 'knowledge and skills

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

8.3. Assessment policy

Deadlines and exam retaking policy:	Works that are submitted late without valid reasons will be assessed with a lower grade. Module tests may be retaken with the permission of the lecturer if there are valid reasons (e.g., a sick leave).
Academic integrity policy:	Cheating during tests and exams is prohibited (including using mobile devices). Term papers and essays must have correct references to the literature used
Attendance policy:	Attendance is compulsory. For good reasons (e.g., illness, international internship), training can take place individually (online by the faculty dean's consent)

9. Teaching and learning aids

1. <https://elearn.nubip.edu.ua/enrol/index.php?id=2402> Radiobiology and Radioecology
2. 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.
3. Gudkov I. M. Radiobiology and Radioecology / I. M. Gudkov, M. M. Vinichuk. – К. : NAUU, 2006. – 295 p.
4. Choppin G. R., Liljenzin J.-O., Rydberg J. Radiochemistry and nuclear chemistry. 4th ed., Academic Press, 2013, 858 p.

10. Recommended sources of information

1. Chernobyl: 30 Years of Radioactive Contamination Legacy. Report. Lead writer and coordination of report: Prof. Valerii Kashparov, Kyiv, 2016, 59 p.
2. Climate change and nuclear power. International Atomic Energy Agency, VIENNA, 2005, 112 p.
3. Natural and induced radioactivity in food. International Atomic Energy Agency, VIENNA, 2002, 136 p.
4. 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.
5. 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.

6. Radiation biology: a handbook for teachers and students. International Atomic Energy Agency, VIENNA, 2010, 150 p.
7. Гродзинський Д.М. Радіобіологія. – К.: Либідь, 2000. – 448 с.
8. Гудков І.М. Радіобіологія: підручник. – Херсон : Олді-Плюс, 2016. – 504 с.
9. Гудков І.М., Гайченко В.А., Кашпаров В.О. Сільськогосподарська радіоекологія: підручник. – К.: Ліра-К, 2017. – 268 с.
10. Кічно В.О., Поліщук С.В., Гудков І.М. Основи радіобіології та радіоекології. – К.: Хай-Тек Прес, 2008 (2009). – 316 с.
11. НРБУ-97/2000.
12. Хомутинін Ю.В., Кашпаров В.О., Жебровська К.І. Оптимізація відбору і вимірювань проб при радіоекологічному моніторингу, Монографія. – К.: Український науково–дослідний інститут сільськогосподарської радіології, 2002, 160 с.
13. Паренюк О.Ю., Ілєнко В.В., Гудков І.М. Мікрофлора забруднених радіонуклідами ґрунтів. – К.: Вид-во НУБіП України, 2018. – 198 с.
14. Бондар О.І., Фещенко В.П., Гудков І.М., Гуреля В.В. Радіоекологічний термінологічний словник (україно-англійсько-російський). – Житомир: ПП Експертний центр Укреколбіокон, 2018. – 254 с.
15. Якість ґрунту. Методи відбору проб ґрунту для радіаційного контролю, СОУ 74.14-37-425:2006.
16. Якість ґрунту. Визначення щільності забруднення території сільськогосподарських угідь радіонуклідами техногенного походження, СОУ 74.14-37-424:2006
17. Якість продукції рослинництва. Методи відбору проб для радіаційного контролю, СОУ 01.1-37-426:2006.
18. Якість продукції тваринництва. методи відбору проб для радіаційного контролю, СОУ 01.2-37-427:2006.
19. Якість продукції тваринництва. Проведення прижиттєвого контролю тварин на територіях, забруднених радіонуклідами, СОУ 01.2-37-428:2006.