**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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Kyiv – 2025

## 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 lectures**

| No. | Topic | 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**

| No. | Topic | 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 caesium 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**

| No. | Topic | 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

| Educational activity | Results | Assessment |
|---|---|---|
| Module 1. Introduction. Physical foundations of radiobiology and radioecology | | |
| Lecture 1 Introduction. Radiobiology and radioecology as a continuous science | Know the main stages of development of world and domestic radiobiology | - |
| Laboratory work 1. Rules for working with ionizing radiation sources in radiological laboratories | Assess the contribution of Ukrainian radiobiologists to world radiobiology and radioecology | 10 |
| Self-study 1. | | 5 |
| Lecture 2. Radioactivity, types of ionizing radiation and their dosimetry | Understand the basic physical processes of interaction of ionizing radiation with substances of living cells | - |
| Laboratory work 2. Determination of the dose rate of γ-radiation created by the reference source $^{137}Cs$ through protective materials | Solving problems on the translation of radioactivity units and doses in the SI system and non-system units | 15 |
| Self-study 2. | | 5 |
| Lecture 3. Sources of radioactive substances and ionizing radiation | Distinguish between natural and artificial radionuclides; family-forming and non-family | - |
| Laboratory work 3. Determination of the flow of β-particles from the radiation source | Analyze the contribution of various sources in the formation of the radiation background of the environment | 15 |
| Self-study 3. | | 5 |
| Lecture 4. Physical bases of interaction of ionizing radiations with substances | Analyze radiobiological effects, distinguish between somatic and genetic, near and far, deterministic and | - |

| | | |
|---|---|---|
| of cells of living organisms | stochastic | |
| Laboratory work 4. Physical bases of interaction of ionizing radiations with substances of cells of living organisms | Justify the stochasticity of certain radiobiological effects | 10 |
| Self-study 4. | | 5 |
| **Module control work 1.** | | **30** |
| **Total for module 1** | | **100** |
| Module 2. Effect of ionizing radiation on living organisms and production in radionuclide-contaminated areas | | |
| Lecture 5. Biological effects of ionizing radiation on plants and animals. Radiosensitivity of plants, animals and other organisms | 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 | - |
| Laboratory work 5. Measurement of the specific and volume activity of β-emitting radionuclides using the "Beta" radiometer | Justify the stochasticity of certain radiobiological effects. Give examples of calculation of LD50 and LD100 | 10 |
| Self-study 5. | | 5 |
| Lecture 6. Radiation protection and radiosensitization | Understand and know the basic means of physical and chemical-pharmacological means of radiation protection | - |
| Laboratory work 6. Determination of the β-radiation half-attenuation layer | Evaluate the comparative contribution of individual pathways of post-radiation recovery to the overall recovery of higher plants and animals | 15 |
| Self-study 6. | | 5 |
| Lecture 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 | Know the migration routes of radionuclides in the environment. Factors influencing the accumulation of radionuclides by living organisms | - |
| Laboratory work 7. Express determination by γ-radiation of caesium radionuclides in water, soil, food and agricultural products using the RUB-01-P6 radiometer | Calculate the projected level of contamination of livestock and crop products at a certain level of radionuclide contamination of the territory | 15 |
| Self-study 7. | | 5 |
| Lecture 8. Measures to reduce the inflow of radionuclides into crop and livestock products and its purification from radionuclides by primary technological processing | Understand the possibilities of various countermeasures to reduce the entry of radionuclides into products. Know how to process radionuclide-contaminated products | - |
| Laboratory work 8. Assessment of the state and quality of natural and anthropogenically modified ecosystems | Assess the suitability of products for consumption by the level of radionuclide contamination | 10 |
| Self-study 8. | | 5 |
| **Module control work 2.** | | **30** |
| **Total for module 2** | | **100** |
| **Class work** | | **(M1 + M2)/2*0,7 ≤ 70** |
| **Exam/credit** | | **30** |
| **Total for year** | | **(Class work + exam) ≤ 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. – K. : 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. Кіцно 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. Хомутінін 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., Іллєнко 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 термінологічий 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.