



## **Description of the discipline Veterinary Radiobiology**

Veterinary radiobiology has become a mandatory component of educational programs in agricultural universities after the Chernobyl radiation accident in 1986, when 12 regions (47 districts) of Ukraine were contaminated, more than 300 thousand hectares of agricultural production stopped, more than 100 thousand cattle were sent for forced slaughter and about 10 thousand tons of raw meat are buried as radioactive waste. Veterinary radiobiology provides basic concepts on the effects of ionizing radiation on various species of farm animals, classification of radiobiological effects, protection of animals from IP, obtaining good quality livestock products in radionuclide-contaminated areas, and studies the patterns of behavior of radionuclides in farm animals. The study of the discipline "Veterinary Radiobiology" provides the acquisition of such general competencies as the ability to use modern knowledge about the patterns of ionizing radiation on the body of farm animals to effectively manage livestock production processes in contaminated areas.

<b>Academic degree, specialty, academic programme</b>		
Academic degree	<i>master's</i>	
Specialty	<i>H6 Veterinary Medicine</i>	
Academic programme	<i>" Veterinary Medicine "</i>	
<b>Characteristics of the discipline</b>		
Type	compulsory	
Total number of hours	120	
Number of ECTS credits	4	
Number of modules	3	
Course project (work) (if any)		
Form of assessment	<i>exam</i>	
<b>Indicators of the discipline for full-time and part-time forms of university study</b>		
	Full-time	Part-time
Year of study	2	
Semester	4	
Lectures	<i>15 hours</i>	<i>hours</i>
Practical classes and seminars		<i>hours</i>
Laboratory classes	<i>30 hours</i>	<i>hours</i>
Self-study	<i>75 hours</i>	<i>hours</i>
Number of hours per week for full-time students	<i>3 hours</i>	

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

The aim of studying the discipline "Veterinary Radiobiology" is to train a specialist who will be able to highly assess the radiation situation and develop measures to ensure the safety of animal husbandry in contaminated areas and obtaining "clean" from radionuclides livestock products.

*List of courses that must be completed prior to studying 'Veterinary Radiobiology' (where applicable) Inorganic chemistry, biophysics, animal physiology, animal pathophysiology*

### **Acquisition of competences:**

Integral competence (IC): ability to solve complex tasks and problems in the field of

veterinary medicine, which involves research and/or innovation and is characterised by uncertainty of conditions and requirements.

General competencies (GC):

GC03. Knowledge and understanding of the subject area and profession.

GC09. Ability to make informed decisions.

Special (professional) competences (SC):

SC16. Ability to protect the environment from contamination by livestock waste, as well as materials and veterinary products.

SC21. Ability to develop and implement measures to manage and prevent radiation damage and contamination of domestic animals and census in general with radionuclides.

Expected Learning Outcomes (ELO):

ELO10. Propose and use appropriate innovative methods and approaches to solving problem situations of professional origin.

ELO21. Develop measures to prevent radiation damage and contamination of livestock and census with radionuclides.

## 2. Programme and structure of the discipline

Modules and topics	Number of hours													
	full-time							part-time						
	weeks	total	including					total	including					
			l	p	lab	ind	s.st		l	p	lab	ind	s.s t	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	
<b>Module 1. Introduction. Physical foundations of radiobiology</b>														
Topic 1. Introduction Radiobiology and radioecology as a complete science	1	8	1		2		5							
Topic 2. Radioactivity, types of ionising radiation and their dosimetry	2	16	2		4		10							
Topic 3. Sources of ionising radiation on the Earth	3	8	1		2		5							
Topic 4. Physical basis of interaction ionising radiation with substances of cells of living organisms	4	8	1		2		5							
Total for module 1		40	5		10		25							
<b>Module 2. Effects of ionising radiation on living organisms</b>														
Topic 1. Biological effects of ionising radiation in plants and animals	5	14	2		2		10							
Topic 2. Radiosensitivity of plants, animals and other organisms	6	8	1		2		5							
Topic 3. Anti-radiation	7	9	1		2		6							

biological protection and radiosensitisation													
Topic 4. Methods of protecting agricultural animals from the effects of ionising radiations	8-9	9	1		4		4						
Total for module 2		40	5		10		25						
<b>Module 3. Migration of radionuclides in the environment in the environment. Conducting livestock farming in areas contaminated with radionuclides territories</b>													
Topic 1. Atmosphere and soil as initial links in the migration of radionuclides in the natural environment	10	6	1				5						
Topic 2. Uptake of radionuclides from soil into plants and animals, biological effect of incorporated radionuclides	10-12	10	1		4		5						
Topic 3. Measures to reduction of radionuclides intake in products livestock	13	8	1		2		5						
Topic 4. Cleaning of products livestock products from radionuclides by means of primary technological processing	14	8	1		2		5						
Topic 5. The use of ionising radiation in the biological and natural sciences human activity and method of isotopic indicators in biology and ecology.	15	8	1		2		5						
Total for module 3		40	5		10		25						
<i>Total hours</i>		120	15		30		75						

### 3. Topics of lectures

№	Topic title	Hours
1	Introduction. Radiobiology and radioecology as a complete science	1
2	Radioactivity, types of ionizing radiation and their dosimetry	2
3	Sources of ionising radiation on the Earth	1
4	Physical basis of interaction ionising radiation with substances of cells of living organisms	1
5	Biological effects of ionising radiation in plants and animals	2

6	Radiosensitivity of plants, animals and other organisms	1
7	Anti-radiation biological protection and radiosensitisation	1
8	Methods of protecting agricultural animals from the effects of ionising radiations	1
9	Atmosphere and soil as initial links in the migration of radionuclides in the natural environment	1
10	Uptake of radionuclides from soil into plants and animals, biological effect of incorporated radionuclides	1
11	Measures to reduction of radionuclides intake in products livestock	1
12	Cleaning of products livestock products from radionuclides by means of primary technological processing	1
13	The use of ionising radiation in the biological and natural sciences human activity and method of isotopic indicators in biology and ecology	1

#### 4. Topics of laboratory classes

№	Topic title	Hours
1	Radiation safety standards and sanitary rules for working with ionising radiation sources	4
2	Classification of dosimetric monitoring devices and their components. Preparation for operation of general general dosimetric monitoring devices - radiometers and roentgenometers	2
3	Calculations of absorbed and equivalent doses of external and internal exposure of the body of humans and animals at different levels of contamination of the territory by radionuclides	2
4	Determination of total $\beta$ -activity of various environmental objects and agricultural products by express methods	2
5	Types of ionising radiation doses, their measurement units, calculation and application	2
6	Determination of $\gamma$ -radiation dose rate on the ground, indoors, from control sources and compliance of the results with radiation safety standards (NRBU-97)	2
7	Determination of the density of $^{137}\text{Cs}$ contamination of the territory	2
8	Determination of $^{137}\text{Cs}$ in water, soil, feed, livestock, bee and fish products using modern radiometric equipment and compliance of the research results with the requirements of current regulatory documents	4
9	In vivo determination of $^{137}\text{Cs}$ content in animals and humans	2
10	Forecast of contamination levels of crop and livestock products with main dose-forming radionuclides	8

#### 5. Topics for self-study

№	Topic title	Hours
1	Radiation safety standards and sanitary rules for working with ionising radiation sources in Ukraine and in developed countries	5
2	The history of nuclear weapons and its consequences for the radiation state of the environment. Dynamics of changes in the radiation state after nuclear tests	10
3	Calculations of absorbed and equivalent doses of external and internal radiation in real conditions of radioactive contamination of the territory after the Chernobyl accident	10
4	Determination of total $\beta$ -activity of various environmental objects and agricultural products by express methods	10
5	Why there are several types of radiation doses in radiobiology	5
6	Determination of $\gamma$ -radiation dose rate on the ground, indoors, from control sources and compliance of the results with radiation safety standards	10
7	Methods for determining the density of contamination of the territory with artificial radionuclides	10
8	Peculiarities of determination of $^{137}\text{Cs}$ in water, soil, feed, livestock, bee and fish products using modern radiometric installations and compliance of research results with the requirements of current regulatory documents	10

9	In vivo determination of $^{137}\text{Cs}$ content in animals and humans	5
10	Forecast of contamination levels of crop and livestock products with main dose-forming radionuclides	10

## 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

Type of learning activity	Learning outcomes	Assessment
<b>Module 1. Introduction. Physical foundations of radiobiology</b>		
Lecture 1 Introduction. Radiobiology and radioecology as a complete science	ELO10, ELO21. Know the basic concepts of the nature of ionizing radiation, the structure of the atom and its basic physical characteristics. The structure of electronic shells and the nucleus of the atom. Nuclear forces, mass defect. The phenomenon of radioactivity, sources of ionizing radiation of natural and artificial origin. Types of ionizing radiation - electromagnetic and corpuscular, their physical characteristics. Types of nuclear transformations and the law of radioactive decay. Be able to characterize the phenomena of radioactivity, use units of measurement of radioactivity, determine the specific activity.	<b>5</b>
Laboratory class 1. Radiation safety standards and sanitary rules for working with ionising radiation sources		<b>5</b>
Self-study 1.		<b>5</b>
Lecture 2 Radioactivity, types of ionizing radiation and their dosimetry		<b>5</b>
Laboratory class 2. Classification of dosimetric monitoring devices and their components. Preparation for operation of general dosimetric monitoring devices - radiometers and roentgenometers		<b>10</b>
Self-study 2.		<b>5</b>
Lecture 3 Sources of ionising radiation on the Earth		<b>5</b>
Laboratory class 3. Calculations of absorbed and equivalent doses of external and internal exposure of the body of humans and animals at different levels of contamination of the territory by radionuclides		<b>10</b>
Self-study 3.		<b>5</b>
Lecture 4 Physical basis of interaction ionising radiation with substances of cells of living organisms		<b>5</b>

Laboratory class 4. Determination of total $\beta$ -activity of various environmental objects and agricultural products by express methods		<b>5</b>
Self-study 4.		<b>5</b>
Module test 1.		<b>30</b>
<b>Total for Module 1</b>		<b>100</b>
<b>Module 2. Effects of ionising radiation on living organisms</b>		
Lecture 5 Biological effects of ionising radiation in plants and animals	ELO10, ELO21. Know the patterns of biological action of ionizing radiation on biological structures and the body as a whole, classification of radiobiological effects and their dependence on the dose of ionizing radiation, modern ideas about the causes of different radiosensitivity of organisms, theoretical foundations of radiation sickness in farm animals and methods of farming.	<b>5</b>
Laboratory class 5. Types of ionising radiation doses, their measurement units, calculation and application		<b>5</b>
Self-study 5.		<b>5</b>
Lecture 6 Radiosensitivity of plants, animals and other organisms		<b>5</b>
Laboratory class 6. Determination of $\gamma$ -radiation dose rate on the ground, indoors, from control sources and compliance of the results with radiation safety standards (NRBU-97)	Understand the patterns of formation of absorbed doses of ionizing radiation in the body of animals and individual organs. Be able to calculate radiation doses and predict the severity of radiation damage to animals. Use laboratory equipment to determine dose criteria	<b>10</b>
Self-study 6.		<b>5</b>
Lecture 7 Anti-radiation biological protection and radiosensitisation		<b>5</b>
Laboratory class 7. Determination of the density of $^{137}\text{Cs}$ contamination of the territory		<b>10</b>
Self-study 7.		<b>5</b>
Lecture 8 Methods of protecting agricultural animals from the effects of ionising radiations		<b>5</b>
Laboratory class 8. Determination of $^{137}\text{Cs}$ in water, soil, feed, livestock, bee and fish products using modern radiometric equipment and compliance of the research results with the requirements of current regulatory documents		<b>5</b>
Self-study 8.		<b>5</b>
Module test 2.		<b>30</b>
<b>Total for Module 2</b>		<b>100</b>
<b>Module 3. Migration of radionuclides in the environment in the environment. Conducting livestock farming in areas contaminated with radionuclides territories</b>		
Lecture 9 Atmosphere and soil as initial links in the migration of radionuclides in the natural environment	ELO10, ELO21. To know the patterns of behavior of the main dose-forming radionuclides in agricultural ecosystems and ways of their entry into the body of farm animals, the danger of incorporated radionuclides.	<b>5</b>
Laboratory class 9. In vivo determination of $^{137}\text{Cs}$ content in animals and humans		<b>10</b>
Self-study 9.	Understand the hazard criteria for incorporated radionuclides and the principles of standardization of levels of radioactive contamination of livestock products.	<b>10</b>
Lecture 10 Uptake of radionuclides from soil into plants and animals, biological effect of incorporated radionuclides		<b>5</b>

Laboratory class 10. Forecast of contamination levels of crop and livestock products with main dose-forming radionuclides	Be able to determine the presence of radioactive contamination of farm animals and livestock products. Use laboratory equipment, modern laboratory devices to study the content of radionuclides in animals and products of animal origin.	<b>10</b>
Self-study 10.		<b>10</b>
Lecture 11 Measures to reduction of radionuclides intake in products livestock	To know the basics of radiation protection from ionizing radiation, the main directions of introduction of radiation technologies in agricultural production, to have an idea of the mechanisms and basic advantages of radiation technologies in terms of their application in animal husbandry and veterinary medicine. Understand the main processes occurring under the influence of radiation and the registration of radioactive indicators in biological objects. Use laboratory equipment for registration of radioactive indicators.	<b>10</b>
Lecture 12 Cleaning of products livestock products from radionuclides by means of primary technological processing		<b>5</b>
Lecture 13 The use of ionising radiation in the biological and natural sciences human activity and method of isotopic indicators in biology and ecology		<b>5</b>
Module test 3.		<b>30</b>
<b>Total for Module 3</b>		<b>100</b>
<b>Educational work</b>		<b><math>(M1 + M2+M3)/3*0,7 \leq 70</math></b>
<b>Examination</b>		<b>30</b>
<b>Total for the course</b>		<b><math>(Academic\ work + examination) \leq 100</math></b>

## 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

<b>Deadlines and exam retaking policy:</b>	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).
<b>Academic integrity policy:</b>	Cheating during tests and exams is prohibited (including using mobile devices). Term papers and essays must have correct references to the literature used
<b>Attendance policy:</b>	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

- <https://elearn.nubip.edu.ua/course/view.php?id=667> Veterinary Radiobiology
- 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. *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., Ілленко 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.

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

Department of General Ecology, Radiobiology and Safety of Life Activity

**APPROVED**

by the Dean of the Faculty of Veterinary Medicine

\_\_\_\_\_ Oleksandr VALCHUK

“ \_\_\_\_ ” \_\_\_\_\_ 2026

**APPROVED**

at the meeting of the Department of General  
Ecology, Radiobiology and Safety of Life Activity

Minutes No9 of “14” May 2026

Head of the Department

\_\_\_\_\_ (Alla KLEPKO)

**REVIEWED**

Guarantor of the AP “Veterinary Medicine”

\_\_\_\_\_ Volodymyr MELNYK

**CURRICULUM OF ACADEMIC DISCIPLINE  
VETERINARY RADIOBIOLOGY**

Field of knowledge 21 Veterinary Science

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