NATIONAL UNIVERSITY OF LIFE AND ENVIRONMENTAL SCIENCES OF UKRAINE

Radiobiology and Radioecology Department

"CONFIRMED"
Acting Dean of Faculty of Plant Protection,
Biotechnology and Ecology
_____J.V. Kolomiets
"___" _____2020

CONSIDERED AND APPROVED
at the meeting of Radiobiology and Radioecology Department
Protocol №_12_ from "_17_" _June___2020 p.
Head of the Department
_____A.V. Klepko

CURRICULUM WORKING PROGRAM

"EXPERIMENTAL RADIOECOLOGY"

Specialty:	101 - Ecology
Educational program:	«Ecology and Environmental Protection»
Faculty:	Plant protection, biotechnology and ecology
Developers:	Volodymyr Illienko , PhD in Biology, senior lecturer of Radiobiology and Radioecology Department
	Alla Klepko , PhD in Biology, Head of the Radiobiology and Radioecology Department

Kyiv – 2020

1. PURPOSE AND OBJECTIVE OF THE DISCIPLINE

The purpose of teaching the discipline "Experimental Radioecology" 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 task 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.

2. AFTER FINISHING OF COURSE STUDENTS HAVE TO

The student should 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.

Student should 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.

3. DISCIPLINE CONTENT AND TYPES OF EDUCATIONAL WORK

Types of educational activity	Total hours
The total laboriousness of the discipline	180
Lectures	30
Practical training	15
Independent student work	135
Type of final control	Exam

4. CONTENTS OF DISCIPLINE MODULES AND TYPES TO WORK

№	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	*Literature: 1-8*	4		14
1.2.	Biological effects of ionizing radiation Assessing impacts of ionizing radiation to man and the environment (principles, mechanisms,		4		14

	biomarkers)	*Literature: 1-5, 7,8*			
1.3.	Speciation of radionuclides in the environment	*Literature: 1-5, 7,8*	4	2	12
		Module 2. Experiment in radioecological research			
2.1	Field sampling and statistics in radioecology	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. 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. *Literature: 6-10*	2	3	12
2.2	Particularities of radionuclide contamination measurements	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. Requirements for soil sampling and preparation and measurement of radionuclide activity in them. *Literature: 6-8,11*	2	2	12
2.3	Radioactive particles and solid state speciation		2	2	14

		Literature: 6-8,13			
2.4.	Modeling within radioecology		4	2	15
		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.		2	2	14
		Literature: 1-5, 7,8			
3.2.	Freshwater radioecology		2	2	14
		Literature: 1-5, 7,8			
3.3	Terrestrial radioecology, transfer and countermeasures		4		14
		Literature: 1-3, 7			
		Total:	**30**	**15**	**135**

5.1 Criteria for calculating the maximum number of points in conditions of rating by hours:

Lectures - for each hour of listened and recapitulated lecture – 0.5 points.

Practical classes - for every hour of completed and assigned task of practical classes - 1 point.

Independent work - for every hour of self-prepared and assigned task – 0.2 points.

Rating (maximum) of the student by modules considering hours as a criterion

Module	$R_{e.w.}$	Credits	Lectures	Practice sessions	Independent work	Total
1	M_1	2.0	12 · 0.5 = 6	2 · 1 = 2	40 · 0.2 = 8	16
2	M_2	2.0	10 · 0.5 = 5	9 · 1 = 9	53 · 0.2 = 10.6	24.6
3	M_3	2.0	8 · 0.5 = 4	4 · 1 = 4	42 · 0.2 =8.4	16.4
	Total	6.0	15	15	27	**57**

Rating of educational work $\mathbf{R_{e.w.}}$ = 70 %, and rating of exam $\mathbf{R_{exam}}$ = 30 % from the total number of points (according to the Regulations).

In case of 100% mastering of discipline the student can get $\mathbf{R_{e.w.}}$ - 40 points, and $\mathbf{R_{exam}}$ - 17 points.

5.2 Rating of attestation for discipline

National score	ECTS	Definition ECTS	$R_{dis.}$, points	$R_{dis.}$, actual points for discipline
Excellent	A	***Excellent*** - perfectly performance, with only a small number of errors.	(0,9 – 1,0) · $R_{dis.}$	51 – 57
Good	B	***Very good*** - above average level with several mistakes	(0,82 – 0,89) · $R_{dis.}$	47 – 50
	C	***Good*** - generally correct with some mistakes	(0,75 – 0,81) · $R_{dis.}$	49 – 46
Satisfactory	D	***Satisfactory*** - not bad, but with a significant number of shortcomings	(0,66 – 0,74) · $R_{dis.}$	45 – 42
	E	***Enough*** - execution satisfies the minimum criteria	(0,60 – 0,65) · $R_{dis.}$	41 – 37

Unsatisfactory	FX	***Unsatisfactory*** **-** you need to work before getting a score (positive rating)	$(0{,}35 – 0{,}59) \cdot R_{dis.}$	36 – 33
	F	***Unsatisfactory*** **-** serious further work is needed	$(0{,}01 – 0{,}34) \cdot R_{dis.}$	1 – 32

5.3 Discipline rating

$$R_{dis.} = R_{e.w.} + R_{exam} + R_{add.w.} – R_{penal}$$

Assume that the student scored only 43 points, which is 75% of 6.0 credits or $\mathbf{R_{dis.}}$ of student is 4.5 credit.

6. EXAMPLE OF CONTROL TASKS

<table>
<tr><td colspan="4">National University of Life and Environmental Sciences of Ukraine</td></tr>
<tr><td>Master 1st year study
Specialty
Radioecology</td><td>Radiobiology and Radioecology Department
2020/2021 study year</td><td>Test № 1
from the course
Experimental Radioecology</td><td>Approved
Head of department

Klepko A.V.</td></tr>
<tr><td colspan="4">Questions</td></tr>
<tr><td colspan="4">1. Which are the key sources contributing to doses from ionizing radiation to the population in Ukraine?</td></tr>
<tr><td colspan="4">2. How can the radionuclide speciation influence the choice of countermeasures? Give minimum 3 examples of countermeasures that can reduce the biological uptake of radionuclides in animals and humans and explain your choices.</td></tr>
<tr><td colspan="4">Tests</td></tr>
<tr><td>1.</td><td colspan="3">1 Sievert is equal to ... ber</td></tr>
<tr><td>2.</td><td colspan="3">What element has an antagonist with Cs?
a) Sr; b) Ca; c) K; d) Pb</td></tr>
<tr><td>3.</td><td colspan="3">What phase of cell cycle is the most radiosensitive?
a) S; b) G_1; c) M; d) G_2</td></tr>
<tr><td>4.</td><td colspan="3">Arrange the correct links on types of radionuclides distribution in animals (few radionuclides can respond to one type)
<table><tr><td>1</td><td>bone</td></tr><tr><td>2</td><td>diffuse</td></tr><tr><td>3</td><td>reticuloendothelial</td></tr></table><table><tr><td>a</td><td>Transuranic elements</td></tr><tr><td>b</td><td>Cs</td></tr><tr><td>c</td><td>Sr</td></tr><tr><td>d</td><td>Rb</td></tr><tr><td>e</td><td>Pu</td></tr></table></td></tr>
<tr><td>5.</td><td colspan="3">Critical tissue in plants are:
a) phloem; b) xylem; c) meristem; d) parenchyma</td></tr>
<tr><td>6.</td><td colspan="3">Which of the natural potassium isotopes is radioactive?
a) ^{39}K; b) ^{40}K; c) ^{41}K; d) ^{42}K</td></tr>
<tr><td>7.</td><td colspan="3">Among vertebrate animals, the highest radioresistance have:
a) fishes; b) birds; c) mammals; d) reptile</td></tr>
<tr><td>8.</td><td colspan="3">A critical organ to ^{14}C is:
a) eye lens; b) bone tissue; c) spleen; d) fatty tissue</td></tr>
<tr><td>9.</td><td colspan="3">To construct the survival curve is carried out:
a) experiments in vacuum conditions; b) experiments on the neutralization of ionizing radiation; c) experiments with irradiation in different doses; d) experiments on irradiation in stimulating doses</td></tr>
<tr><td>10.</td><td colspan="3">The most effective way of removing ^{137}Cs from the organism of mammals:
a) through the kidneys; b) through sweat glands; c) through the mammary gland; d) through the gastrointestinal tract</td></tr>
</table>

7. RECOMMENDED LITERATURE

1. Choppin G. R., Liljenzin J.-O., Rydberg J. Radiochemistry and nuclear chemistry. 4th ed., Academic Press, 2013, 858 p.
2. Chernobyl: 30 Years of Radioactive Contamination Legacy. Report. Lead writer and coordination of report: Prof. Valerii Kashparov, Kyiv, 2016, 59 p.
3. Climate change and nuclear power. International Atomic Energy Agency, VIENNA, 2005, 112 p.
4. Natural and induced radioactivity in food. International Atomic Energy Agency, VIENNA, 2002, 136 p.
5. 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.
6. 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.
7. Radiation biology: a handbook for teachers and students. International Atomic Energy Agency, VIENNA, 2010, 150 p.
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. Tessier, A., Campbell, P. G. C. & Bisson, M. Sequential extraction procedure for the speciation of particulate trace-metals. Analytical Chemistry, 51 (7), 1979, p. 844-851.
12. Гудков І.М. Радіобіологія: підручник. – Херсон : Олді-Плюс, 2016. – 504 с.
13. Гудков І.М., Гайченко В.А., Кашпаров В.О. Сільськогосподарська радіоекологія: підручник. – К.: Ліра-К, 2017. – 268 с.
14. Моисеев А.А., Иванов В.И. Справочник по дозиметрии и радиационной гигиене. - М.: Энергоатомиздат, 1990. - 252с.
15. НРБУ-97/2000
16. Пристер Б.С., Лощилов Н.А., Немец О.Ф., В.А. Поярков. Основы сельскохозяйственной радиологии. - К.: -Урожай, 1991.- 472с.
17. 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.

18. Радиационный мониторинг облучения населения в отдаленный период после аварии на Чернобыльской АЭС, Рабочий Документ: ТС проект RER/9/074, Вена, Австрия, 2006, 81с.
19. Паренюк О.Ю., Іллєнко В.В., Гудков І.М. Мікрофлора забруднених радіонуклідами ґрунтів. – К.: Вид-во НУБіП України, 2018. – 198 с.
20. 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.
21. Якість ґрунту. Методи відбору проб ґрунту для радіаційного контролю, СОУ 74.14-37-425:2006.
22. Якість ґрунту. Визначення щільності забруднення території сільськогосподарських угідь радіонуклідами техногенного походження, СОУ 74.14-37-424:2006
23. Якість продукції рослинництва. Методи відбору проб для радіаційного контролю, СОУ 01.1-37-426:2006.
24. Якість продукції тваринництва. методи відбору проб для радіаційного контролю, СОУ 01.2-37-427:2006.
25. Якість продукції тваринництва. Проведення прижиттєвого контролю тварин на територіях, забруднених радіонуклідами, СОУ 01.2-37-428:2006.