**SYLLABUS OF AN ACADEMIC DISCIPLINE**
**« Experimental Radiobiology »**

**Academic degree - Master**
**Specialty – 101 «Ecology»**
**Academic programme « Ecology and Environmental Protection»**
**Year of study - 1-st, semester 2-nd**
**Form of study - full-time education**
**Number of ECTS credits - 4**
**Language(s) of instruction - English**

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| **Lecturer of the discipline** | **Ph.D., senior lecturer Volodymyr Illienko** |
| **Lecturer's contact information (e-mail)** | **illienkovv@gmail.com** |
| **URL of the e-learning course on the NULES e-learning portal** | **https://elearn.nubip.edu.ua/course/view.php?id=2682** |

## ACADEMIC DISCIPLINE DESCRIPTION

The purpose 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 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.

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 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.

***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.

## ACADEMIC DISCIPLINE STRUCTURE

| Topic | Hours (lectures/ practical works) | Results of study | Task | Evaluation |
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| **Module 1.** Radionuclides in the environment | | | | |
| **Topic 1.** Consequences of the largest radiation accidents and prospects for the use of contaminated areas for research | 4/- | **Know** foliar uptake of radionuclides into plants. Receipt of soluble radionuclides in plants from the air. Influence of physico-chemical properties of radionuclides on their transition from soil to plants through the roots. Influence of biological characteristics of plants, phases of their development and physiological state on the transition of radionuclides from the soil to plants. **Understand** features of migration of radionuclides in forest biogeocoenoses. Ways of radionuclides uptake into the body of animals. Quantitative indices of accumulation of radionuclides in the animal body: concentration factor (CF), absorption coefficient ($C_a$), biological elimination half-life of radionuclides ($T_{biol}$). The main ways of radionuclides withdrawal from the body of animals. | . | **10 point** |
| **Topic 2.** Biological effects of ionizing radiation Assessing impacts of ionizing radiation to man and the environment (principles, mechanisms, biomarkers) | 4/- | **Know** interaction of microorganisms with elements of nuclear fuel. Extremely radio-resistant microorganisms. **Understand** mechanisms of various interactions of bacteria and uranium: bioreduction, biomineralization, | | **10** |

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| | | biosorption and bioaccumulation. | | |
| **Topic 3.** Speciation of radionuclides in the environment | 4/2 | **Know** metabolism of strontium in natural contaminated ecosystems. Biogeochemistry of cesium and its interaction with soil microorganisms. **Understand** accumulation of $^{137}Cs$ by bacteria and their effect on the biological availability of radionuclides. | **Delivery of practical work №1.** | **10** |
| **Total module 1** | | | | **30** |
| **Module 2.** Experiment in radioecological research | | | | |
| **Topic 4.** Field sampling and statistics in radioecology | 2/3 | 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. | **Delivery of practical work №2.** | **10** |
| **Topic 5.** Particularities of radionuclide contamination measurements | 2/2 | 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. | **Delivery of practical work №3.** | **10** |

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| **Topic 6.** Radioactive particles and solid state speciation | 2/2 | **Know** labeled atoms. Radioactive and stable isotopes. Labeled compounds. Indicative dose. Basic ways of using isotopic indicators in research with plants. Investigation of transport and distribution of separate elements in plant. **Understand** features of the use of radioactive isotopes in vegetative and field studies. Radioautography. Features of the use of stable isotopes. | **Delivery of practical work №4.** | **10** |
| **Topic 7.** Modeling within radioecology | 4/2 | | **Delivery of practical work №5.** | **10** |
| **Total module 2** | | | | **40** |
| **Module 3.** Features of studying the state of radioactive isotopes under different conditions | | | | |
| **Topic 8.** Distribution, main fluxes and deposits of biologically active radionuclides ($^{137}$Cs and $^{90}$Sr) in forest ecosystems. | 2/2 | **Know** extremely radioresistant bacterium *Deinococcus radiodurans, Arthrobacter radiotolerans*. Isolation of strains of radiosensitive bacteria in an environment with extreme conditions of existence. **Understand** radiosensitivity of micromycetes. | **Delivery of practical work №6.** | **10** |
| **Topic 9.** Freshwater radioecology | 2/2 | **Know** assessment of microbial cenosis of territories contaminated by radioactive isotopes after the Chernobyl accident. Level of radioactivity of soil and biodiversity of soil microflora. Determination of soil cellulosic activity. **Understand** dynamics of ecological and trophic groups of soil microorganisms on contaminated radionuclide territories. | **Delivery of practical work №7.** | **10** |
| **Topic 10.** Terrestrial radioecology, transfer and countermeasures | 4/- | **Know** Metagenomics as a complex branch of knowledge. Metageno data analysis. Sequencing metagenoids. Bioinformatics analysis of 16s rRNA metagenome data. Metadata in metagenome analysis and their integration. | | **10** |

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| | | Determination of the main metrics of biodiversity. Check the quality of the sequencing data by the FastQC program. **Understand** MetaGenom data preprocessing in the QIIME software package. Clustering metagenome data in QIIME. | | |
| **Total module 3** | | | | **30** |
| **Additional points** | | | | **10** |
| **Total for the semester (30+30+40)*0,7** | | | | **70** |
| **Exam** | | | | **30** |
| **Total for the course** | | | | **100** |

## ASSESSMENT POLICY

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| ***Deadline and recompilation policy:*** | Works that are submitted in violation of the deadlines for more than a week without good reason are evaluated at a lower score (maximum - 20% of the maximum). Rearrangement of modules takes place with the permission of the lecturer if there are good reasons (for example, hospital or family problems). |
| ***Academic Integrity Policy:*** | Writing while writing modular test papers and the final exam is prohibited. The use of mobile devices during these periods is also prohibited. |
| ***Visiting policy:*** | Attendance is mandatory. For objective reasons (for example, illness, international internship) training can take place individually (in online form in consultation with the dean of the faculty). In case of violations and abuses (non-attendance more than 50% of the time - non-admission to the exam) |

## SCALE FOR ASSESSING STUDENTS 'KNOWLEDGE AND SKILLS

| **Rating of the applicant of higher education, points** | **The assessment is national for the results of examinations** | |
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| | **exams** | **offsets** |
| 90-100 | perfectly | credited |
| 74-89 | good | |
| 60-73 | satisfactorily | |
| 0-59 | unsatisfactorily | not credited |

## RECOMMENDED SOURCES OF INFORMATION


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

6. Natural and induced radioactivity in food. International Atomic Energy Agency, VIENNA, 2002, 136 p.
7. 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.
8. 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.
9. 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.
10. 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.
11. Salbu, B. Fractionation of radionuclide species in the environment. Journal of Environmental Radioactivity, 100 (4), 2009, p. 283-289.
12. https://www.iaea.org/publications
13. https://web.archive.org/web/20110515164252/http://www-pub.iaea.org/MTCD/publications/PDF/INES-2009_web.pdf
14. https://www.who.int/news/item/05-09-2005-chernobyl-the-true-scale-of-the-accident
15. https://www.iaea.org/newscenter/news/fukushima-nuclear-accident-update-log-15
16. http://www.unscear.org/docs/reports/2008/11-80076_Report_2008_Annex_C.pdf
17. https://www.wright.edu/sites/www.wright.edu/files/page/attachments/radiation-safety-biological-effects-of-ionizing-radiation.pdf
18. https://doi.org/10.1016/j.jenvrad.2008.12.013
19. https://doi.org/10.1007/978-3-319-22171-7