MINISTRY OF SCIENCE AND HIGHER EDUCATION OF THE RUSSIAN FEDERATION
Federal State Autonomous Educational Institution of Higher Education
**Far Eastern Federal University**
(FEFU)

**INSTITUTE OF LIFE SCIENCES AND BIOMEDICINE (SCHOOL)**

AGREED
Head of Educational Program
_____ V.V. Kumeiko
(Signed) (Surname)

CLAIM
Director of the Production Company Structural subdivision
_____ V.V. Kumeiko
(Signed) (Surname)
April 12, 2023

WORK PROGRAM OF THE DISCIPLINE
*Radiation Biology*
*Area of study 06.03.01 Biology*
*Form of training: full-time*

*The work program is drawn up in accordance with the requirements of the Federal State Educational Standard in the field of training 06.03.01 Biology, approved by the order of the Ministry of Education and Science of the Russian Federation dated 07.08.2020 No. 9 20*

The work program was discussed at the meeting of the Department of Medical Biology and Biotechnology, Minutes No. 3 dated April 12, 2023.

Director of the Department of Medical Biology and Biotechnology V.V. Kumeiko

Compiled by: Ph.D. Kumeiko V.V.

Vladivostok
2022

Back of the title page of the RPD

*1. The work program was revised at the meeting of the Department/Department/Division (implementing the discipline) and approved at the meeting of the Department/Department/Division (graduating structural unit), minutes of "*
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*2. The work program was revised at the meeting of the Department/Department/Division (implementing the discipline) and approved at the meeting of the Department/Department/Division (graduating structural unit), minutes of "*
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# Abstract of the discipline

*Radiation Biology*

The total labor intensity of the discipline is 1 credit unit / 36 academic hours. It is a discipline of the optional part of the EP, studied in the 2nd year and ends *with a test.* The curriculum provides for lectures in the amount of *8* hours, practical classes of *18* hours , and also allocated hours for independent work of the student - *10 hours.*

**Language:** Russian.

**Purpose:** to form a stable system of ideas about modern radiobiology as a fundamental complex scientific discipline that studies the effect of ionizing radiation on biological objects of different levels of organization.

**Tasks:**

- to give an idea of the physical and dosimetric foundations of radiobiology;
- to develop a deep understanding of the essence of the main radiobiological phenomena and problems in various areas of this fundamental science;
- to assimilate modern ideas about the mechanisms of biological action of radiation and protection from its damaging effects;
- to acquaint with the possibilities of practical use of radiobiology achievements;
- to contribute to the formation of the necessary skills of general biological thinking through the study of the basics of radiobiology.

For successful study of the discipline, students should have the following preliminary competencies:

- Provides knowledge of the basics of interaction between organisms and their environment, environmental factors and mechanisms of response of organisms, principles of population ecology, ecology of communities; fundamentals of the organization and stability of ecosystems and the biosphere as a whole;
- comprehends the principles of structural and functional organization of biological systems;
- and uses physiological, cytological, histological, biochemical, biophysical methods of analysis to assess the state of living objects and monitor their habitat.

Competencies are obtained as a result of studying the disciplines of *general biology and biochemistry.*

Students' Competencies, Indicators of Their Achievement and Learning Outcomes in the Discipline

| Competency code and name (result of mastering) | Code and name of the competency indicator |
|---|---|
| PC-4 Able to understand and analyze, and apply the principles of cellular and tissue organization of biological objects, biochemical and molecular-biological mechanisms of the development of pathological processes in cells and tissues of the human body to preserve the health of the population | PC-4.3 Understands and investigates the physical processes underlying the functioning of the body in normal and pathological conditions, understands the influence of physical factors on the functioning of biological systems, is able to study the physical structure of biologically important molecules in order to identify the relationship between the structure of substances and their biological activity |

| Code and name of the competency indicator | Name of the assessment indicator (the result of learning in the discipline) |
|---|---|
| PC-4.3 Understands and investigates the physical processes underlying the functioning of the body in normal and pathological conditions, understands the influence of physical factors on the functioning of biological systems, is able to study the physical structure of biologically important molecules in order to identify the relationship between the structure of substances and their biological activity | Knows<br>the physical structure of biologically important molecules and the physical processes underlying their functioning.<br>Can<br>determine the relationship between the physical structure and properties and the functions that perform them in the body.<br>Owns<br>skills to study the physical structure of biologically important molecules and the physical processes underlying their functioning |

To form the above competencies within the framework of the discipline "Radiation Biology", the following educational technologies and methods of active/interactive learning are used: business game, work in small groups, round table.

## I. Goals and objectives of mastering the discipline

**Purpose:** to form a stable system of ideas about modern radiobiology as a fundamental complex scientific discipline that studies the effect of ionizing radiation on biological objects of different levels of organization.

**Tasks:**

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- to assimilate modern ideas about the mechanisms of biological action of radiation and protection from its damaging effects;
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| | |
|---|---|
| | physical processes underlying their functioning |

## II. Labor intensity of the discipline and types of training in the discipline

The total labor intensity of the discipline is 1 credit unit (36 academic hours), (1 credit corresponds to 36 academic hours).

## III. Structure of the discipline:

The form of study is full-time.

| № | Section Name Discipline | Semester | Number of hours by type of training and work of the student | | | | | | Forms of intermediate attestation |
|---|---|---|---|---|---|---|---|---|---|
| | | | Mild | Lab | Ave | OK | WED | Control | |
| 1 | Introduction to chickenswith radiobiology. History of radiobiology development. | 3 | 0,5 | | 2 | | | | Questions for the test |
| 2 | Physical Basis of the Effect of Ionizing Radiation on Biological Objects. | | 0,5 | | 2 | | | | |
| 3 | Direct and indirect effects of ionizing radiation. Theoretical Concepts of the Mechanism of Biological Action of Ionizing Radiation. | | 0,5 | | 1 | | | | |
| 4 | Molecular Aspects of the Biological Action of Ionizing Radiation. Reaction of cells to radiation. | | 1 | | 2 | | | | |
| 5 | Radiosensitivity of tissues, organs, body. Radiation syndromes. | | 1 | | 2 | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 6 | Acute and chronic radiation sickness. | | 1 | | 2 | | | | |
| 7 | Biological action of incorporated radioactive substances. | | 0,5 | - | 2 | - | 10 | - | |
| 8 | Post-radiation cell restoration. Recovery processes in the irradiated body. | | 1 | | 2 | | | | |
| 9 | Long-term effects of radiation exposure. Radiation-induced carcinogenesis. Hereditary effects of irradiation. | | 1 | | 1 | | | | |
| 10 | Fundamentals of Radioecology. | | 1 | | 2 | | | | |
| | Total: | 3 | 8 | - | 18 | - | 10 | - | Credit |

## IV. CONTENT OF THE THEORETICAL PART OF THE COURSE

### Lecture

Section 1. Introduction to chickenswith radiobiology. History of the development of radiobiology.

Radiobiology as a subject. The main tasks of general radiobiology. Radiobiological paradox. Discovery of X-rays and radioactivity. The role of scientists V.K. Röntgen, A.A. Becquerel, M. Curie-Skłodowska, P. Curie and others in the formation of the science of radiobiology as an independent discipline. Three stages of radiobiology development.

Section 2. Physical Basis of the Effect of Ionizing Radiation on Biological Objects.

Atomic structure. Radionuclides. Radioactive decay. Activity of a radioactive element, units of activity. Basic Properties and Characteristics of Ionizing Radiation. Electromagnetic radiation. Corpuscular radiation. Linear Power Transmission (LPE). Ionization density. Penetrating power. Protection against external ionizing radiation.

Section 3. Direct and indirect effects of ionizing radiation. Theoretical Concepts of the Mechanism of Biological Action of Ionizing Radiation.

Direct action of radiation. Physical stage. Physicochemical stage. Chemical stage. Indirect (indirect) effects of radiation. The effect of radiation on water molecules (radiolysis of water). Formation of solute radicals. Contribution of direct and indirect actions to the destruction of target molecules. "Dilution effect". Modification of the indirect effect of radiation. Quantitative and Qualitative Approaches to Explaining the Paradox of the Biological Action of AI. The Principle of Hitting and the Theory of the Target. Hit and target theory. Stochastic Theory of the Biological Action of Ionizing Radiation. Probabilistic model of radiation damage to the cell. Hypothesis of lipid radiotoxins and chain reactions. Structural-metabolic theory of the effect of radiation on the cell.

Section 4. Molecular Aspects of the Biological Action of Ionizing Radiation. Reaction of cells to radiation.

Molecular damage that occurs in a cell when exposed to ionizing radiation. Radiation delay of cell division. Cell death after irradiation. Cellular radiosensitivity. Cell survival curves under the influence of densely ionizing radiation. Cell survival curves under sparsely ionizing radiation. Curves of cell survival in the region of low doses of radiation. Radiosensitivity of cells in different phases of the cell cycle. Impaired reproductive function of cells when exposed to radiation. Interphase cell death. Apoptosis. Necrosis.

Section 5. Radiosensitivity of tissues, organs, body. Radiation syndromes.

Methods and Criteria for Radiosensitivity Assessment. The relativity of the concept of "tissue radiosensitivity". Factors that determine radiosensitivity. The integral indicator of radiosensitivity of the body is LD50/30. Interspecific radiosensitivity. Intraspecific radiosensitivity. Age-related radiosensitivity. Radiation syndromes: bone marrow, intestinal, cerebral. Deterministic effects of irradiation.

Section 6. Acute and chronic radiation sickness.

Classification of Acute Radiation Sickness (ARS). Severity of ARS. Dose-dependent survival (prognostic categories). Factors influencing the course of ARS (type of exposure, time factor, spatial factor). Primary general reaction phase; the phase is latent; the height of the disease; Early recovery phase. Classification of chronic radiation sickness (CHD). Periods of disease development. Severity of CLB. Grade 1 HLB: clinical manifestations; the condition of blood cells and bone marrow; biochemical parameters; morphological changes in tissues and organs.

Section 7. Biological action of incorporated radioactive substances.

Basic properties of radioactive substances as toxic agents (nature of radiation, intensity of radiation, value of absorption coefficient, distribution within the body, rate of excretion from the body, duration of intake of radioactive substances). Routes

of entry of radioactive substances into the body. Radiobiological assessment of lesions with incorporated radionuclides. Difference between external and internal irradiation. Consequences of radionuclide lesions. Preventing absorption and accelerating the elimination of radionuclides from the body.

Section 8. Post-radiation cell restoration. Recovery processes in the irradiated body.

Repair of radiation damage to DNA. Recovery from potentially lethal damage. Recovery from sublethal injuries. Cell Recovery and Dose Rate. LPE and the cell's ability to regenerate. A method of quantitative assessment of the post-radiation recovery of the body. Dynamics of Radiosensitivity of the Organism in the Post-Radiation Period. Post-radiation restoration of the blood system. Acceleration of the processes of division and maturation of hematopoietic cells in the post-radiation period. Sequence of restoration of various hematopoietic sprouts. Post-radiation restoration of low-renewal tissues.

Section 9. Long-term effects of radiation exposure. Radiation-induced carcinogenesis. Hereditary effects of irradiation.

Somatic and inherited long-term effects of radiation exposure. Stochastic and non-stochastic radiation effects. Shortening of life expectancy, development of sclerotic and degenerative changes, occurrence of malignant neoplasms. Mechanisms of long-term effects of irradiation. Prediction of carcinogenic effects of radiation. Regularities of radiation carcinogenesis. Radiation leukemias. Thyroid cancer. Mechanisms of radiation-induced carcinogenesis. Mechanism of action of radiation on the body in the molecular genetic aspect. Radiation-induced genome instability. Biological and medical consequences of induced mutagenesis in the human population. Hereditary effects of irradiation. Radiation mutations (gene, chromosomal, multifactorial).

Section 10. Fundamentals of Radioecology.

Natural background radiation – cosmic radiation; terrestrial sources. External and internal irradiation. Biological significance of natural background. Sources of radioactive contamination of the environment. Migration of the most significant radionuclides in the main natural environments (atmosphere, soil, etc.). The concept of biological and food chains of radionuclide migration. Protection of the environment from radioactive contamination: regulation of the content of radionuclides in the environment.

## V. CONTENT OF THE PRACTICAL PART OF THE COURSE AND INDEPENDENT WORK

### Practical exercises

**Topic 1.** Introduction to chickenswith radiobiology. History of the development of radiobiology.

**Topic 2**. Physical Basis of the Effect of Ionizing Radiation on Biological Objects.

**Topic 3**. Direct and indirect effects of ionizing radiation. Theoretical Concepts of the Mechanism of Biological Action of Ionizing Radiation.

**Topic 4**. Molecular Aspects of the Biological Action of Ionizing Radiation. Reaction of cells to radiation.

**Topic 5.** Radiosensitivity of tissues, organs, body. Radiation syndromes.

**Topic 6.** Acute and chronic radiation sickness.

**Topic 7.** Biological action of incorporated radioactive substances.

**Topic 8.** Post-radiation cell restoration. Recovery processes in the irradiated body.

**Topic 9.** Long-term effects of radiation exposure. Radiation-induced carcinogenesis. Hereditary effects of irradiation.

**Topic 10.** Fundamentals of Radioecology.

### Self-paced work

Independent work includes:

1) library or homework with educational literature and lecture notes;

2) preparation for practical exercises;

3) work with microslides in the laboratory;

4) preparation for testing and control interviews;

The order of independent work by students is determined by the schedule of independent work in the discipline (see below)

Control of the results of independent work is carried out in the course of laboratory classes, oral surveys, interviews and tests, including by testing

Control questions and tasks for current control and intermediate certification based on the results of mastering the discipline follow from the thematic content of the discipline.

Students' independent work consists of preparing for practical classes, working on recommended literature, writing reports on the topic of the seminar, and preparing presentations.

The teacher offers each student individual and differentiated assignments. Some of them can be carried out in a group (for example, the preparation of a report and a presentation on the same topic can be done by several students with a division of their responsibilities - one prepares the scientific and theoretical part, and the second analyzes the practice).

Independent work can be carried out individually or by groups of students, depending on the purpose, volume, specific topic of independent work, level of complexity and level of skills of students.

Control of the results of students' independent work should be carried out within the time allotted for compulsory classes and extracurricular independent work of students in the discipline, can take place in written, oral or mixed form.

**Self-paced tasks**

1. Writing an essay on a topic proposed by the teacher or independently chosen by the student and agreed with the teacher.
2. Preparation of presentations using multimedia equipment.

**Topics of abstracts and presentations**

1. Natural background radiation (ERF) and radioactive contamination of the environment. The effect of hormesis on an increase in ERF.
2. Creation of atomic weapons. The Manhattan Project. Atomic Project.
3. Low doses of ionizing radiation. Threshold and non-threshold concepts of low-dose biological risk.
4. Aftermath of the atomic bombing of Hiroshima and Nagosaki.
5. Radiation accidents, catastrophes, incidents. International Nuclear Event Scale (IAEA 88)
6. Nuclear power plants. Pros and cons.
7. Radioisotope dosimetry.
8. Radiopharmaceuticals in medical diagnostics.
9. CyberKnife and Gamma Knife in Radiation Therapy
10. Biography and scientific activity of N.V. Timofeev-Ressovsky.
11. Ionizing radiation as a component of the biosphere environment. The significance of radiations for the development and existence of living beings.
12. Development of nuclear physics and power engineering. Application of radiation in various fields of economic activity, science, medicine.
13. The problem of protecting man and the environment from the damaging effect of ionizing radiation and radioactive contamination.
14. Anthropocentric and ecocentric approaches to radiation safety.
15. Relevance of the study of the biological effect of radiation.

16. Ensuring radiation safety of the population.
17. Biological monitoring of radioactively contaminated territories.

## VI. EDUCATIONAL AND METHODOLOGICAL SUPPORT OF STUDENTS' INDEPENDENT WORK

Independent work is defined as individual or collective learning activities carried out without the direct supervision of the teacher, but according to his tasks and under his supervision. Independent work is a cognitive learning activity, when the sequence of the student's thinking, his mental and practical operations and actions depends and is determined by the student himself.

Independent work of students contributes to the development of independence, responsibility and organization, a creative approach to solving problems at the educational and professional levels, which ultimately leads to the development of the skill of independent planning and implementation of activities.

The purpose of students' independent work is to acquire the necessary competencies in their field of training, experience in creative and research activities.

Forms of independent work of students:

- work with basic and additional literature, Internet resources;
- independent acquaintance with the lecture material presented on electronic media, in the library of an educational institution;
- preparation of abstract reviews of periodical press sources, reference notes, predetermined by the teacher;
- search for information on the topic with its subsequent presentation in the audience in the form of a report, presentations;
- preparation for classroom tests;
- Performing home tests;
- Performance of test tasks, problem solving;
- compilation of crosswords, schemes;
- preparation of reports for presentation at a seminar, conference;
- filling in the workbook;
- writing essays, term papers;
- preparation for business and role-playing games;
- Writing a resume;
- preparation for tests and exams;
- other types of activities organized and carried out by the educational institution and student self-government bodies.

## Guidelines for writing and formatting an abstract

An essay is a creative activity of a student, which reproduces in its structure research activities to solve theoretical and applied problems in a certain branch of scientific knowledge. For this reason, coursework is the most important component of the educational process in higher education.

An essay, being a model of scientific research, is an independent work in which the student solves a problem of a theoretical or practical nature, applying scientific principles and methods of this branch of scientific knowledge. The result of this scientific research can have not only subjective, but also objective scientific novelty, and therefore can be presented for discussion by the scientific community in the form of a scientific report or a report at a scientific and practical conference, as well as in the form of a scientific article.

The abstract involves the acquisition of skills for building business cooperation based on ethical standards of scientific activity. Purposefulness, initiative, disinterested cognitive interest, responsibility for the results of one's actions, conscientiousness, competence are the personal qualities that characterize the subject of research activities that correspond to the ideals and norms of modern science.

An essay is an independent educational and research activity of a student. The instructor provides advice and evaluates the process and results. He provides an approximate topic of abstracts, clarifies the problem and topic of research together with students, helps to plan and organize research activities, appoints a time and a minimum number of consultations.

The teacher accepts the text of the essay for review at least ten days before the defense.

Traditionally, there is a certain structure of the abstract, the main elements of which, in the order of their arrangement, are the following:

1. Title page.
2. Task.
3. Table of Contents.
4. List of symbols, symbols and terms (if necessary).
5. Introduction.
6. Main part.
7. Conclusion.
8. References.
9. Applications.

The title page indicates: educational institution, graduating department, author, teacher, research topic, place and year of the abstract.

The title of the abstract should be as brief as possible and fully correspond to its content.

The table of contents (contents) reflects the names of the structural parts of the abstract and the pages on which they are located. It is advisable to place the table of contents at the beginning of the work on one page.

The presence of a detailed introduction is a mandatory requirement for the abstract. Despite the small volume of this structural part, its writing causes significant difficulties. However, it is the high-quality introduction that is the key to understanding the entire work, testifying to the professionalism of the author.

Thus, the introduction is a very important part of the abstract. The introduction should begin with a justification of the relevance of the chosen topic. When applied to an abstract, the concept of "relevance" has one peculiarity. How the author of the essay is able to choose a topic and how correctly he understands and evaluates this topic from the point of view of modernity and social significance, characterizes his scientific maturity and professional training.

In addition, in the introduction, it is necessary to identify the methodological base of the abstract, to name the authors whose works formed the theoretical basis of the study. A review of the literature on the topic should show the author's thorough familiarity with specialized literature, his ability to systematize sources, critically consider them, highlight the essential, and determine the main thing in the current state of study of the topic.

The introduction reflects the significance and relevance of the chosen topic, defines the object and subject, the purpose and objectives, and the chronological framework of the study.

The introduction concludes with a statement of general conclusions about the scientific and practical significance of the topic, the degree of its study and provision with sources, and the formulation of a hypothesis.

In the main part, the essence of the problem is stated, the topic is revealed, the author's position is determined, factual material is provided as an argument and to illustrate the proposed provisions. The author needs to demonstrate the ability to consistently present the material while simultaneously analyzing it. Preference is given to the main facts rather than small details.

The abstract ends with the final part, which is called the "conclusion". Like any conclusion, this part of the abstract plays the role of a conclusion conditioned by the logic of the research, which is in the form of a synthesis of the scientific information accumulated in the main part. This synthesis is a consistent, logically harmonious presentation of the results obtained and their correlation with the general goal and specific tasks set and formulated in the introduction. It is here that the so-called "inferential" knowledge is contained, which is new in relation to the original

knowledge. The conclusion may include suggestions of a practical nature, thereby increasing the value of the theoretical materials.

So, the conclusion of the abstract should include: a) the conclusions of the study; b) theoretical and practical significance, novelty of the abstract; c) the possibility of applying the results of the study is indicated.

After the conclusion, it is customary to place a bibliographic list of the references. This list is one of the essential parts of the abstract and reflects the independent creative work of the author of the abstract.

A list of the sources used is placed at the end of the work. It is drawn up either in alphabetical order (by the author's surname or the title of the book), or in the order in which references appear in the text of the written work. In all cases, the full title of the work, the names of the authors or the editor of the publication, if a team of authors participated in the writing of the book, data on the number of volumes, the name of the city and publishing house in which the work was published, the year of publication, the number of pages are indicated.

**Guidelines for Preparing Presentations**

To prepare a presentation, it is recommended to use: PowerPoint, MS Word, Acrobat Reader, LaTeX beamer package. The easiest program to create presentations is Microsoft PowerPoint. To prepare a presentation, it is necessary to process the information collected when writing the abstract.

Sequence of presentation preparation:

1. Clearly state the purpose of the presentation.

2. Determine what the format of the presentation will be: live performance (how long it will be) or e-mailing (what will be the context of the presentation).

3. Select all the content for the presentation and build a logical chain of presentation.

4. Identify the key points in the content of the text and highlight them.

5. Determine the types of visualization (pictures) to be displayed on slides in accordance with the logic, purpose and specifics of the material.

6. Choose the design and format the slides (the number of pictures and text, their location, color and size).

7. Check the visual perception of the presentation.

Types of visualization include illustrations, images, diagrams, tables. An illustration is a representation of a real-life visual series. Images, as opposed to illustrations, are metaphors. Their purpose is to evoke an emotion and create an attitude towards it, to influence the audience. With the help of well-thought-out and presented images, information can stay in a person's memory for a long time. Diagram – visualization of quantitative and qualitative relationships. They are used for convincing demonstration of data, for spatial thinking in addition to logical

thinking. A table is a concrete, visual and accurate display of data. Its main purpose is to structure information, which sometimes makes it easier for the audience to perceive the data.

*Practical tips for preparing a presentation*

– printed text + slides + handouts are prepared separately;

– Slides – visual presentation of information, which should contain a minimum of text, a maximum of images that carry a semantic load, look clear and simple;

– Textual content of the presentation – oral speech or reading, which should include arguments, facts, evidence and emotions;

– Recommended number of slides 17-22

– mandatory information for the presentation: topic, surname and initials of the speaker; Communication plan brief conclusions from all that has been said; list of references;

– Handouts – should provide the same depth and reach as a live performance: people trust what they can take with them more than disappearing images, words and slides are forgotten, and the handout remains a constant tangible reminder; Handouts should be given out at the end of the presentation, handouts should be different from slides, should be more informative.

**Criteria for evaluating the abstract.**

The stated understanding of the abstract as an integral author's text determines the criteria for its evaluation: novelty of the text; the reasonableness of the choice of source; the degree of disclosure of the essence of the issue; compliance with the design requirements.

**Novelty of the text:** a) relevance of the research topic; b) novelty and independence in the formulation of the problem, formulation of a new aspect of the known problem in the establishment of new connections (interdisciplinary, intra-subject, integration); c) ability to work with research, critical literature, systematize and structure material; d) the manifestation of the author's position, the independence of assessments and judgments; e) stylistic unity of the text, unity of genre features.

**Degree of disclosure of the essence of the issue:** a) correspondence of the plan to the topic of the abstract; b) correspondence of the content to the topic and outline of the abstract; c) completeness and depth of knowledge on the topic; d) the validity of the ways and methods of working with the material; f) the ability to generalize, draw conclusions, compare different points of view on one issue (problem).

**Reasonableness of the choice of sources:** a) assessment of the literature used: whether the most well-known works on the topic of research are involved

(including journal publications of recent years, the latest statistical data, summaries, references, etc.).

**Compliance with formatting requirements:** a) how correctly the references to the literature used, the list of references; b) assessment of literacy and culture of presentation (including spelling, punctuation, stylistic culture), knowledge of terminology; c) compliance with the requirements for the length of the abstract.

**The reviewer should clearly formulate** a comment and questions, preferably with references to the work (it is possible to specific pages of the work), to research and factual data that the author did not take into account.

**The reviewer can also indicate: whether the student** has addressed the topic before (essays, written works, creative works, Olympiad works, etc.) and whether there are any preliminary results; how the graduate conducted the work (plan, intermediate stages, consultation, revision and revision of the written or lack of a clear plan, rejection of the recommendations of the supervisor).

**The student submits an abstract for review no later than a week before the defense.** The reviewer is the teacher. Experience shows that it is advisable to familiarize the student with the review a few days before the defense. Opponents are appointed by a teacher from among the students. 10-20 minutes is enough for a student to make an oral presentation (this is about the time it takes to answer the exam tickets).

**Grade 5 is given if all the requirements for writing and defending an abstract are met: the problem is** identified and its relevance is justified, a brief analysis of various points of view on the problem under consideration is made and one's own position is logically stated, conclusions are formulated, the topic is fully disclosed, the volume is maintained, the requirements for external design are met, correct answers to additional questions are given.

**Grade 4 – the** main requirements for the abstract and its defense have been met, but at the same time there are shortcomings. In particular, there are inaccuracies in the presentation of the material; there is no logical consistency in judgments; the volume of the abstract is not maintained; there are omissions in the design; Incomplete answers were given to additional questions during the defense.

**Grade 3** – there are significant deviations from the abstract requirements. In particular, the topic is covered only partially; factual errors were made in the content of the abstract or in answering additional questions; There is no conclusion during the defense.

**Grade 2 – the** topic of the abstract is not disclosed, a significant misunderstanding of the problem is revealed.

**Grade 1 – the** abstract is not submitted by the student.

## VII. MONITORING THE ACHIEVEMENT OF THE COURSE OBJECTIVES

| Item No. | Supervised sections/topics of the discipline | Codes and Stages of Competency Formation | | Evaluation Tools | |
|---|---|---|---|---|---|
| | | | | Current control | Intermediate Attestation |
| 1 | Introduction to chickenswith radiobiology. History of radiobiology development. | PC-4.3 Understands and investigates the physical processes underlying the functioning of the body in normal and pathological conditions, understands the influence of physical factors on the functioning of biological systems, is able to study the physical structure of biologically important molecules in order to identify the relationship between the structure of substances and their biological activity | Knows<br>the physical structure of biologically important molecules and the physical processes underlying their functioning.<br>Can<br>determine the relationship between the physical structure and properties and the functions that perform them in the body.<br>Owns<br>skills to study the physical structure of biologically important molecules and the physical processes underlying their functioning | Oral Questioning | Exam Questions |
| 2 | Physical Basis of the Effect of Ionizing Radiation on Biological Objects | | | Test | Exam Questions |
| 3 | Direct and indirect effects of ionizing radiation. Theoretical Concepts of the Mechanism of Biological Action of Ionizing Radiation. | | | Oral Questioning | Exam Questions |
| 4 | Molecular Aspects of the Biological Action of Ionizing Radiation. Reaction of cells to radiation. | | | Oral Questioning | Exam Questions |
| 5 | Radiosensitivity of tissues, organs, body. Radiation syndromes. | | | Test | Exam Questions |
| 6 | Acute and chronic radiation sickness. | | | Test | Exam Questions |

| | | | | | |
|---|---|---|---|---|---|
| 7 | Biological action of incorporated radioactive substances. | | | Test | Exam Questions |
| 8 | Post-radiation cell restoration. Recovery processes in the irradiated body. | | | Test | Exam Questions |
| 9 | Long-term effects of radiation exposure. Radiation-induced carcinogenesis. Hereditary effects of irradiation. | | | Test | Exam Questions |
| 10 | Fundamentals of Radioecology. | | | Test | Exam Questions |

## VIII. LIST OF REFERENCES AND INFORMATIONAL AND METHODOLOGICAL SUPPORT OF THE DISCIPLINE

Reference citations

1. General and Medical Radiology: Radiation Technologies: Textbook for Higher Educational Institutions / V. N. Kulakov [i dr.] ; edited by A. N. Usenko. — 2nd ed. — Moscow: Yurayt Publishing House, 2023. — 217 p. — (Higher education). — ISBN 978-5-534-15184-8. — Text : electronic // Educational platform Yurayt [site]. — URL: https://urait.ru/bcode/519363

2 Bespalov, V. I. Supervision and control in the field of security. Radiation Protection: Textbook for Higher Educational Institutions / V. I. Bespalov. — 6th ed., add. — Moscow: Yurayt Publishing House, 2022 ; Tomsk: Tomsk Polytechnic University Publ.. — 722 p. — (Higher education). — ISBN 978-5-534-15062-9 (Urait Publishing House). ISBN 978-5-4387-0924-4 (Tomsk Polytechnic University Press). — Text : electronic // Educational platform Urait [site]. — URL: https://urait.ru/bcode/490313

3. Tashlykov, O. L. Yadernye tekhnologii: uchebnoe posobie dlya srednego professional'nogo obrazovaniya [Nuclear Technologies: Textbook for Secondary Professional Education] / O. L. Tashlykov; edited by S. E. Shcheklein. - Moscow: Yurayt Publishing House, 2023. — 210 p. — (Professional education). — ISBN 978-5-534-14184-9. — Text : electronic // Educational platform Urait [site]. — URL: https://urait.ru/bcode/519966

4. Klimanov, V. A. Nuclear Medicine. Radionuclide Diagnostics: Textbook for Higher Educational Institutions / V. A. Klimanov. - 2nd ed., ispr. i dop. — Moscow: Yurayt Publishing House, 2023. — 307 p. — (Higher education). — ISBN 978-5-534-06485-8. — Text : electronic // Educational platform Urait [site]. — URL: https://urait.ru/bcode/514613

Further reading

1. Radiobiology [Text]: textbook for higher education institutions / [N. P. Lysenko et al.] ; edited by N. P. Lysenko, V. V. Pak. — Ed. 2nd, ispr. — St. Petersburg [et al.]: Lan, 2012. — 569 p. : ill. — (Textbooks for Higher Educational Institutions, Special Literature). — Words. Radio Ecol Terms: P. 560-563. — Author. are indicated in the region. — References: p. 564-565. — ISBN 978-5-8114-1330-0.

2. Osnovy radiobiologii i radiatsionnoy meditsina [Basics of radiobiology and radiation medicine] [Text]: textbook / A. N. Grebenyuk [i dr.]. St. Petersburg, Foliant Publ., 2012. — 226 p. : ill. — References: p. 225-226 and at the end of the chapter — ISBN 978-5-93929-223-8.

List of resources of the information and telecommunication network "Internet"

1. http://elibrary.ru/ - Scientific Electronic Library
2. http://molbiol.ru/ - Molecular Biology Information Resource
3. http://macroevolution.narod.ru/ is an electronic resource on evolutionary biology.
4. http://science.km.ru/ - electronic resource on different sections of biology
5. http://elementy.ru/ is an informational and educational resource dedicated to natural sciences.
6. http://www.iprbookshop.ru/ is the IPRbooks electronic library system.
7. http://znanium.com/ - EBS "Znanium".
8. https://nplus1.ru/ - N+1, a popular science online publication about science, engineering and technology
9. http://antropogenez.ru/ is a popular science information resource about human evolution
10. http://web.a.ebscohost.com/ehost/search/basic?sid=851485f8-6200-4b3e-aaab-df4ba7be3576@sessionmgr4008&vid=1&tid=2003EB is a collection of books on various sections from the EBSCOhost database.
11. http://rosalind.info/problems/locations/-resource for self-study of bioinformatics Rosalind.
12. http://www.ncbi.nlm.nih.gov/ website of the-National Center for Biotechnology Information (NCBI).
13. http://www.mendeley.com/-Mendeley: Free reference manager and PDF organizer; Librarian Program.
14. http:// www.ebi.ac.uk-website of the European Bioinformatics Institute
15. http:// www.scopus.com – Scopus bibliographic database and citation index
16. http://thomsonreuters.com/thomson-reuters-web-of-science/ Web of Science bibliographic database and citation index

List of information technologies and software

1. Microsoft Office Professional Plus 2013 is an office suite that includes software for working with various types of documents (texts, spreadsheets, databases, etc.);
2. 7Zip 16.04 - free file archiver with high data compression ratio;
3. Adobe Acrobat XI Pro is a software package for creating and viewing electronic publications in PDF format;

4. AutoCAD Electrical 2015 - three-dimensional computer-aided design and drafting system;
5. ESET Endpoint Security 5 is a comprehensive protection solution for Windows-based workstations. Virtualization support + new technologies;
6. WinDjView 2.0.2 is a program for recognizing and viewing files with the same DJV and DjVu formats; SolidWorks 2016 is a CAD software package for automating the work of an industrial enterprise at the stages of design and technological preparation of production
7. Compass-3D LT V12 - Three-Dimensional Simulation System
8. Notepad++ 6.68 – Text Editor

## IX. METHODICAL INSTRUCTIONS FOR MASTERING THE DISCIPLINE

### Lecture

**The lecture is the**-main active form of classroom classes, the explanation of the fundamental and most difficult theoretical sections of molecular biology and the theory of genetic engineering, which involves intensive mental activity of the student and is especially important for mastering the subject. A lecture should always be cognitive, developmental, educational and organizing. Lecture notes help to assimilate the theoretical material of the discipline. When listening to a lecture, you need to take notes main information, preferably with your own wording, which allows you to better remember the material. An outline is useful when it is written by the student independently.

In the lecture, the teacher gives only a small part of the material on certain topics that are presented in the textbooks. In addition, the instructor informs students about what additional information can be obtained on the topics discussed, and from what sources. Therefore, when working with lecture notes, it is always necessary to use the main textbooks, additional literature and other recommended sources on this discipline. It is this serious work of the student with the lecture material that allows him to achieve success in mastering new knowledge.

To present a lecture course on the discipline "Genetic Engineering", the following are used as forms of active learning: lecture-conversation, lecture-visualization, which are built on the basis of knowledge received by students in the framework of subjects preceding the course. Electronic presentations, tables, video files, and blackboard diagrams are used to illustrate verbal information. In the course of the lecture material, problematic questions or questions with elements of discussion are posed.

**Lecture – visualization**

The lecture is accompanied by the demonstration of tables, electronic presentations, video files - such a combination of ways of presenting information significantly simplifies its mastering by students. Verbal presentation of the material should be accompanied and combined with the visual form. The information presented in the form of diagrams on the board, tables, slides allows you to form problematic questions, and contribute to the development of professional thinking of future specialists.

**Lecture-conversation**

Lecture-conversation, "dialogue with the audience", is the most common form of active learning and allows students to be involved in the educational process, since there is direct contact between the teacher and the audience. Such contact is achieved during the lecture, when students are asked questions of a problematic or informational nature, or when they are invited to ask the teacher questions themselves. Questions are offered to the entire audience, and any of the students can offer their own answer; another can complement it. In the course of the educational process, this allows you to identify the most active students and activate those who do not participate in the work. This form of lecture allows you to involve students in the work process, attract their attention, stimulate thinking, gain collective experience, and learn how to form questions. The advantage of a lecture-conversation is that it allows you to draw students' attention to the most important issues of the topic, determine the content and pace of the presentation of educational material, as well as determine the topics that are most interesting to students, in order to possibly adjust the form of the material taught.

**Labs**

They are used for conducting experiments, observations of phenomena and processes by students mainly in special laboratories, classrooms and with the use of technical means. This method stimulates action both in the preparation for research and in the process of its implementation. Laboratory work improves the quality of education, contributes to the development of cognitive activity in students, their logical thinking and creative independence. In the process of laboratory work, theoretical knowledge is deepened and concretized, and the ability to apply it in practice is developed. Skills in working with microscopes, tables and atlases are acquired. The student learns to analyze the data obtained, identify the norm and deviation from it, acquires the skills of working with a living object and physiological measuring devices, performing operations, conducting a comparative analysis, summarizing the material obtained and drawing conclusions. All this allows for a deeper understanding of the mechanisms of the functioning of a living organism and the principles of its interaction with the environment. Research skills and professional competencies are formed.

Traditionally, laboratory classes are the main type of training aimed at experimental confirmation of theoretical positions. In the course of a laboratory lesson, students perform one or more laboratory works (tasks) under the guidance of a teacher in accordance with the content of the educational material being studied. Students perform laboratory work aimed at:

- generalization, systematization, deepening of theoretical knowledge on specific topics of the academic discipline;
- formation of skills to accept the acquired knowledge in practical activities;
- development of analytical, design and constructive skills;
- development of independence, responsibility and creative initiative.

Necessary structural elements of the laboratory lesson:

- instruction given by the teacher;
- independent activities of students;
- Discussion of the results of the laboratory work (task).

Before completing the laboratory task (work), the students' knowledge is tested, i.e. their theoretical readiness to perform the task.

**A laboratory task (work) can be reproductive, partially exploratory and exploratory in nature**.

Works of **a reproductive** nature are distinguished by the fact that when conducting them, students use detailed instructions, which indicate: the purpose of the work, explanations (theory, main characteristics), equipment, apparatus, materials and their characteristics, the procedure for performing the work, tables, conclusions (without formulations), control questions, educational and special literature.

The works, which are of a **partial-exploratory** nature, are distinguished by the fact that during the conduct of the works, students do not use detailed instructions, they are not given the order of performing the necessary actions, students are required to independently select equipment, choose ways to perform work, instructive and reference literature.

**Exploratory** works are distinguished by the fact that students have to solve a problem that is new to them, relying on their theoretical knowledge.

The forms of organization of students for conducting a laboratory lesson - frontal, group and individual - are determined by the teacher, based on the topic, goal, and order of work. In the frontal form of organizing classes, all students do the same work. In the group form of organizing classes, the same work is carried out in teams of 2-5 people. With an individual form of organizing classes, each student performs an individual task.

The results of the laboratory task (work) are drawn up by students in the form of a report, the grades for the performance of the laboratory task (work) are indicators of the current performance of students in the academic discipline.

Research skills and professional competencies are formed.

## Colloquia

Colloquium is a collective form of consideration and consolidation of educational material. Colloquia is one of the types of practical classes designed for in-depth study of the discipline, held in an interactive mode. In the classes on the topic of the colloquium, questions are analyzed, and then, together with the teacher, they are discussed, which is aimed at consolidating the material, forming polemic skills, developing independence and critical thinking, the ability of students to navigate in large information flows, to develop and defend their own position on problematic issues of the academic discipline.

As methods of interactive learning at colloquiums, the following are used: an extended conversation, a dispute, a press conference.

**An extended conversation involves the** preparation of students on each issue of the lesson plan with a single list of recommended mandatory and additional literature. Reports are prepared by students on a pre-proposed topic.

**A** dispute in a group has a number of advantages. A dispute can be caused by the teacher during the lesson or planned by him in advance.

**Press conference. The teacher** assigns several students to prepare short (thesis) reports. After the presentations, students ask questions, which are answered by the speakers and other members of the expert group. Based on the questions and answers, a creative discussion unfolds together with the teacher.

**Case study** method**.**The case-study method is a method of active problem-situational analysis based on learning by solving specific problems (case solving). The method of specific situations (case-study method) refers to non-game imitation active teaching methods and is considered as a tool that allows you to apply theoretical knowledge to solving practical problems. At the end of the lesson, the teacher tells a series of situations and offers to find solutions for those problems that are voiced in them. At the same time, the problem itself does not have unambiguous solutions. Students must analyze the situation, understand the essence of the problems, propose possible solutions and choose the best one. Thanks to the knowledge gained at the lecture, it is easy for the student to correlate the theoretical knowledge received with a real practical situation. As an interactive teaching method, it gains a positive attitude from students, who see it as an opportunity to take the initiative, feel independent in mastering theoretical provisions and mastering practical skills. No less important is the fact that the analysis of situations has a strong impact on the professionalization of students, contributes to their

maturation, forms interest and positive motivation for learning. The method is aimed not so much at mastering specific knowledge or skills, as at developing the general intellectual and communicative potential of the student and the teacher.

It is a learning method designed to improve skills and gain experience in the following areas:

- identifying, selecting and solving problems;
- working with information – comprehending the meaning of the details described in the situation;
- analysis and synthesis of information and arguments;
- working with assumptions and conclusions;
- evaluation of alternatives;
- decision-making;
- Listening to and understanding other people is a group work skill. The main function of the case method is to teach students to solve complex unstructured problems that cannot be solved in an analytical way. The case activates students, develops analytical and communicative skills, leaving students face to face with real situations.

**The case** study is designed to increase the effectiveness of educational activities: as an illustration for solving a certain problem, explaining a particular phenomenon, studying the features of its manifestations in real life, developing competence aimed at solving various life and work situations (the use of the case involves individual and group work of students).

**Brainstorming is** a widely used way of generating new ideas to solve scientific and practical problems. Its goal is to organize collective thinking to find non-traditional ways to solve problems.

The use of the brainstorming method in the educational process allows you to solve the following tasks:

- creative assimilation of educational material by students;
- connection of theoretical knowledge with practice;
- • activation of educational and cognitive activities of students;
- formation of the ability to concentrate attention and mental efforts on the solution of an urgent task;
- formation of the experience of collective thinking activity.

The problem formulated in the brainstorming class should have theoretical or practical relevance and arouse the active interest of students. A common requirement that must be taken into account when choosing a problem for brainstorming is the possibility of many ambiguous solutions to the problem, which is put forward to students as a learning task.

### Quizzes & Testing

Current control of material assimilation is assessed by oral answers, tests, as well as paper testing.

Assessments of laboratories, colloquiums, tests and testing mainly form the grade for this discipline.

## X. LOGISTICAL SUPPORT OF DISCIPLINE

Training sessions on the discipline are held in rooms equipped with appropriate equipment and software.

The list of logistical and software of the discipline is given in the table.

### Logistical and software of the discipline

| Name of special rooms and rooms for independent work | Equipment special rooms and rooms for self-study | List of licensed software. Details of the supporting document |
|---|---|---|
| 690922, Primorsky Krai, Vladivostok, Russky Island, Saperny Peninsula, Ajax village, 10, aud. M 605 | Multimedia audience: Electric Screen 236*147cm Trim Screen Line; DLP Projector, 3000 ANSI Lm, WXGA 1280x800, 2000:1 EW330U Mitsubishi; CORSA-2007 Tuarex Specialized Equipment Fastening Subsystem; Video Switching Subsystem: Extron DXP 44 DVI Pro DVI Matrix Switcher; Extron DVI 201 Tx/Rx twisted-pair DVI extender Audio switching and sound amplification subsystem; Extron SI 3CT LP ceiling mount speaker system; Extron DMP 44 LC Digital Audio Processor; Extension for IPL T CR48 control controller;Wireless LAN for students is provided by a system based on 802.11a/b/g/n 2x 2 MIMO (2SS) access points. Моноблок HP ProOne 400 All-in-One 19.5 (1600x900), Core i3-4150T, 4GB DDR3-1600 (1x4GB), 1TB HDD 7200 SATA, DVD+/-RW, GigEth, Wi-Fi, BT, usb kbd/mse, | - |

| | | |
|---|---|---|
| | Win7Pro (64-bit)+Win8.1Pro(64-bit), 1-1-1 Wty | |
| 690922, Primorsky Krai, Vladivostok, Russky Island, Saperny Peninsula, Ajax village, 10, aud. M 422 | Multimedia audience: HP ProOne 400 G1 AiO 19.5" Intel Core i3-4130T 4GB DDR3-1600 SODIMM (1x4GB)500GB All-in-One PC; Projection screen Projecta Elpro Electrol, 300x173 cm; Multimedia projector, Mitsubishi FD630U, 4000 ANSI Lumen, 1920x1080; Mortise interface with TLS TAM 201 Stan automatic cable retraction; Avervision CP355AF visualizer; Sennheiser EW 122 G3 UHF lavalier microphone radio system consisting of a wireless microphone and receiver; LifeSizeExpress 220-Codeconly- Non-AES video conferencing codec; Multipix MP-HD718 Network Video Camera; Two 47" LCD panels, Full HD, LG M4716CCBA; Audio switching and sound amplification subsystem; Centralized, uninterrupted power supply | - |
| 690922, Primorsky Krai, Vladivostok, Russky Island, Saperny Peninsula, Ajax village, 10, aud. M 627 | Light microscope Carl Zeiss GmbH Primo Star 3144014501 (13 pcs.); Light microscope with digital camera Altami BIO8 (2 pcs.). | - |
| Computer class of the School of Biomedicine aud. M723, 15 workplaces | Electric Screen 236*147cm Trim Screen Line; DLP projector, 3000 ANSI Lm, WXGA 1280x800, 2000:1 EW330U Mitsubishi; CORSA-2007 Tuarex Specialized Equipment Fastening Subsystem; Video Switching Subsystem: Extron DXP 44 DVI Pro DVI Matrix Switcher; Extron DVI 201 Tx/Rx twisted-pair DVI extender Audio switching and sound amplification subsystem; Extron SI 3CT LP Ceiling Mount Speaker System Extron DMP 44 LC Digital Audio Processor; extension for IPL T CR48 | - |

| | | |
|---|---|---|
| | control controller; Wireless LAN for students is provided by a system based on 802.11a/b/g/n 2x2 MIMO(2SS) access points. Monoblock HP RgoOpe 400 All-in-One 19.5 (1600x900), Core and3-4150T, 4GB DDR3-1600 (1x4GB), 1TB HDD 7200 SATA, DVD+/-RW, GigEth, Wi- Fi, VT, usb kbd/mse, Win7Pro (64-bit)+Win8.1Pro(64-bit), 1-1-1 Wty | |