Ministry of Science and Higher Education of the Russian Federation
Federal State Autonomous Institution of Higher Education
“National Research Nuclear University “MEPhI”

INSTITUTE OF ENGINEERING PHYSICS FOR BIOMEDICINE

APPROVED НТС ИФИБ

Protocol No. 3.1

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ACADEMIC COURSE OUTLINE

РАДИОБИОЛОГИЯ / RADIOBIOLOGY

Educational program track (speciality) [1] 31.05.01 General Medicine

Semester	**Labour input, credits**	**Total course academic, hours**	**Lectures, hrs.**	**Practical sessions, hrs.**	**Laboratory sessions, hrs.**	**In the form of practical studies, hrs.**	**Independent studies, hrs.**	**Independent studies monitoring, hrs.**	**Course progress, Exam/Pass-fail exam/Term**
3	3	108	18	36	0		54	0	PFE
Total	3	108	18	36	0	0	54	0	

ABSTRACT

The academic discipline is aimed at acquiring knowledge in the field of radiation biology and nuclear medicine.

The discipline is an introduction to radiobiology, in particular those aspects of the subject that have practical applications. Radiation is used to treat cancer, but it can also cause it. Radiation is also used in medical diagnostics and in nuclear power plants. In these areas, where questions about the benefits and harms arise, it is now possible to predict the biological effects of radiation. The discipline is aimed at studying the mechanisms by which ionizing radiation causes damage to molecules and cells. It will be useful for medical students interested in radiation therapy, nuclear medicine, and diagnostic radiography. This discipline provides an excellent opportunity to fill the gap in the biological effects of radiation on humans.

1. ACADEMIC COURSE GOALS AND OBJECTIVES

The main goal of studying the academic discipline is development of professional competence in the field of radiobiology and nuclear medicine.

2. PLACE OF THE ACADEMIC COURSE IN THE MAIN HIGHER EDUCATION CURRICULUM

The academic discipline belongs to the cycle of the variable part. It is the basis for the study of such academic disciplines as Radio diagnostics, Radiotherapy and Medical physics that medical students will study in their senior years.

3. DEVELOPED COMPETENCIES AND INTENDED LEARNING OUTCOMES

Universal and/or general professional competencies:

Competency code and title	**Code and title of competency-based rubrics**
ОПК-5 [1] – Capable of assessing morphofunctional and physiological states, as well as pathological processes in the human body to solve professional tasks.	З-ОПК-5 [1] – Know: - basic medical, pharmaceutical, and morphofunctional terminology, including Latin terms; - structure and functions of the human body, age-related, gender-specific, and individual characteristics of the structure and development of a healthy organism; - physical and chemical nature of processes occurring in a living organism; - patterns of vital activity of the organism, mechanisms of self-regulation and regulation; - features of regulation of the functioning of human body systems in pathological conditions; - patterns of occurrence, development, and outcome of typical pathological processes, the concept of sanogenesis; - etiology and pathogenesis of the most common diseases; - the concept of nosology, principles of disease classification; - principles of microorganism classification, their morphology, physiology, and impact on human health; - structure and functions of the human immune system. У-ОПК-5 [1] – Be able to: - analyze mechanisms of disease

	development and manifestation; - recognize morphological and functional changes in cells, tissues, organs, and systems of the human body; - use basic physical-chemical and other natural science concepts and methods in solving professional tasks; - determine the cause of death and formulate a pathological diagnosis. B-ОПК-5 [1] – Possess skills in: - conducting microscopy and analyzing microscopic specimens; - correlating morphological and clinical manifestations of diseases; - assessing morphofunctional, physiological states, and pathological processes in humans; - clinical-anatomical analysis of autopsy results.

4. PEDAGOGIC POTENTIAL OF THE COURSE

Pedagogic tracks/objectives	**Pedagogic goals (code)**
Intellectual education	Establishing conditions for: formation of culture of intellectual work (B11)
Vocational and labor education	Establishing conditions for: formation of a deep understanding of the profession's social role, a positive and active commitment to the values of the chosen specialty, and a responsible attitude towards professional activity and work (B14)

5. ACADEMIC COURSE STRUCTURE AND CONTENT

Academic course sections, their scope, terms of study and assessment:

No.	**Academic course section name**	**Weeks**	**Lectures/ Practical (seminars)/ Laboratory sessions, hrs.**	**Compulsory current assessment (form*, week)**	**Maximum grade per section****	**Section assessment (form*, week)**	**Competency-based rubrics**
	3 Semester						
1	Unit 1	1-8	8/16/0	TstP-8 (25)	25	SA-8	З-ОПК-5, У-ОПК-5, В-ОПК-5
2	Unit 2	9-15	10/20/0	TstP-14 (25)	25	SA-15	З-ОПК-5, У-ОПК-5, В-ОПК-5
	Totals for 3 Semester		18/36/0		50		
	Assessment events for 3 Semester				50	PFE	З-ОПК-5, У-ОПК-5, В-ОПК-5

* – abbreviated name of assessment

** – 100 maximum points per semester including a pass/fail exam and (or) an exam

Abbreviated current assessment forms and section assessment

Abbreviation	**Full name**
SA	Summative assessment
TstP	Test paper
PFE	Pass/fail examination

SYLLABUS

Weeks	**Topics / Content**	**Lect., hrs.**	**Pr./sem., hrs.**	**Lab., hrs.**
	3 Semester	18	36	0
1-8	**Unit 1**	8	16	0
1 - 4	**Fundamentals of radiobiology** Accidental exposure / Nuclear explosions. Hiroshima and Nagasaki (August 1945). Nuclear explosions. Nuclear bomb tests. Major accidents. The Chernobyl accident. Major accidents. The Fukushima Daiichi accident Occupational exposure / Industry. Occupational exposure: Nuclear fuel cycle. Industry. Uranium Mine Personnel. Medical personnel. Occupational exposure: radiologists. Medical personnel Exposure from natural sources / Cosmic ray. Cancer incidence in airline cabin crew. High natural background. Health effect of radon. Radon cancer Europe.	All 0 Online 4 (FtL)	 0 8 (FtM)	 0 0
5 - 8	**Basic radiobiology and radiotherapy** Medical exposure, Exposure from natural sources Medical exposure / X-ray diagnostics. CT-scan. PET-Technology. Brachytherapy. Risk of cancer following radiotherapy Classification of radiations in radiobiology. Cell cycle and cell death. Irradiation of cells. Type of radiation damage. Cell survival curves. Dose response curves. Measurement of radiation damage in tissue. Normal and tumour cells: Therapeutic ratio. Oxygen effect. Relative biological effectiveness. Dose rate and fractionation. Radioprotectors and radiosensitizers	All 0 Online 4 (FtL)	 0 8 (FtM)	 0 0
9-15	**Unit 2**	10	20	0
9 - 12	**Acute Radiation Syndrome. Clinical picture, diagnosis and treatment** Clinical manifestations. Approaches to diagnosis and treatment.	All 0 Online 4 (FtL)	 0 8 (FtM)	 0 0
13 - 16	**Radiation safety of ionizing radiation** Chromosome aberrations & exposure to mutagens Radiation effects and timescales. Biological properties of ionizing radiation. Molecular effects of radiation and their modifiers. DNA damage and repair. Cellular effects of	All 0 Online 3 (FtL)	 0 7 (FtM)	 0 0

	radiation. Gross radiation effects on tumours and tissues/organs. Special radiobiological consideration in targeted radionuclide therapy Radiation safety of ionizing radiation			

Abbreviated names of online options:

Abbreviation	**Full name**
EC	E-course
FtM	Full-text material
FtL	Full-text lectures
VM	Video materials
AM	Audio materials
Prs	Presentations
T	Tests
ERM	E-reference materials
IS	Interactive site

PRACTICAL SESSIONS TOPICS

Weeks	**Topics / Content**
	3 Semester
1 - 4	**Exposure to environmental mutagens.** Cancer & environmental mutagens.
5 - 8	**Fundamentals of radiobiology** Occupational exposure
9 - 12	**Acute Radiation Syndrome.** Clinical manifestations. Approaches to diagnosis and treatment.
13 - 16	**Radiation safety of ionizing radiation** Chromosome aberrations & exposure to mutagens

6. EDUCATIONAL TECHNOLOGIES

Teaching methods include the use of multimedia, interactive teaching methods and laboratory equipment to acquire theoretical knowledge and practical skills.

For self-preparation for practical classes and exams, students are given access to full-text textbooks and articles from electronic databases:

1. www.isir.ras.ru/ - Integrated Information Resources System of the Russian Academy of Sciences.

2. www.merlot.org/merlot/materials.htm?category=2608&&sort.property=overallRating - MERLOT - Multimedia Educational Resource for Learning and Online Teaching. Section "Biology"

3. www.nature.ru - Textbooks, scientific monographs, reviews, laboratory workshops in free access on the website of the journal Nature.

4. Test tasks on topics on electronic media.

7. ASSESSMENT TOOLKIT

The assessment toolkit ensures verification of the intended learning outcomes achievement (competency-based rubrics) using current, midterm and interim assessment of the course.

The link between developed competencies and their assessment is presented in the following table:

Competency	**Achievement rubrics**	**Assessment activity (Syl 1)**
ОПК-5	З-ОПК-5	PFE, SA-8, SA-15, к.р-8, к.р-14
	У-ОПК-5	PFE, SA-8, SA-15, к.р-8, к.р-14
	В-ОПК-5	PFE, SA-8, SA-15, к.р-8, к.р-14

Educational achievement rubrics scales

The scale of each assessment activity varies from 0 to the maximum established point, inclusive. The final assessment of the course is performed on a 100-point scale and represents the sum of the points earned by the student in the section assessments, framework of current and interim assessment.

Sections and interim assessments are considered passed when the student achieves a minimum score equal to 60% of the maximum. The final grade is assigned only upon passing all sections and the interim assessment.

The final grade is assigned in accordance with the following scale:

<table>
<tr><th>Total score</th><th>Rating on a 4-point scale</th><th>Pass/fail examination</th><th>ECTS assessment</th></tr>
<tr><td>90-100</td><td>5 – «excellent»</td><td rowspan="7">«pass»</td><td>A</td></tr>
<tr><td>85-89</td><td rowspan="3">4 – «good»</td><td>B</td></tr>
<tr><td>75-84</td><td>C</td></tr>
<tr><td>70-74</td><td rowspan="2">D</td></tr>
<tr><td>65-69</td><td rowspan="2">3 – «satisfactory»</td></tr>
<tr><td>60-64</td><td>E</td></tr>
<tr><td>below 60</td><td>2 – «fail»</td><td>«fail»</td><td>F</td></tr>
</table>

An “excellent” grade indicates a deep and solid mastery of the program material by a student who presents their answers consistently, clearly, and logically, is able to closely link theory with practice, and uses materials from monographic literature in their answers.

A “good” grade corresponds to a student’s solid knowledge of the material, who presents their answers competently and to the point, without any significant inaccuracies.

A “satisfactory” grade corresponds to the basic level of mastery of the material by the student, in which the main material has been mastered, but its details have not been assimilated, the answers contain inaccuracies, insufficiently correct wording and logical inconsistencies.

A grade “pass” corresponds to at least a basic level of mastery of the program material, in which the student possesses the necessary knowledge, skills, and abilities, and is able to apply theoretical principles to solve typical practical problems.

A grade “fail” is given to a student who lacks a significant understanding of the curriculum material, makes significant errors in their answers, or fails all required assignments. These students are generally unable to continue their studies without additional classes.

8. ACADEMIC COURSE EDUCATIONAL, METHODOLOGICAL AND INFORMATIONAL SUPPORT

CORE READING:

1. ЭИ L35 Laser-Driven Particle Acceleration Towards Radiobiology and Medicine : , , Cham: Springer International Publishing, 2016

2. ЭИ S15 Physics and Radiobiology of Nuclear Medicine : , Saha, Gopal B. , New York, NY: Springer New York,, 2006

3. ЭИ R13 Radiobiology of Glioblastoma : Recent Advances and Related Pathobiology, , Cham: Springer International Publishing, 2016

FURTHER READING:

1. ЭИ H99 Applications of Synchrotron Radiation : Micro Beams in Cell Micro Biology and Medicine, Ide-Ektessabi, Ari. , Berlin, Heidelberg: Springer Berlin Heidelberg,, 2007

SOFTWARE:

1. Microsoft Office 2016+ ()

2. Microsoft Word (K64-303)

LMS AND ONLINE RESOURCES

1. Radiation biology (https://online.mephi.ru)

https://online.mephi.ru/

http://library.mephi.ru/

9. LOGISTICAL SUPPORT

1. Персональный компьютер: Моноблок Lenovo V540-24IWL All-In-One 23,8" i3-8145U 8Gb 256GB_SSD_M.2 Intel (64-304)

2. Мышь, клавиатура (64-304)

3. Проектор SMART P109 (64-304)

4. Мебель лабораторная, стулья, шкафы для хранения (64-304)

5. Шкаф лабораторный вытяжной "Лабтех" ШВ202 (64-304)

6. Бинокулярные микроскопы "Микромед 2" (64-304)

7. Тринокулярный микроскоп "Микромед 1" (64-304)

8. Видеоокуляр ToupCam 10,0 MP (64-304)

9. Интерактивная доска SMART SBM 685 (64-401)

10. EDUCATIONAL AND METHODOLOGICAL RECOMMENDATIONS FOR STUDENTS

5-point rating-ECTS score 90 ÷ 100 a student is rated as "excellent" if he has thoroughly and firmly mastered the program material, presents it comprehensively, consistently, clearly and logically harmoniously, is able to closely correlate theory with practice, and uses the material of monographic literature in his answer.

D, C, B "good" 70 ÷ 89 a student is rated "good" if they have a solid knowledge of the material, correctly and substantially present it, avoiding significant inaccuracies in the answer to the question.

D, d "satisfactory" 60 ÷ 69 a student is rated "satisfactory" if he / she only knows the main material, but has not mastered its details, admits inaccuracies, insufficiently correct wording and violations of the logical sequence in the presentation of the program material.

F "unsatisfactory" less than 60 the "unsatisfactory" rating is given to a student who does not know a significant part of the program material and makes significant mistakes. As a rule, the rating “unsatisfactory " is assigned to students who cannot continue their studies without additional classes in the relevant discipline.

11. EDUCATIONAL AND METHODOLOGICAL RECOMMENDATIONS FOR TEACHERS

Grading and criteria for tests, extended quizzes, homework, and the final test:

1) - Tests are graded according to the following formula: 1 point for every 1 correct answer. A student who has not started the test receives -1 point.

2) - Extended quizzes are graded according to the following formula: complete answer -2 points, incomplete answer -1 point, no answer -0 points, student who has not started the test -2 points.

3) - Homework must be completed by all students to be eligible for the final assessment. Late submissions will result in a deduction of -1 point from the final score.

4) - Presentation report grading criteria. Conversion from a 100-point to a 10 (5)-point system

5) - Essay evaluation criteria. Maximum 10 points. May be upgraded to a 5-point system.

10 points are awarded if all essay writing requirements are met: the problem is identified and its relevance justified, a brief analysis of the issue is provided and a logically presented personal position is presented, conclusions are formulated, the article is fully analyzed, the length is maintained, and formatting requirements are met.

9 points are awarded if the following essay writing requirements are met: the problem is identified and its relevance justified, a brief analysis of the issue is provided and a logically presented

personal position is presented, conclusions are formulated, the article is fully analyzed, but the length is not maintained and formatting requirements are not met.

8 points - the main essay requirements are met, but some shortcomings are present. In particular, there are inaccuracies in the presentation of the material; there is a lack of logical consistency in the judgments; The abstract's length is not maintained; there are omissions in the formatting.

7 points – the basic abstract requirements are met, but the following shortcomings are present: there are inaccuracies in the presentation of the material; there is a lack of logical consistency in the judgments; conclusions are not formulated, the abstract's length is not maintained; there are omissions in the formatting.

6 points – there are significant deviations from the abstracting requirements; the topic is only partially covered; there are factual errors in the abstract's content, conclusions and a personal point of view on the problem are missing.

5 points – there are significant deviations from the abstract requirements: the topic is only partially covered; there are factual errors in the presentation of materials and methods, conclusions and a personal point of view on the problem are missing, the format is not maintained.

4 points – there are significant deviations from the abstract requirements: the relevance of the topic is not disclosed; Factual errors were made in the presentation of materials and methods, conclusions and personal perspective on the problem are missing, and the format is not followed.

3 points – there is no analysis of the relevance of the research topic, approaches, and methods used, although the formal length of the abstract is met.

2 points – the abstract topic is not covered, revealing a significant misunderstanding of the problem. However, the abstract length and formal requirements are met.

1 point – the abstract topic is not covered, revealing a significant misunderstanding of the problem.

0 points – the student did not submit an abstract.

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