MINISTRY OF HEALTH OF THE REPUBLIC OF BELARUS
Educational Institution
BELARUSIAN STATE MEDICAL UNIVERSITY

APPROVED
by Rector of the Educational Institution «Belarusian State Medical University»
_____ S.P.Rubnikovich
20.11.2024
Reg. # UD-091-080/2425 /edu.

RADIATION MEDICINE AND ECOLOGY

Curriculum of the educational institution in the academic discipline for the specialty

7-07-0911-01 «General Medicine»

2024

Curriculum is based on the educational program «Radiation Medicine and Ecology», approved 20.11.2024, registration # УД-091-080/2425/уч.; on the educational plan in the specialty 7-07-0911-01 «General Medicine», approved 15.05.2024, registration # 7-07-0911-01/2425/mf.

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RECOMMENDED FOR APPROVAL:

by the Department of Radiation Medicine and Ecology of the Educational Institution «Belarusian State Medical University»
(protocol # 2 of 10.09.2024);

by the Scientific and Methodological Council of the Educational Institution «Belarusian State Medical University»
(protocol # 3 of 20.11.2024)

EXPLANATORY NOTE

«Radiation Medicine and Ecology» – the educational discipline of the Medical-Prophylactic Module containing systemized scientific knowledge in all aspects of the environmental impacts, ionizing radiation included, on human health, radiation-induced and environmental illnesses rise.

The aim of the discipline «Radiation Medicine and Ecology» is the formation of extended professional competency for environmental and radiation safety ensuring.

The objectives of the discipline «Radiation Medicine and Ecology» are to form students' scientific knowledge about the patterns of the impact of environmental factors on human health, the risks of development and pathogenetic mechanisms of the origin of radiation- and environmentally conditioned health abnormalities, methods for individual and population prevention of diseases and abnormal conditions, caused by chronic low-dose exposure to physical, chemical and biological factors; skills needed to reduce the impact of environmental factors and prevent environmentally conditioned illness.

The knowledge, skills and abilities acquired during the study of the academic discipline «Radiation Medicine and Ecology» are necessary for the successful study of the following disciplines: «Radiodiagnosis and Radiotherapy», «Internal Diseases», «Professional Diseases», «Pediatrics».

A student who has mastered the content of the educational material of the discipline «Radiation Medicine and Ecology» should ensure the formation of extended professional competence: use knowledge about the risks of development and pathogenetic mechanisms of formation of radiation and ecology induced pathology, apply the methods of individual and population based prevention of diseases and pathological conditions caused by chronic low-dose physicochemical and biological effects.

As a result of studying the discipline «Radiation Medicine and Ecology» the student should

know:

mechanisms of influence of natural and anthropogenic environmental factors on human health;

etiology, pathogenesis, clinical manifestations of radiation and environmentally conditioned pathology;

principles of origin and diminution of radiation exposure to the population due to the impact of natural and man-made sources of ionizing radiation;

a set of measures to protect the population in case of radiation accidents;

principles of adhering the healthy lifestyle and rational behavior in the relevant radiation and environmental situation;

be able to:

evaluate radiation dose burden on different categories of exposed individuals under normal operation of ionizing radiation sources and in the event of a radiation accident, to interpret the evaluation results;

analyze regulatory legal acts regulating legal relations in the field of environmental protection and ensuring human radiation safety;

master:

methodology of assessment of health risks from the exposure to environmental factors;

methods for reducing dose burden on the population exposed to radiation;

methodology for choosing the relevant therapeutic and preventive measures in the event of different categories of the population exposure to ionizing radiation;

methodology for conducting activities to promote a healthy lifestyle and rational behavior in the relevant radiation and environmental situation.

Total number of hours for the study of the discipline is 216 academic hours, of which 89 classroom hours and 127 hours of student independent work. Classroom hours according to the types of studies: lectures - 21 hours (including 6 hours of supervised student independent work (SSIW)), laboratory classes - 68 hours.

Intermediate assessment is carried out according to the syllabus of the specialty in the form of a credit (4th semester) and examination (5th semester).

Form of higher education – full-time.

ALLOCATION OF ACADEMIC TIME ACCORDING TO SEMESTERS OF STUDY

Code, name of the specialty	semester	Number of academic hours						Form of intermediate assessment
		total	in-class	including			out-of-class self-studies	
				lectures	supervised student independent work	laboratory studies		
7-07-0911-01 «General Medicine»	4	108	43	6	3	34	65	credit
	5	108	46	9	3	34	62	examination
Total hours		**216**	**89**	**15**	**6**	**68**	**127**	

THEMATIC PLAN

Section (topic) name	Number of class hours	
	lectures (incl. SSIW)	laboratory
1. Ecological Medicine	**9**	**34**
1.1. Fundamentals of environmental medicine. Environmental factors	1,5	2
1.2. Effect of physical factors on the human body and health		6
1.3. Effect of chemical factors on the human body and health	1,5	2
1.4. Effect of biological factors on the human body and health		2
1.5. Heredity and environment		2
1.6. Environmental and medical consequences of air pollution	1,5	4
1.7. Environmental and medical consequences of hydrosphere pollution		4
1.8. Effect of the state of the lithosphere and the quality of food on population health	1,5	4
1.9. Medical aspects of the influence of the indoor environment on human health	1,5	4
1.10. Monitoring the environment and public health	1,5	2
1.11. Regulatory legal framework for environmental protection		2
2. Radiation Medicine	**12**	**34**
2.1. Effects of ionizing radiation	3	6
2.2. Public exposure of humans. Background radiation levels	1,5	4
2.3. Chernobyl Accident		4
2.4. Biomedical consequences of irradiation. Radiosensitivity	1,5	2
2.5. Radiation injuries to humans	1,5	4
2.6. Deterministic and stochastic effects of radiation	1,5	4
2.7. Radiation safety	1,5	4
2.8. Reduction in radiation burden on population	1,5	6
Total hours	**21**	**68**

CONTENT OF THE EDUCATIONAL DISCIPLINE

1. Ecological Medicine

1.1. Fundamentals of environmental medicine. Environmental factors

Environmental medicine: concept, goals, objectives. Heredity, nutritional status and free radical stress as the prominent triggering moments in the environmental diseases evolving. Role and place of Environmental Medicine in the up-to-day system of medical professionals' tuition.

Ecosystem: concept, components (ecotope and biocenosis), profiles. Basic principles of ecosystem life. Ecosystems classification regarding energy sources accessibility; examples of ecosystems and profiles. Human activities pressure on the

ecosystem's sustainability. Trophic levels and food chains. Producers, consumers, reducers. Patterns of energy and substance transfer within the food chain. Stepwise accumulation of foreign chemical substances, toxic compounds and radionuclides included, during their moving up the food chain. Contribution of the environmental factors into the known patterns of the human environmental diseases evolving.

Methods of studying the influence of the environment on human health. Ecologically dependent morbidity. Effect of chronic exposure of subthreshold values of environmental factors on the formation of ecologically dependent morbidity. Peculiarities of approach to diagnosis, treatment and prevention of diseases from the standpoint of ecological medicine.

Factors: basic concepts, classification. Characteristics of abiotic and biotic environmental factors. Mechanisms of influence of environmental factors human population. Human adaptation to ecological factors. Specific and nonspecific mechanisms of protection against the adverse effects of environmental factors. Human adaptation to environmental factors. Ecological factors and human health.

1.2. Effect of physical factors on the human body and health

Chronobiology and chronomedicine. Influence of the visible portion of the solar spectrum and illuminance on the human being. Biological rhythms. Calculation of the daily rhythm of human temperature and pulse. Prevention and treatment of «winter depression» («seasonal affective disorder»). Influence of ultraviolet radiation (UVR) on the human, mechanisms of natural protection from the damaging effect of UV-B, UV-C effects on the human. Evaluation of the type of skin sensitivity to UV radiation. Assessment of risk for skin malignancy.

Geomagnetic factors: characteristics, human reaction to the action of geomagnetic factors, prevention of their adverse effects. Meteosensitivity: concept, classification according to severity of clinical manifestations and types of meteopathical reactions.

1.3. Effect of chemical factors on the human body and health

Pathogenetic mechanisms of action of chemical factors on the human body. Foreign chemicals (xenobiotics): concept, classification, general characteristics. Xenobiotics properties that determine their toxicity. Mechanisms of toxic action. Toxicokinetic: resorption of xenobiotics, distribution in the body, metabolism of xenobiotics, excretion. Epidemiological studies of the populations exposed to xenobiotics.

Effectors of the endocrine system: concept, classification, properties, metabolism and mechanism of the action, possible consequences of their long-term intake by the person. Multiple chemical sensitivity: concept, causes of development, clinical manifestations, treatment and diagnosis tactic. Ecotoxicology: concept and tasks.

1.4. Effect of biological factors on the human body and health

Mechanisms of unfavorable effects of biological factors on human system. Fungi: the role in ecosystem and human pathology. Exorphins: concept, targets and biological effects in humans; chemical substances with exorphin-bearing properties. Hypersensitive pneumonia and Legionnaires' disease. House dust mites as a prominent biological factor of a polluted indoor environment.

1.5. Heredity and environment

The role of genetic factors in the occurrence of ecologically dependent human pathology. Frequency of mutations. Mechanisms of genotoxicity of xenobiotics. Mutations at the chromosomal level. Meaning of genomic instability in occurrence of human diseases. Somatic mutations and tumors meaning of oncogenes and repressor gene tumors. Deoxyribonucleic acid (DNA) reparation processes. Determination of mutational spectra genotoxic xenobiotics screening of the environment.

1.6. Environmental and medical consequences of air pollution

Factors and sources of air pollution. Global and local environmental consequences of air pollution. Chemical transformation of nitrogen oxide, sulfur and carbon in the air. Medical consequences of air pollution. Acute and chronic effects of pollutants on the human body. Assessment of non-carcinogenic risks due to air pollution. Smog: concept, types, conditions of development. Photochemical smog; effects of photochemical oxidants on the human body. Assessment of the level of pollution in the atmospheric air. Ozone layer: characteristics, protective function. The problem of ozone layer depletion. Ecological and health consequences of reducing the total amount of stratospheric ozone. «Greenhouse effect»: concept, causes of development. Ecological and health consequences of the global rise of the temperature on the planet. Cross-border transfer of pollutants.

1.7. Environmental and medical consequences of hydrosphere pollution

Hydrosphere: concept, characteristics. Factors and sources of hydrosphere pollution. Global and local environmental consequences of hydrosphere pollution. Eutrophication: concept, causes of development consequences. Characteristics and peculiarities of the action of xenobiotics entering the human body with water, including peculiarities of neurotoxicity and nephrotoxicity. Medical consequences of hydrosphere pollution. Acute and chronic effects of pollutants on the human body. Ecologically depending morbidity. Drinking water quality criteria: epidemiological safety, chemical composition safety, favorable organoleptic properties, radiation safety. Assessment of the level of pollution in drinking water.

1.8. Effect of the state of the lithosphere and the quality of food on population health

Geomedicine - the area of ecological medicine. The concept of essential and non-essential elements and their role in development of disease in humans. Migration of xenobiotics in the biosphere. Features of the toxic action of xenobiotics in ingestion into the human body. Endemic pathology in the World and Republic of Belarus. Iodine consumption standards for different population groups. Epidemiological criteria of population iodine provision. Iodine deficiency disorders among the population. Conditions and factors contributing to the formation of the endemic goiter, the influence of xenobiotics on the thyroid function. Nonspecific and specific prophylaxis of the endemic goiter. Side effects of specific iodine prophylaxis. Medical monitoring of iodine prophylaxis effectiveness.

Main sources and consequences of soil contamination. Ecological and health consequences of intensive agronomic and agrochemical activities soil contamination by sewage, exhaust gases, radioactive elements, waste of production and consumption. Nitrites and nitrates: chemical characteristics, in take sources,

metabolism, mechanism of damaging action, medical consequences of their intake, the role in childhood pathology. N-nitroso compounds: chemical characteristics, sources of intake, mechanisms of action, health consequences of their intake. Characteristics of food: composition; basic xenobiotics, taken with food (pesticides, mycotoxins, fertilizers, heavy metals, carcinogens, radionuclides, etc.); compounds forming the organoleptic quality of products; biologically active substances. Food composition assessment.

Features of hepatotoxicity of xenobiotics entering the body with food. Genetically modified organisms and food products: concept, possible risks to the environment and human health, biosafety. Prevention of possible adverse effects of xenobiotics, intaken with food. Detoxification of xenobiotics: concept, phases. Chemical modification of xenobiotics. Microsomal oxidation system. Cytochrome P - 450. Main ways of oxidation of hydrophobic substrates. Concept of metabolic activation. Inhibitors and inducers of microsomal oxidation. Conjugation of xenobiotics; enzymes involved in conjugation reactions, regulation of their activity.

1.9. Medical aspects of the influence of the indoor environment on human health

Ecological characteristics of the environment of residential and public buildings. Physical, chemical, biological factors of indoor environment affecting human health. Characteristics of non-ionizing electromagnetic radiation (NIEMR). International Classification of electromagnetic waves in frequencies. Use of non-ionizing electromagnetic radiation in medicine. Mechanisms of interaction of non-ionizing electromagnetic radiation and biological structures. Medical aspects of impact of non-ionizing electromagnetic radiation on the human body. Electro-sensitivity: concept prevalence among the population, clinical manifestations. Consequences of NIEM actions on the nervous, endocrine, immune and reproductive systems. Electromagnetic fields (electro smog): concept, sources, features, reducing the adverse effects of its impact on the population. Assessment of the electromagnetic environment in the room. Radiotelephony. Mobile communications: principles, particularies of the influence of pulsating radiation on the human body. Electromagnetic compatibility. Features of NIEMI standartisation effects on the population. Ionization of indoor air quality. «Sick Building Syndrome»: concept, causes of development, clinical manifestations (sensory irritation, skin irritation and specific reactions, asthenic), treatment and diagnosis tactics.

1.10. Monitoring the environment and public health

Monitoring: concept, types. Systems of global and local monitoring. National Environmental Monitoring System. Social and hygienic monitoring: concept, goals, objectives, stages. Analysis of monitoring information results, forecasting of possible developments. Study of environmental factor influence on human health: method of modeling on animals, observation population (questionnaire method, processing of statistical data, epidemiological studies), health risk assessment under the influence of environmental factors. Assessment of the environmental cancer risk.

1.11. Regulatory legal framework for environmental protection

Basic principles of ecological law. Ecological and natural conservation and resource legislation: Constitution of the Republic of Belarus, laws of the Republic of

Belarus «On Ecological Protection», «On State Ecological Expertise», etc. The rights of citizens to health protection, healthy environment and compensation for damages caused by the violation of this right. Liability for contempt of the environmental law.

2. Radiation Medicine

2.1. Effects of ionizing radiation

Radiation medicine: concept, goals, objectives, methods. The role of radiation in human life and society. History of radiation medicine development.

Bonds between Radiation Medicine and Nuclear Physics, General Biology, Biochemistry, Cytology, Genetics, Radiobiology, Radiation Hygiene, clinical disciplines.

Ionizing radiation types classification, properties.

Essence of radioactivity phenomenon. Radioactivity units. Types of radioactive transformations of nuclei. The law of radioactive decay. Interaction between charged particles and substance. Calculation of the percentage of radionuclides after an accidental release. Calculation of the time required to achieve a given activity in environmental objects. Linear energy transfer (LET) concept. Interaction of electromagnetic radiation and substance. Neutrons and substance interaction features. The phenomenon of induced radioactivity.

Stages of radiation damage. Direct and indirect effects ionizing radiation. Radiolysis of water, basic products of radiolysis. The effect of oxygen on the radiolysis progress. Oxygen effect. The role of water radiolysis products in the inactivation of macromolecules and cell death. Common pattern of oxidative stress. Radiotoxins. Radiation biochemistry of nucleic acids. DNA reparation. Changes to supramolecular structures of chromatin. Chromosomal aberrations. Radiation biochemistry of proteins, lipids and carbohydrates. Effects of ionizing radiation on the cell membrane structure. Disorders in lipid, carbohydrate, water and mineral metabolism in the exposed to ionizing radiation organism. Types of cell responses to ionizing radiation exposure. Nowaday views on the mechanisms of interphase and mitotic cell death. Post-radiation recovery.

Methods of ionizing radiation registration: physical, chemical, biological, features and employment in radiation medicine and hygiene. Biological dosimetry. Reconstruction of doses incurred by humans.

Dosimetry: concept, essence. Radiological dose quantities: exposure, absorbed, equivalent, effective, ambient dose equivalent; correlation between traditional units and the units International System of Unis. Air Kerma. Collective dose quantities. Radiological physical/basic, protective, operational dose quantities. Calculation of doses incurred from external and internal exposure of humans to radionuclides of Chernobyl Nuclear Power Plant accidental release. Common and individual dosimetry.

Radiometry. Principles of radiometric studies. Measurement of the dose incurred by humans from internal exposure to ionizing radiation. Methods of measurement of incorporated radioactive cesium.

2.2. Public exposure of humans. Background radiation levels

Radiation background of the Earth, its components. The contribution of various components of the radiation background to the formation of the average annual effective dose in humans. Natural and man-made sources of ionizing radiation.

Natural radiation background, profiles of natural terrestrial and extraterrestrial sources of ionizing radiation. Radionuclides of decay chains, mostly contributing to the human dose burden from exposure to ionizing radiation: U-238, Th-232, Ra-226, Rn-222, Po-210, Pb-210, Bi-210. Radon, its sources, values of doses incurred in humans through exposure to radon. Optimization of human dose burden from exposure to radon and its decay products. Natural radionuclides beyond the decay chains. Significance of K-40 for the human radiation burden in the Republic of Belarus. State of the environmental radiation in the Republic of Belarus prior to the Chernobyl Nuclear Plant (NPP) Accident. Importance of the optimization of the dose burden from radiation background for the Republic of Belarus residents.

Man-made (artificial) radiation background, its components contributing to the human dose burden from exposure to ionizing radiation. Global fallout of radionuclides owing to nuclear weapons testing and regular operation of nuclear reactors. Contribution of ionizing radiation sources used for medical purposes to the radiation burden on patients in the Republic of Belarus.

Achievements of the nuclear energetics worldwide and in the Republic of Belarus. Stages of the nuclear fuel cycle; radionuclides generated during the nuclear reactor operation; dose values incurred in humans from the Nuclear Power Plant regular operation. Belarusian Nuclear Power Plant, radiation safety ensuring for the members of the public in planned exposure situation. Evaluation of the ambient dose equivalent rate of roentgen and gamma radiation.

2.3. Chernobyl Accident

Radiation accidents: concept, stages of evolving. Formation of population radiation doses during and after a radiation accident. The Chernobyl Nuclear Plant Accident, radionuclides emission temporal and spatial aspects. Effect on humans of radionuclides of Chernobyl release in the Republic of Belarus. Migration of radionuclides in the biosphere: profiles of deposition of radionuclides in the lithosphere and hydrosphere, progressing accumulation of radionuclides moving up the food chain. Principal pathways for radionuclides entry into the body, types of distribution in the body. Features of the mostly dose causing radionuclides: C-14, Cs-137, Sr-90, H-3, I-131, Pu-239, Am-241, «hot» particles. Evaluation of radioactive cesium incorporated in the human body. The Law of the Republic of Belarus No. 1228-XII from 12.11.1991 «On the legal status of the territories contaminated as a result of the Chernobyl Nuclear Plant Accident». Radiation background in the Republic of Belarus nowadays. Medical consequences of the Chernobyl accident. Principles of protective measures. Radiation monitoring. Assessment of the annual effective dose of external human exposure to radionuclides due to the Chernobyl accident.

2.4. Biomedical consequences of irradiation. Radiosensitivity

Radiosensitivity issue – the central problem of radiobiology and radiation medicine. Molecular basis of radiosensitivity. Radiosensitivity of cells, organs and tissues. The rule of Bergonie-Tribondeau. The effect of ionizing radiation on organs and systems. Individual and age variations in radiosensitivity. The effect of radiation on the embryo and fetus.

Modification of radiosensitivity of biological systems.

2.5. Radiation injuries to humans

Factors causing ionizing radiation injuries to human body. The concept of «critical organ». Acute Radiation Syndromes: red bone marrow syndrome, gastrointestinal syndrome, cerebral (neurovascular) syndrome, profiles. The radiation dose dependent clinical presentation of the syndromes; human death causes.

Radiation injuries: dependence on the type and the history of exposure; acute radiation sickness (ARS) and chronic radiation sickness; pathogenetic classification of ARS owing to the body homogeneous exposure to external radiation, dose dependence, characteristics. Determination of the severity of acute radiation sickness. Measurement of an individual equivalent dose.

2.6. Deterministic and stochastic effects of radiation

Deterministic effects of radiation: concept, dose dependence, characteristics of the effects. Comparative profile of deterministic and stochastic effects of exposure.

Stochastic effects of radiation: concept, dose dependence, characteristics of effects. Somatic and genetic stochastic effects. Concept of «low-dose ionizing radiation». Variants for dependence of stochastic effects in humans on received dose of low-dose range. Epigenetic responses to ionizing radiation exposure: radiation-induced genomic instability, signal transfer from the exposed cells to the non-exposed nearby cells («bystander effect»). Adaptive response and radiation hormesis. Radiation hormesis.

Expected health effects of the particular individual and overall human population under long-term low-dose exposure.

2.7. Radiation safety

Radiation safety: concept, guiding principles and ways of implementation. International organizations involved in the upgrade of the radiation safety provision. State administration and regulation in the field of radiation safety. Generic profile of the cornerstone legal acts regulating work with the sources of ionizing radiation: the Law of the Republic of Belarus «On radiation safety», sanitary standards and regulations «Requirements for radiation safety», hygienic standard «Criteria for radiation exposure assessment», sanitary standards and regulations «Requirements for provision of radiation safety of personnel and members of the public under execution of activities involving the employment of atomic energy and sources of ionizing radiation». Categories and situations of exposure, categories of exposed individuals and corresponding approaches to dose limitations. Evaluation of the external radiation exposure of population living in a territory contaminated with radionuclides. Evaluation of the long-term radiation exposure of the population due to entry of radionuclides into the human body by oral and inhalation routes.

Sealed and unsealed sources concept. Measures for protecting against ionizing radiation: measures based on time, distance, shielding, quantity-based protective approach. Radiation safety of the personnel and the members of the public in existing exposure situations.

Radiation accident concept. Decision making criteria for protecting members of the public in radiation accidents. Provision of radiation safety in emergency exposure situation. Criteria for transition to existing exposure situation.

2.8. Reduction in radiation burden on population

The state unified system for monitoring and recording the individual doses.

Exposure to ionizing radiation for medical purposes. Reducing exposure of patients and members of the public to the sources of ionizing radiation employed for medical purposes: legal acts regulating exposure incurred by patients; referral to X-ray and radiodiagnostic examination justification; reference levels for patients in X-ray and radiodiagnostic examinations; organizational, methodological and technical measures to diminish the dose received by the patient.

Principles of reduction of the annual effective dose incurred within the early, interim and recovery phases of the post-accidental period. Reduction of the annual effective dose from external exposure: decontamination of the terrain and the environmental objects; evacuation, resettlement and relocation of people, other measures. Reduction of the annual effective dose from internal exposure: limiting the intake of radionuclides, limiting the absorption of radionuclides in the gastrointestinal tract, exercising rational and healthy dietary habits, facilitating the excretion of radionuclides from the body, reducing the detrimental effects of radionuclides, enhancing the adaptive-compensatory potency of the human body.

Principles of habitation on the terrains contaminated with radionuclides. A set of measures to diminish the annual effective dose from external and internal exposure.

ACADEMIC DISCIPLINE CURRICULAR CHART

Section, topic #	Section (topic) name	Number of hours		Supervised student independent work	Literature	Practical skills	Form of control	
		lectures	laboratory				of practical skills	of current / intermediate assessment
	4th semester							
	Ecological Medicine	**6**	**-**	**3**				
1.1. 1.2.	Basics of environmental medicine. Environmental factors. Effect of physical factors on the human body and health	1,5	-	-	8			
1.3. - 1.5.	Effect of chemical factors on the human body and health. Effect of biological factors on the human body and health. Heredity and environment	-	-	1,5	8			Interviews, preparation and presentation of abstracts
1.6. 1.7.	Environmental and medical consequences of air pollution. Environmental and medical consequences of hydrosphere pollution	1,5	-	-	8			
1.8.	Effect of the state of the lithosphere and the quality of food on population health	1,5	-	-	8			
1.9.	Medical aspects of the influence of the indoor environment on human health	-	-	1,5	8			Interviews, preparation and presentation of abstracts
1.10. 1.11.	Monitoring the environment and public health.Regulatory legal framework for environmental protection	1,5	-	-	8			
	Laboratory lessons	**-**	**34**	**-**				
1.1.	Fundamentals of environmental medicine.	-	2	-	2, 3,	Human adaptation to	Account on	Express-interview,

	Environmental factors. Environmentally dependent morbidity of the population. Lab.w.: «Human adaptation to environmental factors»				4, 8	environmental factors	laboratory work	electronic tests, reporting and defense of the essays
1.2.	Environmental factors. Effect of physical factors on the human body and health: the influence of the visible region of the solar spectrum and illumination on the human body. Lab.w.: Assessment of the risk of seasonal emotional disease»	-	2	-	4, 8	Assessment of the risk of seasonal emotional disease	Account on laboratory work	Express-interview, electronic tests, reporting and defense of the essays
1.2.	Effect of physical factors on the human body and health: human health effect of ultraviolet radiation (UVR). Lab.w. «Evaluation of the type of skin sensitivity to UV radiation. Assessment of risk for skin malignancy»	-	2	-	4, 8	Evaluation of the type of skin sensitivity to UV radiation. Assessment of risk for skin malignancy	Solving situational problems*	Express-interview, electronic tests, reporting and defense of the essays
1.2.	The effect of ultraviolet radiation on humans. Stochastic and deterministic effects of UV exposure. Geomagnetic factors. Lab.w.: «Biological rhythms. Calculation of the daily rhythm of human temperature and pulse»	-	2	-	4, 8	Biological rhythms. Calculation of the daily rhythm of human temperature and pulse	Account on laboratory work	Express-interview, electronic tests, reporting and defense of the essays
1.3.	Effect of chemical factors on the human body and health. Lab.w.: «Epidemiological studies of the populations exposed to xenobiotics using the «case-control» method»	-	2	-	4, 8	Epidemiological studies of the populations exposed to xenobiotics	Account on laboratory work	Express-interview, electronic tests, reporting and defense of the essays
1.4.	Effect of biological factors on the human body and health	-	2	-	4, 8			Express-interview, reporting and defense of the essays
1.5.	Heredity and environment. The role of genetic factors in the occurrence of environmentally dependent human pathology	-	2	-	4, 8			Express-interview, electronic tests, reporting and defense of the essays, colloquium*

1.6.	Environmental and medical consequences of air pollution. Factors and sources of air pollution. Global and local environmental consequences of air pollution. Lab.w.: «Assessment of ozone level in ambient air»	-	2	-	4, 8	Assessment of the level of pollution in the atmospheric air	Account on laboratory work	Express-interview, electronic tests, reporting and defense of the essays
1.6.	Environmental and medical consequences of air pollution. Medical consequences of air pollution. Acute and chronic effects of pollutants on the human body. Lab.w.: «Assessment of non-carcinogenic risks due to air pollution»	-	2	-	4, 8	Assessment of non-carcinogenic risks due to air pollution	Solving situational problems	Express-interview, electronic tests, reporting and defense of the essays
1.7.	Environmental and medical consequences of hydrosphere pollution. Factors and sources of hydrosphere pollution. Global and local environmental consequences of hydrosphere pollution	-	2	-	4, 8			Express-interview, electronic tests, reporting and defense of the essays
1.7.	Environmental and medical consequences of hydrosphere pollution. Medical consequences of hydrosphere pollution. Acute and chronic effects of pollutants on the human body. Lab.w.: «Quantitative estimation of sulfates level in drinking water»	-	2	-	4, 8	Assessment of the level of pollution in drinking water	Account on laboratory work	Express-interview, electronic tests, reporting and defense of the essays
1.8	Effect of the state of the lithosphere and the quality of food on population health. Factors and sources of lithosphere contamination. Migration of xenobiotics in the Biosphere	-	2	-	4, 8			Express-interview, electronic tests, reporting and defense of the essays
1.8.	Effect of the state of the lithosphere and the quality of food on population health. Characteristics of food products. Preventive practices addressing potential adverse effects of xenobiotics ingested with foods. Lab.w.: «Food composition assessment»	-	2	-	4, 8	Food composition assessment	Account on laboratory work	Express-interview, electronic tests, reporting and defense of the essays, colloquium*
1.9.	Medical aspects of the influence of the indoor environment on human health. Ecological characteristics of the environment of residential	-	2	-	4, 6, 8	Assessment of the environmental cancer risk	Solving situational problems*	Express-interview, electronic tests, reporting and defense

	and public premises. Lab.w.: «Assessment of the environmental cancer risk»							of the essays
1.9.	Medical aspects of the influence of the indoor environment on human health. Non-ionizing electromagnetic radiation as a factor of the indoor environment. Lab.w.: «Assessment of the electromagnetic environment in the room»	-	2	-	4, 8	Assessment of the electromagnetic environment in the room	Account on laboratory work	Express-interview, electronic tests, reporting and defense of the essays
1.10.	Monitoring of the environment and the health status of the population	-	2	-	8			Express-interview, electronic tests, reporting and defense of the essays
1.11.	Regulatory and legal foundation of environment protection	-	2	-	8			Express-interview, electronic tests, reporting and defense of the essays. Credit
	5th semester							
	Lectures	**9**	**-**	**3**				
2.1.	Effects of ionizing radiation	1,5	-	1,5	1, 8			Interviews, preparation and presentation of abstracts
2.2. 2.3.	Public exposure of humans. Background radiation levels. Chernobyl Accident	1,5	-	-	1, 8			
2.4.	Biomedical consequences of irradiation. Radiosensitivity	1,5	-	-	1, 8			
2.5.	Radiation injuries to humans	1,5	-	-	1, 8			
2.6.	Deterministic and stochastic effects of radiation	-	-	1,5	1, 8			Interviews, preparation and presentation of abstracts
2.7.	Radiation safety	1,5	-	-	1, 8			
2.8.	Reduction in radiation burden on population	1,5	-	-	1, 8			
	Laboratory lessons	**-**	**34**	**-**				
2.1.	Effects of ionizing radiation. Physical basis of	-	2	-	1, 8	Calculation of the	Solving	Express-interview,

	the action of ionizing radiation. Laboratory work: «Calculation of the percentage of radionuclides after an accidental release»					percentage of radionuclides after an accidental release	situational problems	electronic tests, reporting and defense of the essays
2.1.	Effects of ionizing radiation. The effects of ionizing radiation on the biological objects. Laboratory work: «Calculation of the time required to achieve a given activity in environmental objects»	-	2	-	1, 5, 8	Calculation of the time required to achieve a given activity in environmental objects	Solving situational problems	Express-interview, electronic tests, reporting and defense of the essays
2.1.	Effects of ionizing radiation. Methods of ionizing radiation registration. Introduction to dosimetry	-	2	-	1, 5, 8			Express-interview, electronic tests, reporting and defense of the essays
2.2.	Public exposure of humans. Background radiation levels. Natural background radiation	-	2	-	1, 8			Interviews, electronic tests, reporting and defense of the essays
2.2.	Public exposure of humans. Background radiation levels. Technologically modified radiation background. Laboratory work: «Evaluation of the ambient dose equivalent rate of roentgen and gamma radiation by the MKC-6130A dosimeter-radiometer»	-	2	-	1, 8	Evaluation of the ambient dose equivalent rate of roentgen and gamma radiation	Account on laboratory work	Express-interview, electronic tests, reporting and defense of the essays
2.3.	Chernobyl accident. Radiation accidents: concept, stages of evolving. Formation of population radiation doses during and after a radiation accident. Laboratory work: «Evaluation of radioactive cesium incorporated in the human body»	-	2	-	1, 8	Evaluation of radioactive cesium incorporated in the human body	Account on laboratory work	Express-interview, electronic tests, reporting and defense of the essays
2.3.	Chernobyl accident. Characteristics of the mostly dose causing radionuclides. Radiation background in the Republic of Belarus nowadays. Medical consequences of the Chernobyl accident. Principles of protective measures.	-	2	-	1, 8	Comparative profile of the main groups radionuclides	Account on laboratory work	Express-interview, electronic tests, reporting and defense of the essays

	Laboratory work: «Comparative profile of the main groups radionuclides»							
2.4.	Biomedical consequences of irradiation. Radiosensitivity	-	2	-	1, 5, 8			Express-interview, electronic tests, reporting and defense of the essays
2.5.	Radiation injuries to humans. Acute radiation syndromes. Laboratory work: «Individual dosimetry. Measurement of an individual equivalent dose with a ДКС-АТ3509А dosimeter»	-	2	-	1, 8	Measurement of an individual equivalent dose	Account on laboratory work	Express-interview, electronic tests, reporting and defense of the essays
2.5.	Radiation injuries to humans: dependence on the type and history of exposure; acute radiation sickness and chronic radiation sickness. Laboratory work: «Determination of the severity of acute radiation sickness (Human hemogram analysis)»	-	2	-	1, 8	Determination of the severity of acute radiation sickness	Solving situational problems	Express-interview, electronic tests, reporting and defense of the essays
2.6.	Deterministic and stochastic effects of radiation. Laboratory work: «Comparative profile of deterministic and stochastic effects of exposure»	-	2	-	1, 5, 8	Comparative profile of deterministic and stochastic effects of exposure	Account on laboratory work	Interviews, electronic tests, reporting and defense of the essays
2.6.	Deterministic and stochastic effects of radiation. Variants for dependence of stochastic effects in humans on received dose of low-dose range	-	2	-	1, 5, 8			Express-interview, electronic tests, reporting and defense of the essays, colloquium*
2.7.	Radiation safety. Prescriptive legal foundation for radiation safety. Principles of radiation safety, practical application	-	2	-	1, 8			Express-interview, electronic tests, reporting and defense of the essays
2.7.	Radiation safety. Sealed and unsealed sources of ionizing radiation concept. Methods of protection against ionizing radiation at work with sources of ionizing radiation and appliances	-	2	-	1, 8	Evaluation of the external radiation exposure of population living in a	Solving situational problems*	Express-interview, electronic tests, reporting and defense of the essays

	generating ionizing radiation. Laboratory work: «Evaluation of the external radiation exposure of population living in a territory contaminated with radionuclides»					territory contaminated with radionuclides		
2.8.	Reduction in radiation burden on population. Medical exposure. Reduction of medical exposure of patients and members of the public from the sources of ionizing radiation used for medical purposes. Laboratory work: «Evaluation of the long-term radiation exposure of the population due to entry of radionuclides into the human body by oral and inhalation routes»	-	2	-	1, 8	Evaluation of the long-term radiation exposure of the population due to entry of radionuclides into the human body by oral and inhalation routes	Solving situational problems*	Express-interview, electronic tests, reporting and defense of the essays
2.8.	Reduction in radiation burden on population. Emergency exposure situation. Decision making criteria for protecting members of the public in radiation accidents. Reducing the annual effective dose from external exposure	-	2	-	1, 8			Express-interview, electronic tests, reporting and defense of the essays
2.8.	Reduction in radiation burden on population. Reducing the committed effective dose from internal exposure. Principles of habitation on the terrains contaminated with radionuclides. Laboratory work: «A set of measures to diminish the annual effective dose from external and internal exposure»	-	2	-	1, 8	A set of measures to diminish the annual effective dose from external and internal exposure	Solving situational problems*	Express-interview, electronic tests, reporting and defense of the essays. Credit
	Total hours	**15**	**68**	**6**				

*This is a mandatory form of current certification.

INFORMATION AND INSTRUCTIONAL UNIT

LITERATURE

Basic (relevant):

1. Radiation medicine : textbook for foreign students of higher education institutions in medical specialties / A. N. Stozharov [et al.]; edited by A. N. Stozharov. – Minsk : Novoe znanie, 2020. – 205 p.

Additional:

2. Setting global research priorities for urban health. Geneva: World Health Organization; 2022. – electronic resource https://iris.who.int/bitstream/handle/10665/363443/9789240041820-eng.pdf

3. Review of indicator frameworks supporting urban planning for resilience and health: third report on protecting environments and health by building urban resilience. Copenhagen: WHO Regional Office for Europe; 2022. : – electronic resource https://iris.who.int/bitstream/handle/10665/355760/WHO-EURO-2022-5650-45415-64990-eng.pdf

4. Compendium of WHO and other UN guidance in health and environment, 2024 update. Geneva: World Health Organization; 2024. : – electronic resource https://iris.who.int/bitstream/handle/10665/378095/9789240095380-eng.pdf

5. Radiation biology. Molecular and cellular aspects : textbook / A. N. Batyan [etc.]. – Minsk : Adukatsiya i Vyhavanne, 2024. – 239 p.

6. ICRP publication 115. Lung Cancer Risk from Radon and Progeny and Statement on Radon. – Normative regulatory acts: – electronic resource https://journals.sagepub.com/toc/anib/40/1

7. ICRP publication 117. Radiological Protection in Fluoroscopically Guided Procedures Performed Outside the Imaging Department. – Normative regulatory act. : – electronic resource https://journals.sagepub.com/toc/anib/40/6

Electronic courseware for the academic discipline «Radiation Medicine and Ecology»

8. https://etest.bsmu.by/course/view.php?id=295.

METHODOLOGICAL RECOMMENDATIONS FOR THE ORGANIZATION AND PERFORMANCE OF STUDENT INDEPENDENT WORK IN THE ACADEMIC DISCIPLINE

The time allocated for independent work can be used by students for:
preparing for lectures and laboratory classes;
preparing for colloquiums, credit and exams in the academic discipline;
studying the topics (issues) designed for independent work;
problem solving;
performing research and creative tasks;
preparing thematic reports, abstracts, presentations;
taking notes of educational literature;
preparing reports;

compiling a review of scientific literature on a given topic;
compilation of a thematic selection of literature sources, Internet sources.

METHODOLOGICAL RECOMMENDATIONS FOR THE ORGANIZATION AND PERFORMANCE OF SUPERVISED STUDENT INDEPENDENT WORK IN THE ACADEMIC DISCIPLINE

APPROXIMATE LIST OF TASKS FOR SUPERVISED STUDENT INDEPENDENT WORK:

preparation and presentation of abstracts;
presentation of reports;
studying topics and problems that have not been discussed at the lectures;
computer testing.

FORMS OF CONTROL OF SUPERVISED STUDENT INDEPENDENT WORK:

interview;
preparation and presentation of abstracts.

LIST OF AVAILABLE DIAGNOSTIC TOOLS

The following forms are used for competence assessment:
reporting and defense of the essays;
express-interview;
interview;
colloquium;
electronic tests.

LIST OF AVAILABLE TEACHING METHODS

Traditional method;
active (interactive) methods:
Problem-Based Learning (PBL).

LIST OF PRACTICAL SKILLS

Name of practical skills	Form of practical skills control
1. Human adaptation to environmental factors	Account on laboratory work
2. Assessment of the risk of seasonal emotional disease	Account on laboratory work
3. Evaluation of the type of skin sensitivity to UV radiation. Assessment of risk for skin malignancy	Solving situational problems
4. Biological rhythms. Calculation of the daily rhythm of human temperature and pulse	Account on laboratory work
5. Epidemiological studies of the populations exposed to xenobiotics	Account on laboratory work
6. Assessment of the level of pollution in the atmospheric air	Account on laboratory work
7. Assessment of non-carcinogenic risks due to air pollution	Solving situational problems

Name of practical skills	Form of practical skills control
8. Assessment of the level of pollution in drinking water	Account on laboratory work
9. Food composition assessment	Account on laboratory work
10. Assessment of the environmental cancer risk	Solving situational problems
11. Assessment of the electromagnetic environment in the room	Account on laboratory work
12. Calculation of the percentage of radionuclides after an accidental release	Solving situational problems
13. Calculation of the time required to achieve a given activity in environmental objects	Solving situational problems
14. Evaluation of the ambient dose equivalent rate of roentgen and gamma radiation	Account on laboratory work
15. Evaluation of radioactive cesium incorporated in the human body	Account on laboratory work
16. Comparative profile of the main groups radionuclides	Account on laboratory work
17. Measurement of an individual equivalent dose	Account on laboratory work
18. Determination of the severity of acute radiation sickness	Solving situational problems
19. Comparative profile of deterministic and stochastic effects of exposure	Account on laboratory work
20. Evaluation of the external radiation exposure of population living in a territory contaminated with radionuclides	Solving situational problems
21. Evaluation of the long-term radiation exposure of the population due to entry of radionuclides into the human body by oral and inhalation routes	Solving situational problems
22. A set of measures to diminish the annual effective dose from external and internal exposure	Solving situational problems

PROTOCOL OF THE CURRICULUM APPROVAL
BY OTHER DEPARTMENTS

Title of the discipline requiring approval	Department	Amendments to the curriculum in the academic discipline	Decision of the department, which designed the curriculum (date, protocol #)
1. Radiodiagnosis and Radiotherapy	Radiodiagnosis and Radiotherapy	No comments or suggestions	Protocol # 2 of 10.09.2024
2. Internal Diseases	Internal Medicine, Gastroenterology and Nutrition with a course of advanced training and retraining	No comments or suggestions	Protocol # 2 of 10.09.2024

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Curriculum content, composition and the accompanying documents comply with the established requirements.

Head of the Office of Educational Activities of the Educational Institution «Belarusian State Medical University» — I.L.Kotovich

18.11.2024

Methodologist of the Educational and Methodological department of the Office of Educational Activities of the Educational Institution «Belarusian State Medical University» — S.V.Zaturanova

18.11.2024