

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

DEPARTMENT OF FUNDAMENTAL MEDICINE

APPROVED ИТС ИФИБ

Protocol No. 3.1

dated 30.08.2024

ACADEMIC COURSE OUTLINE

НОРМАЛЬНАЯ ФИЗИОЛОГИЯ / NORMAL PHYSIOLOGY

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	16	0	56		36	0	PFE
4	5	180	14	0	66		64	0	Ex
Total	8	288	30	0	122	0	100	0	

ABSTRACT

This academic discipline is a fundamental one, contributing to the development of the ability to assess morphofunctional, physiological states, and pathological processes in the human body to solve professional problems.

Mastering this discipline develops a system of knowledge and modern understanding of the functional systems of the human body, their regulation and self-regulation under the influence of the external environment, the laws of functioning of individual organs and systems, and their interrelationships, as well as the ability to analyze the current state of problems in the subject area.

Successful mastery of this curriculum is necessary for studying subsequent basic disciplines, such as "Pathological Physiology" and "Pathological Anatomy." These, combined with the study of clinical medicine, form a holistic understanding of physiology as a scientific basis for assessing a person's health, functional state, and performance.

1. ACADEMIC COURSE GOALS AND OBJECTIVES

The purpose of studying this course is to develop a system of knowledge about the vital functions of the holistic organism and its individual parts, the fundamental patterns of functioning and the mechanisms of regulation and self-regulation in the interaction of organs and systems with each other and with environmental factors, the development of physiological principles of a healthy lifestyle, and the development of skills and abilities in assessing morphofunctional and physiological states in the human body to solve professional problems.

Objectives:

- to develop in students a systems approach to understanding the physiological mechanisms underlying the functioning of organs and systems, their interactions with environmental factors, and the implementation of the human body's adaptive strategies for normal functioning from the perspective of the concept of functional systems;
- to develop in students skills in analyzing the functions of the holistic organism from the perspective of integral physiology;
- to study the patterns of functioning of various systems of the human body and the interactions between systems and organs in the context of goal-oriented activities from the perspective of adaptation theory;
- study of modern methods for studying basic physiological functions
- development of skills in assessing the condition of organs and body systems necessary for functional diagnostics;
- development of physiological thinking and an understanding of the role of higher nervous activity in regulating physiological processes, as well as an understanding of the possibilities for managing vital processes.
- fostering humanism, instilling bioethical norms and rules in physician activities;
- development of safety skills in research and teaching laboratories.

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

The basic knowledge necessary for studying this discipline is formed through previous study of such disciplines as biology, chemistry, medical and biological physics, radiobiology, anatomy, histology, embryology, cytology, and biochemistry. This course presages the study of such disciplines as pathological anatomy, pathological physiology, pharmacology, and others. It is a prerequisite for subsequent study of clinical disciplines, aimed at understanding the nature of morphofunctional, physiological conditions, and pathological processes in the human body for solving professional problems. The course "Normal Physiology" consists of two sections, which are taught to second-year medical students in the third and fourth semesters.

3. DEVELOPED COMPETENCIES AND INTENDED LEARNING OUTCOMES

Universal and/or general professional competencies:

Competency code and title	Code and title of competency-based rubrics
OPIK-5 [1] – Capable of assessing morphofunctional and physiological states, as well as pathological processes in the human body to solve professional tasks.	3-OPIK-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. Y-OPIK-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-OPIK-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)
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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
	<i>3 Semester</i>						
1	The First Section	1-8	8/0/30	SA-8 (25)	25	SA-8	3-ОПК-5, У-ОПК-5, В-ОПК-5
2	The Second Section	9-15	8/0/26	SA-15 (25)	25	SA-15	3-ОПК-5, У-ОПК-5, В-ОПК-5
	<i>Totals for 3 Semester</i>		16/0/56		50		
	Assessment events for 3 Semester				50	PFE	В-ОПК-5, 3-ОПК-5, У-ОПК-5
	<i>4 Semester</i>						
1	The First Station	1-8	8/0/40	T-8 (25)	25	SA-8	3-ОПК-5, У-ОПК-5, В-ОПК-5
2	The Second Station	9-15	6/0/26	T-16 (25)	25	SA-15	3-ОПК-5, У-ОПК-5, В-ОПК-5
	<i>Totals for 4 Semester</i>		14/0/66		50		
	Assessment events for 4 Semester				50	Ex	3-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
T	Testing

PFE	Pass/fail examination
Ex	Exam

SYLLABUS

Weeks	Topics / Content	Lect., hrs.	Pr./sem., hrs.	Lab., hrs.
	<i>3 Semester</i>	16	0	56
1-8	The First Section	8	0	30
1 - 2	Introduction to Normal Physiology. Regulation of physiological functions Introduction to physiology. Physiology as a scientific basis for assessing a person's state of health, functional status and working capacity. A brief description of the stages of development of normal physiology: empirical, anatomical and physiological, functional. Modern problems, tasks and trends in the development of physiology. The concept of an organism and its constituent elements. Levels of morphofunctional organization of the human body. The concept of physiological functions. The concept of the internal environment of the body and its components (blood, lymph, intercellular fluid). The concept of homeostasis, homeokinesis. Psychological adaptive response. The concept of regulation of functions. The basic principles of the formation and regulation of physiological functions: deviation, violation, prediction. Levels and mechanisms of regulation of functions (physico-chemical, nervous, humoral). The idea of self-regulation is about the constancy of the internal environment of the body. System organization of functions (I.P. Pavlov, P.K. Anokhin). The organization's system levels. The physiological system. The functional system and its components (P.K. Anokhin). The concept of a system-forming factor. Principles of organization and interaction of functional systems.	All		
		2	0	6
		Online		
		0	0	0
3 - 4	Physiology of excitable tissues The history of the discovery of bioelectric phenomena in living tissues (experiments by L. Galvani, K. Matteucci). Irritability as the basis of tissue response to irritation. Classification of stimuli. The concept of excitability and irritability. The structure and functions of biological membranes. Active and passive transport of substances through the membrane. Ion channels and pumping mechanisms. Resting membrane potential. Membrane-ion theory of resting potential formation (A. Hodgkin, A. Huxley, B. Katz). The action potential and its phases. The critical level of depolarization. Threshold potential. Mechanisms of ion excitation. The conditions of arousal. Practical use of biotope registration in medicine. Physiological properties of excitable tissues. Excitability, its level and evaluation criteria: strength threshold, time, gradient of increase in the strength of the stimulus over time. The force-	All		
		2	0	6
		Online		
		0	0	0

	time curve. The concept of rheobase, chronaxy, and useful time. The influence of the parameters of the stimulus on the nature of the reaction of excitable systems. Optimal and pessimal answers. The concept of lability. A measure of lability. Classification of nerve fibers. Physiological properties of nerve fibers. Mechanisms of conduction of excitation along nerve fibers. The laws of conducting excitation through nerves. Physiological properties of skeletal muscles. Features of skeletal muscle structure. The mechanism of muscle contraction. Muscle strength. Muscle fatigue. Electromyography. Physiological features and properties of smooth muscles. Their importance in the myogenic regulation of motor functions of internal organs.			
5 - 6	Physiology of the central nervous system. Physiology of pain Functions of the central nervous system. Methods of studying the functions of the central nervous system. Morphofunctional organization of a neuron as a unit of the nervous system. Classification of neurons. The integrative function of a neuron. Glial elements of the central nervous system and their functional significance. A reflex. Classification of reflexes. Principles of reflex theory. Morphological bases of somatic and vegetative reflexes. The concept of adaptive result of reflex activity. The nature of the spread of arousal in the central nervous system (divergence, convergence, circulation in neural networks). Patterns of propagation of excitation along the reflex arc (unilateral conduction, summation of excitations, transformation of the rhythm of excitations, post-tetanic potentiation, aftereffect). The synapse concept. Classification of synapses. Synapse structure. Functional properties of electrical and chemical synapses. The mechanism of signal transmission in a chemical synapse. Types of synaptic neurotransmitters and neuromodulators. The occurrence of local and propagating excitations in a neuron. Properties of nerve centers (low lability, increased fatigue, hypersensitivity to neurotropic drugs, hypoxia, acidosis, plasticity). Inhibition in the central nervous system. The history of the discovery of central braking. Mechanisms of inhibition (presynaptic, postsynaptic, postactivation, and pessimal). Mechanisms of interaction of excitatory and inhibitory effects on a neuron. Types of inhibition (lateral, recurrent, recurrent). The importance of inhibition in the body's activity. The concept of pain, nociception. Pain functions. Classification of pain. Pain as an integrative reaction of the body to the damaging effect of an irritant. Components of the pain response. The role of the thalamus and cerebral cortex in the integration and analysis of pain arousal. Concepts of antinociception and the antinociceptive system. ANCS levels: the system of descending inhibition of primary afferents; limbic-hypothalamic level; cortical level (secondary somatosensory and orbitofrontal areas	All		
		2	0	6
		Online		
		0	0	0

	of the cerebral cortex). Algometry.			
7 - 8	Physiology of sensory systems The concept of the sensor system. The concept of the analyzer from the standpoint of the teachings of I.P. Pavlov. An idea of the basic and auxiliary structures of the sensory organ. The concept of the receptor. Functional properties and features of receptors. Classification of receptors. The mechanism of receptor excitation. Coding of signals in receptors. Functional properties and organization features of the conducting department of the sensory system. Features of the organization of the cortical department of the sensory system. Encoding of information in various departments of sensory systems. Morphofunctional characteristics of parts of the visual sensory system. The concept of visual field and visual acuity. Methods of their determination. Refraction, accommodation, and adaptation of the eye. The mechanisms of these processes, their anomalies (astigmatism, myopia, hyperopia, presbyopia). Pupillary reflex. Rods and cones, mechanisms of light reception and perception, and color perception. The main types of color perception disorders.	All		
		2	0	6
		Online		
		0	0	0
8 - 9	Physiology of sensory systems II Auditory sensory system. Sound-conducting tracts and sound-receiving apparatus of the auditory sensory system. Sound reception mechanisms. Binaural hearing. Research methods of the auditory sensory system. The general morphofunctional organization of the departments of the sensory system of the skin. Tactile and temperature sensor systems as its component parts. Classification of tactile receptors, their structural and functional differences. Research methods of the tactile sensory system. The concept of the spatial threshold of tactile sensitivity. Classification of thermoreceptors. Methods of studying the temperature sensor system. The general morphofunctional organization of the departments of the gustatory sensory system. Receptors of the gustatory sensory system. Taste buds, taste buds. Types of taste buds of the tongue. The mechanism of reception and perception of taste. Methods of studying the gustatory sensory system (measurement of density and functional mobility). The general morphofunctional organization of the departments of the olfactory sensory system. The mechanism of odor perception. Methods of olfactory sensory system research (olfactometry). The role of the interaction of the olfactory and other sensory systems in the formation of taste sensations. Skin analyzer: tactile, temperature and pain sensitivity. The taste analyzer. Olfactory analyzer.	All		
		2	0	6
		Online		
		0	0	0
9-15	The Second Section	8	0	26
9 - 10	Physiology of the blood Blood, its composition. Blood functions. The main constants of blood, their significance and functional significance. The	All		
		2	0	6
		Online		

	concept of osmotic blood pressure. Functional systems that maintain a constant pH and osmotic blood pressure. The concept of hemolysis, its types and plasmolysis. Corpuscular elements of blood, their physiological significance. Hematopoiesis. The concept of erythro-, leuko- and thrombocytopoiesis, their nervous and humoral regulation. Hemoglobin, its compounds, functional significance. Lymph, its composition and functions. Understanding the protective function of blood and its manifestations (immune reactions, blood clotting). Blood types. Types of blood group systems (AB0, Rhesus affiliation). Their meaning. The process of blood coagulation (hemostasis), its significance. The main factors involved in the blood clotting process (tissue, plasma, thrombotic, erythrocyte and leukocyte), their functional characteristics. The concept of external (tissue) and internal (blood) blood coagulation systems, phases of blood coagulation, processes of retraction and fibrinolysis. Factors that accelerate and slow down blood clotting. Features of the blood system in children: corpuscles, blood plasma, formation of group affiliation in ontogenesis, immunity.	0	0	0
11 - 12	Physiology of blood circulation Physiology of blood circulation The concept of the physiological circulatory system (cardiovascular system). Morphofunctional features of the heart organization. Pumping (pumping) function of the heart. Typical and atypical (P and T cells) cardiomyocytes, cardiac conduction system, valvular apparatus, and heart cavities. Physical and physiological properties of the heart muscle. The concept of functional syncytium for the heart. The occurrence and spread of arousal in the heart. Automation, its essence, centers and bias. Ionic mechanisms of excitation of atypical myocardiocytes. Mechanisms of slow diastolic depolarization. Changes in excitability during the excitation of typical cardiomyocytes. Electromechanical interface. Extrasystole. Compensation pause. The cardiac cycle and its phase structure. Types of regulation of cardiac activity. Intracardiac regulation. Nervous and humoral mechanisms of extracardiac regulation of cardiac activity. Endocrine function of the heart. The effect of natriuretic peptide on vascular tone and urination.	All		
		2	0	6
		Online		
		0	0	0
13 - 14	Physiology of blood circulation Functional classification of blood vessels. The basic laws of hydrodynamics and their use to explain the physiological functions and patterns of blood flow through the vessels. Factors that ensure the movement of blood through blood vessels. Parameters of peripheral blood circulation (arterial pressure, linear and volumetric blood flow velocity, blood circulation time). Changes in resistance, blood pressure, and blood flow velocity in different parts of the vascular bed. Nervous, humoral and myogenic regulation of vascular tone. The concepts of systolic, diastolic, pulse, and mean blood pressure. Factors determining the value of blood pressure. A	All		
		2	0	6
		Online		
		0	0	0

	functional system that maintains a normal blood pressure level. Microcirculation and its role in the mechanisms of fluid and various substances exchange between blood and tissues. External manifestations of the activity of the heart (electrical, sound, mechanical). The mechanisms of EMF of the heart. Einthoven's theory.			
15 - 16	Physiology of the heart Physiology of the heart Methods of registration of electrical manifestations of cardiac activity. The main leads of the human ECG. Structural analysis of a normal ECG. Methods of studying the sound manifestations of cardiac activity. The origin of heart tones, their types and places of best listening. Arterial (sphygmographic) pulse examination methods. Clinical assessment of the human pulse. Methods of measuring blood pressure (direct and indirect). The Riva-Rocci and Korotkov methods. Cardiac activity during exercise. Cardiac output is an essential indicator of heart function. The mechanism of changes in cardiac output during exercise. Changes in the structure of the heart rate under conditions of physically strenuous activity. Regulation of vascular tone during physical exertion. Mechanisms of increased venous return during muscular work (venous, muscular, respiratory "pumps"). Methods for assessing a person's physical performance based on heart parameters	All		
		2	0	6
		Online		
		0	0	0
	<i>4 Semester</i>	14	0	66
1-8	The First Station	8	0	40
1 - 2	Physiology of digestion I Digestion, its meaning, types and forms. General principles of neurohumoral regulation of digestive tract functions. Neurohumoral mechanisms of hunger and satiety. Salivation and salivation. Nervous and moral mechanisms of regulation of these processes. Phases of salivation, salivary reflex. Swallowing, its phases and mechanisms. Functions of the stomach. Quantity, composition and properties of gastric juice. The value of hydrochloric acid and other components of gastric juice. Phases of gastric secretion, their neurohumoral mechanisms. Gastric motility. Nervous and humoral factors affecting the motor and evacuation functions of the stomach	All		
		2	0	8
		Online		
		0	0	0
3 - 4	Physiology of digestion II Physiology of digestion II The importance and role of digestion in the duodenum. Functions of the pancreas. The amount, composition and properties of pancreatic juice. Pancreatic juice enzymes secreted in the active state. Mechanisms of regulation of pancreatic secretion. Contours of pancreatic secretion self-regulation, their significance. Liver function. Bile, its quantity, composition, importance for digestion. Recycling of bile acids in the intestine and liver. The importance and role of digestion in the small intestine. The mechanism of formation of intestinal juice. Quantity,	All		
		2	0	8
		Online		
		0	0	0

	properties, and enzyme composition of intestinal juice. Regulation of intestinal juice separation. Oral and membranous digestion, their interrelation and severity in various parts of the gastrointestinal tract. Intracellular digestion. Motor activity of the small and large intestines, its features, significance, mechanisms of regulation. Features of digestion, the importance of microflora in this process.			
5 - 6	The metabolic basis of physiological functions The metabolic basis of physiological functions Metabolism is the main condition for ensuring vital activity and maintaining homeostasis. The plastic and energetic role of nutrients. Processes of assimilation and dissimilation of substances. Regulation of the content of useful substances in the body. The value of water for the body. The concept of regulation of water and mineral metabolism, the principle of self-regulation of these processes. Vitamins, their importance. The concept of the energy balance of the body. Caloric content of various food substances. Principles of rational nutrition organization. Methods of calorimetry. Daily exchange and its components. Specific dynamic action of nutrients.	All		
		2	0	8
		Online		
		0	0	0
7 - 8	Physiology of thermoregulation Thermoregulation concept. Heat products. Heat transfer. The central link of the thermoregulation system. The center of thermoregulation is the hypothalamus. Thermoregulation setpoint. A functional system that maintains a constant temperature of the internal environment of the body. The constancy of the temperature of the internal environment of the body, as a necessary condition for the normal course of metabolic processes. The temperature scheme of the body, its daily fluctuations. Poikilothermia, homeothermia, hibernation.	All		
		2	0	8
		Online		
		0	0	0
8	Physiology of the respiratory system Physiology of the respiratory system Functions and stages of respiration. Pulmonary volumes. Oxygen transport by blood. Transport of carbon dioxide by blood. Regulation of breathing.	All		
		2	0	8
		Online		
		0	0	0
9-15	The Second Station	6	0	26
9 - 10	Physiology of excretion Physiology of excretion The concept of excretion, its role in maintaining homeostasis. The kidneys are the main excretory organ. Morphofunctional characteristics of the nephron, features of its blood supply. The mechanism of glomerular filtration and its regulation. Primary urine, the difference in its composition from blood plasma. Reabsorption. Mandatory (reverse) and selective (optional) reabsorption. Active and passive processes underlying reabsorption. Understanding threshold and non-threshold substances. Rotary-countercurrent mechanism of urine concentration at the level of the Henle loop and collecting tube. Regulatory mechanisms of the reabsorption process. The role	All		
		2	0	8
		Online		
		0	0	0

	of the main humoral factors: aldosterone and antidiuretic hormone. Secretion in the renal tubules. Secondary urine. Understanding of the homostatic functions of the kidneys (regulation of fluid volume, osmotic pressure, acid-base balance, amount of inorganic and organic substances, blood pressure, hematopoiesis) of the mechanism of urination, its regulation.			
11 - 13	Physiology of higher nervous activity Physiology of higher nervous activity The concept of GNI. Comparative characteristics of conditioned and unconditioned reflexes. The concept of conditioned reflex. The history of the discovery of conditioned reflexes. The significance of I.P. Pavlov's works in the physiology of internal organs. The importance of conditioned reflexes in the adaptation of animals and humans to the conditions of existence. Rules, stages and mechanisms of conditioned reflexes development. Classification of conditioned reflexes. GNI inhibition, its types, conditions of occurrence. The importance of inhibition of conditioned reflexes. Braking in GNI, its types: unconditional, conditional (attenuation, differentiation, conditional braking, delay), the conditions of their occurrence. Modern understanding of the mechanisms of GNI inhibition. The importance of inhibition of conditioned reflexes for the organization of adaptive human activity. Types of GNI (according to I. P. Pavlov). Classification and characterization of GNI types. Types of basic mental functions. The concept of motivation. Classification of motivations. An idea of the mechanism of their occurrence. The concept of emotions. Types of emotions. An idea of the mechanism of their occurrence. Memory, types of memory. Understanding the mechanisms of short-term and long-term memory. The concept of thinking. Kind of thinking. The role of various brain structures in the realization of the thought process. The development of abstract thinking in human ontogenesis. The concept of speech. Types of speech and speech functions. Understanding the mechanisms of speech and functional asymmetry of the cerebral cortex. The connection between speech and thinking. The concept of consciousness. Understanding of physiological and psychophysiological methods of studying mental functions. Analysis of the components of the functional system of a behavioral act. Biologically and socially determined types of purposeful activities. The idea of work as one of the manifestations of purposeful human activity.	All		
		2	0	8
		Online		
		0	0	0
14 - 15	Physiology of functional states The concept of functional States. Methods for assessing the functional state. Systemic mechanisms of motivation, memory, emotions, and sleep. The optimal level of functional state. Individual differences in functional States. Regulation of functional States.	All		
		2	0	8
		Online		
		0	0	0

	The relationship of the level of functional state with the efficiency and productivity of purposeful activity. Functional state of a person in the conditions of emotionally intense activity. Features of forming the architectonics of a purposeful behavioral act. The concept and types of physical activity. Concepts of health and disease. Factors that affect the state of health. Features of health preservation in modern conditions. Health and work. The concept of a healthy lifestyle. Features of students' lifestyle and work. Efficiency. Stages of health. Fatigue, its mechanisms. The concept of passive and active recreation. The concept of stress. Types of stress. The stages of stress according to Hans Selye. Stress-implementing and stress-limiting systems. The role of emotional stress in the development of somatic pathology. The role of individual typological features in the formation of resistance to psychoemotional stress. Prevention of psychoemotional stress.			
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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

LABORATORY (LAB) SESSIONS TOPICS

Weeks	Topics / Content
	<i>3 Semester</i>
1 - 2	Introduction to Normal Physiology. Regulation of physiological functions Introduction to physiology. Physiology as a scientific basis for assessing a person's state of health, functional status and working capacity. A brief description of the stages of development of normal physiology: empirical, anatomical and physiological, functional. Modern problems, tasks and trends in the development of physiology. The concept of an organism and its constituent elements. Levels of morphofunctional organization of the human body. The concept of physiological functions. The concept of the internal environment of the body and its components (blood, lymph, intercellular fluid). The concept of homeostasis, homeokinesis. Psychological adaptive response. The concept of regulation of functions. The basic principles of the formation and regulation of physiological functions: deviation, violation, prediction. Levels and mechanisms of regulation of functions (physico-chemical, nervous, humoral). The idea of self-regulation is about the constancy of the internal environment of the body. System organization of functions (I.P. Pavlov, P.K. Anokhin). The organization's system levels. The physiological system. The functional system and its components (P.K. Anokhin). The concept of a system-forming factor. Principles of organization and interaction of functional systems.
3 - 4	Physiology of excitable tissues

	The history of the discovery of bioelectric phenomena in living tissues (experiments by L. Galvani, K. Matteucci). Irritability as the basis of tissue reaction to irritation. Classification of stimuli. The concept of excitability and irritability. The structure and function of biological membranes. Active and passive transport of substances through the membrane. Ion channels and pumping mechanisms. Resting membrane potential. Membrane-ionic theory of resting potential formation (A. Hodgkin, A. Huxley, B. Katz). Action potential and its phases. Critical level of depolarization. Threshold potential. Ionic excitation mechanisms. Conditions for the occurrence of excitation. Practical use of biocurrent registration in medicine. Physiological properties of excitable tissues. Excitability, its level and assessment criteria: threshold strength, time, gradient of the increase in the strength of the stimulus in time. Force-time curve. The concept of rheobase, chronaxy, useful time. The influence of the parameters of the stimulus (strength, time, the steepness of the increase in strength in time) on the nature of the response of excitable systems. Optimal and pessimal responses. The concept of lability. A measure of lability. Classification of nerve fibers. Physiological properties of nerve fibers. Mechanisms of conduction of excitation along the nerve fibers. The laws of the conduction of excitation in the nerves. Physiological properties of skeletal muscles. The concept of a motor unit. Features of the structure of the membrane and sarcomeres of the fibers of skeletal muscle. The mechanism of muscle contraction. Muscle strength. Muscle fatigue. Electromyography. Physiological features and properties of smooth muscles. Their importance in the myogenic regulation of the motor functions of internal organs.
5 - 6	Physiology of the central nervous system. Physiology of pain Central nervous system functions. Methods for studying the functions of the central nervous system. Morpho-functional organization of a neuron as a unit of the nervous system. Classification of neurons. The integrative function of the neuron. Glial elements of the brain and their functional significance. Reflex. Reflex classification. The principles of reflex theory. Morphological basis of somatic and vegetative reflexes. The concept of the adaptive result of reflex activity. The nature of the propagation of excitation in the central nervous system (divergence, convergence, circulation in neural networks). Patterns of the propagation of excitation along the reflex arc (unilateral conduction, central delay, summation of excitations, transformation of the rhythm of excitations, post-tetanic potentiation, aftereffect). Synapse concept. Synapse classification. Synapse structure. Functional properties of electrical and chemical synapses. The mechanism of signal transmission in a chemical synapse. Types of synaptic neurotransmitters and neuromodulators. The emergence of local and spreading excitations in the neuron. Properties of nerve centers (low lability, high fatigue, high sensitivity to neurotropic drugs, hypoxia, acidosis, plasticity). Inhibition in the central nervous system. The history of the discovery of central braking. Inhibition mechanisms (presynaptic, postsynaptic, post-activation and pessimal). Interaction mechanisms of excitatory and inhibitory influences on a neuron. Types of inhibition (lateral, return, recurrent). The value of inhibition in the activity of the organism. The concept of pain, nociception. Pain functions. Pain classification. Pain as an integrative reaction of the body to the damaging effect of the stimulus. Pain response components. The role of the thalamus and cerebral cortex in the integration and analysis of pain excitement. The concepts of antinociception and antinociceptive system. ANTsS levels: system of top-down braking control of primary afferents and first relay cores; limbic-hypothalamic level; cortical level (secondary soma-tosensory and orbito-frontal areas of the cerebral cortex). Algometry.
7	Physiology of sensory systems Sensory system concept. The concept of the analyzer from the standpoint of the teachings of I.P. Pavlov. The idea of the main and auxiliary structures of the sense organ. Receptor

	concept. Functional properties and features of receptors. Receptor classification. Receptor excitation mechanism. Signal coding in receptors. Functional properties and features of the organization of the conduction department of the sensory system. Features of the organization of the cortical section of the sensory system. Information coding in various departments of sensory systems. Morphofunctional characteristics of the parts of the visual sensory system. The concept of the field of vision and visual acuity. Methods for their determination. Refraction, accommodation and adaptation of the eye. The mechanisms of these processes, their anomalies (astigmatism, myopia, hyperopia, presbyopia). Pupillary reflex. Rods and cones, mechanisms of reception and perception of light and color perception. The main types of color perception disorders.
8	Physiology of sensory systems Auditory sensory system. Sound-collecting formations, sound-conducting paths and sound-receiving apparatus of the auditory sensory system. Sound reception mechanisms. Binaural hearing. Research methods of the auditory sensory system. General morphological and functional organization of the divisions of the skin sensory system. Tactile and temperature sensory systems as its components. Classification of tactile receptors, their structural and functional differences. Research methods of the tactile sensory system. The concept of the spatial threshold of tactile sensitivity. Thermoreceptor classification. Methods for studying the temperature sensory system. General morphological and functional organization of the divisions of the gustatory sensory system. Receptors of the gustatory sensory system. Taste bud, taste buds. Types of taste buds of the tongue. The mechanism of reception and perception of taste. Methods for the study of the gustatory sensory system (density measurement and functional mobility). General morphological and functional organization of the divisions of the olfactory sensory system. The mechanism of reception and perception of smell. Research methods of the olfactory sensory system (olfactometry). The role of interaction between the olfactory and other sensory systems in the formation of gustatory sensations. Features of the activity of analyzers in children: visual analyzer, other analyzers - auditory, vestibular. Skin analyzer: tactile, temperature and pain sensitivity. Flavor analyzer. Olfactory analyzer.
9 - 10	Physiology of blood The concept of the blood system. The amount of circulating blood, its composition. Blood functions. Basic blood constants, their value and functional significance. The concept of osmotic blood pressure. Functional systems that maintain a constant blood pH and osmotic pressure. The concept of hemolysis, its types and plasmolysis. Corpuscular elements of blood, their physiological significance. The concept of erythro-, leuko- and thrombocytopoiesis, their nervous and humoral regulation. Hemoglobin, its compounds, functional significance. Lymph, its composition and functions. Understanding of the protective function of blood and its manifestations (immune reactions, blood clotting). Blood groups. Varieties of blood group systems (AB0, Rh-affiliation). Their meaning. The process of blood coagulation (hemostasis), its meaning. The main factors involved in the process of blood coagulation (tissue, plasma, thrombotic, erythro- and leukocyte), their functional characteristics. Concept of external (tissue) and internal (blood) blood coagulation systems, phases of blood coagulation, processes of retraction and fibrinolysis. Factors that accelerate and slow down blood clotting. Features of the blood system in children: corpuscles, blood plasma, the formation of blood group affiliation in ontogenesis, immunity.
11 - 12	Physiology of blood circulation The concept of the physiological circulatory system (cardiovascular system). Morphofunctional features of the organization of the heart. Pumping (pumping) function of the heart. Typical and atypical (P and T cells) cardiomyocytes, cardiac conduction system, valve apparatus, heart cavities. Physical and physiological properties of the heart muscle. The concept of functional syncytium for the heart. The emergence and spread of excitement in the heart. Automation, its nature, centers and gradient. Ionic mechanisms of excitation of

	atypical myocardiocytes. Mechanisms of slow diastolic depolarization. Changes in excitability during excitation of typical cardiomyocytes. Electromechanical interfacing. Extrasystole. Compensatory pause. Cardiac cycle, its phase structure. The idea of chrono-, batmo-, dromo- and inotropic effects as manifestations of regulatory influences on the work of the heart. Types of regulation of cardiac activity. Intracardiac regulation. Nervous and humoral mechanisms of extracardiac regulation of cardiac activity Endocrine function of the heart. Influence of natriuretic peptide on vascular tone and the process of urination.
13 - 14	Physiology of blood circulation Functional classification of blood vessels. The basic laws of hydrodynamics and their use to explain the physiological functions and patterns of blood flow through the vessels. Factors that ensure the movement of blood through the vessels. Peripheral circulation parameters (blood pressure, linear and volumetric blood flow velocities, blood circulation time). Change in resistance, blood pressure and blood flow rate in different parts of the vascular bed. Nervous, humoral and myogenic regulation of vascular tone. The concepts of systolic, diastolic, pulse and mean arterial pressure. Factors that determine the value of blood pressure. A functional system that maintains a normal level of blood pressure. Microcirculation and its role in the mechanisms of exchange of fluid and various substances between blood and tissues. External manifestations of the activity of the heart (electrical, sound, mechanical). Mechanisms of EMF of the heart. Einthoven's theory
15 - 16	Physiology of blood circulation Methods for recording electrical manifestations of cardiac activity. Basic ECG leads in humans. Structural analysis of a normal ECG. Methods for the study of sound manifestations of heart activity. The origin of heart sounds, their types and places of the best listening. Arterial (sphygmography) pulse research methods. Clinical evaluation of human pulse. Methods for measuring blood pressure (direct and indirect). The Riva-Rocci and Korotkov methods. Cardiac activity during exercise. Cardiac output is an integral indicator of heart function. The mechanism of changes in cardiac output during exercise. Changes in the structure of the heart rhythm in conditions of physically intense activity. Regulation of vascular tone during physical activity. Mechanisms for enhancing venous return during muscular work (venous, muscular, respiratory “pumps”). Methods for assessing the physical performance of a person according to the indicators of the heart. Features of blood circulation in the fetus and in children: the circulation pattern in the fetus and its restructuring after birth, the heart in the fetus and in children of different ages, the vascular system in children of different ages, the formation of vagus nerve tone in children and changes in the heart rate during ontogenesis
	<i>4 Semester</i>
1 - 2	Physiology of digestion I Physiology of digestion I Digestion, its meaning, types and forms. Oral and membranous digestion, their interrelation and severity in various parts of the gastrointestinal tract. Intracellular digestion. General principles of neurohumoral regulation of digestive tract functions. Neurohumoral mechanisms of hunger and satiety. Salivation and salivation. Nervous and moral mechanisms of regulation of these processes. Phases of salivation, salivary reflex. Swallowing, its phases and mechanisms. Functions of the stomach. Quantity, composition and properties of gastric juice. The value of hydrochloric acid and other components of gastric juice. Phases of gastric secretion, their neurohumoral mechanisms. Gastric motility. Nervous and humoral factors affecting the motor and evacuation functions of the stomach
3 - 4	Physiology of digestion II Physiology of digestion II The importance and role of digestion in the duodenum. Functions of the pancreas. The amount, composition and properties of pancreatic juice. Pancreatic juice enzymes secreted in the active state. Mechanisms of regulation of pancreatic secretion. Contours of pancreatic

	secretion self-regulation, their significance. Liver function. Bile, its quantity, composition, importance for digestion. Recycling of bile acids in the intestine and liver. The importance and role of digestion in the small intestine. The mechanism of formation of intestinal juice. Quantity, properties, and enzyme composition of intestinal juice. Regulation of intestinal juice separation. Motor activity of the small and large intestines, its features, significance, mechanisms of regulation. Features of digestion, the importance of microflora in this process.
5 - 6	The metabolic basis of physiological functions The metabolic basis of physiological functions Metabolism is the main condition for ensuring vital activity and maintaining homeostasis. The plastic and energetic role of nutrients. Processes of assimilation and dissimilation of substances. The value of water for the body. The concept of regulation of water and mineral metabolism, the principle of self-regulation of these processes. Vitamins, their importance. The concept of the energy balance of the body. Caloric content of various food substances. Principles of rational nutrition organization. Methods of calorimetry. Specific dynamic action of nutrients.
7 - 8	Physiology of thermoregulation Physiology of thermoregulation The concept of thermoregulation. Heat transfer. The central link of the thermoregulation system. The center of thermoregulation is the hypothalamus. Pyrogens. A functional system that maintains a constant temperature of the body's internal environment. The constant temperature of the internal environment of the body, as a necessary condition for the normal course of metabolic processes. Body temperature chart, its daily fluctuations. Poikilothermy, homoiothermy.
8	Physiology of the respiratory system Physiology of the respiratory system Functions and stages of respiration. Pulmonary volumes. Oxygen transport by blood. Transport of carbon dioxide by blood. Regulation of breathing
9 - 10	Physiology of excretion The concept of excretion, its role in maintaining homeostasis. The kidneys are the main excretory organ. Morphofunctional characteristics of the nephron, features of its blood supply. The mechanism of glomerular filtration and its regulation. Primary urine, the difference in its composition from blood plasma. Reabsorption. Mandatory (reverse) and selective (optional) reabsorption. Active and passive processes underlying reabsorption. Understanding threshold and non-threshold substances. Rotary-countercurrent mechanism of urine concentration at the level of the Henle loop and collecting tube. Regulatory mechanisms of the reabsorption process. The role of the main humoral factors: aldosterone and antidiuretic hormone. Secretion in the renal tubules. Secondary urine. Understanding of the homostatic functions of the kidneys (regulation of fluid volume, osmotic pressure, acid-base balance, amount of inorganic and organic substances, blood pressure, haematopoiesis). The mechanism of urination, its regulation.
11 - 13	Physiology of higher nervous activity The concept of GNI. Comparative characteristics of conditioned and unconditioned reflexes. The concept of conditioned reflex. The history of the discovery of conditioned reflexes. The significance of I.P. Pavlov's works in the physiology of internal organs. The importance of conditioned reflexes in the adaptation of animals and humans to the conditions of existence. Rules, stages and mechanisms of conditioned reflexes development. Classification of conditioned reflexes. GNI inhibition, its types, conditions of occurrence. The importance of

	inhibition of conditioned reflexes. Braking in GNI, its types: unconditional, conditional (attenuation, differentiation, conditional braking, delay), the conditions of their occurrence. Modern understanding of the mechanisms of GNI inhibition. The importance of inhibition of conditioned reflexes for the organization of adaptive human activity. Types of GNI (according to I. P. Pavlov). Classification and characterization of GNI types. Types of basic mental functions. The concept of motivation. Classification of motivations. An idea of the mechanism of their occurrence. The concept of emotions. Types of emotions. An idea of the mechanism of their occurrence. Memory, types of memory. Understanding the mechanisms of short-term and long-term memory. The concept of thinking. Kind of thinking. The role of various brain structures in the realization of the thought process. The development of abstract thinking in human ontogenesis. The concept of speech. Types of speech and speech functions. Understanding the mechanisms of speech and functional asymmetry of the cerebral cortex. The connection between speech and thinking. The concept of consciousness. Understanding of physiological and psychophysiological methods of studying mental functions. Analysis of the components of the functional system of a behavioral act. Biologically and socially determined types of purposeful activities. The idea of work as one of the manifestations of purposeful human activity.
14 - 15	Physiology of functional states The concept of functional States. Methods for assessing the functional state. Systemic mechanisms of motivation, memory, emotions, and sleep. The optimal level of functional state. Individual differences in functional States. Regulation of functional States. The relationship of the level of functional state with the efficiency and productivity of purposeful activity. Functional state of a person in the conditions of emotionally intense activity. Features of forming the architectonics of a purposeful behavioral act. The concept and types of physical activity. Concepts of health and disease. Factors that affect the state of health. Features of health preservation in modern conditions. Health and work. The concept of a healthy lifestyle. Features of students' lifestyle and work. Efficiency. Stages of health. Fatigue, its mechanisms. The concept of passive and active recreation. The concept of stress. Types of stress. The stages of stress according to Hans Selye. Stress-implementing and stress-limiting systems. The role of emotional stress in the development of somatic pathology. The role of individual typological features in the formation of resistance to psychoemotional stress. Prevention of psychoemotional stress.

6. EDUCATIONAL TECHNOLOGIES

The discipline is taught using the following educational technologies

Forms of organization of the educational process:

1. Lecture

2. Laboratory classes, including:

- traditional visual aid classes;

- study of the physiological functions of the body using the Biomed laboratory complex with the recording of material in a notebook and the submission of laboratory work reports for verification;

- solving situational problems;

- execution of written works.

3. Independent work of students

The content of the discipline has both theoretical and practical orientation. Consequently, the teaching of this course is based on a close connection between the achievements of theory and practice and is accompanied by the acquisition of practical skills and abilities.

In this regard, studying the course involves a combination of complementary forms of classes such as lectures, laboratory classes, independent work with scientific and educational sources.

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)	Assessment activity (Syl 2)
ОПК-5	3-ОПК-5	PFE, SA-8, SA-15, КИ-15	Ex, SA-8, SA-15, T-16
	У-ОПК-5	PFE, SA-8, SA-15, КИ-8, КИ-15	Ex, SA-8, SA-15, T-8, T-16
	В-ОПК-5	PFE, SA-8, SA-15, КИ-8, КИ-15	Ex, SA-8, SA-15, T-8, T-16

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:

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

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 N79 Normal physiology : учебник, , Москва: ГЭОТАР-Медиа, 2022
2. ЭИ Н 83 Нормальная физиология : Гриф Минобрнауки России. Рекомендовано ГОУ ВПО "Московская медицинская академия имени И.М. Сеченова" в качестве учебника для студентов учреждений высшего профессионального образования, обучающихся по специальности 060101.65 "Лечебное дело" по дисциплине "Нормальная физиология"., , Москва: ГЭОТАР-Медиа, 2012
3. ЭИ Ф 50 Физиология человека: Атлас динамических схем : учебное наглядное пособие, Киселев И.И. [и др.], Москва: ГЭОТАР-Медиа, 2015

FURTHER READING:

1. ЭИ А 92 Атлас по физиологии. В двух томах. Том 1 : Гриф УМО по классическому университетскому образованию., , Москва: ГЭОТАР-Медиа, 2010
2. ЭИ Л24 Избранные лекции по нормальной физиологии = Selected Lectures on Normal Physiology : учебное пособие, Трутнева Е.А., Лапкин М.М., Москва: ГЭОТАР-Медиа, 2021
3. ЭИ Н 78 Нормальная физиология : учебник, Маслюков П.М., Ноздрачев А.Д., Москва: ГЭОТАР-Медиа, 2021
4. ЭИ Ф 50 Физиология человека: Атлас динамических схем : учебное наглядное пособие, Киселев И.И. [и др.], Москва: ГЭОТАР-Медиа, 2009
5. ЭИ Ф 50 Физиология: руководство к экспериментальным работам : Гриф УМО по медицинскому и фармацевтическому образованию вузов России., , Москва: ГЭОТАР-Медиа, 2011
6. ЭИ Т 48 Эндокринная регуляция. Биохимические и физиологические аспекты : учебное пособие, Ткачук В.А., Смирнов А.Н., Москва: ГЭОТАР-Медиа, 2009

SOFTWARE:

1. Microsoft Office 2016+ ()
2. Microsoft Word (K64-303)

LMS AND ONLINE RESOURCES

1. Terminologia Anatomica (<http://terminologia-anatomica.org/en>)
2. Anatomical Dictionary. (<https://www.memorixanatomy.com/dictionary>)
3. Histology Guide - virtual microscopy laboratory (<https://histologyguide.com/>)

<https://online.mephi.ru/>

<http://library.mephi.ru/>

9. LOGISTICAL SUPPORT

1. Лаборатория функциональной диагностики (64-306)
2. Персональный компьютер: Процессор CPU Intel Core i7-8700 (3.2GHz/12MB/6 cores)
Материнская плата Gig (64-306)
3. Мышь, клавиатура (64-306)
4. Аппарат для электрофизиологических исследований MP35 (Biopac Student Lab, полная комплектация для PC (64-306)
5. «Интерактивный анатомический стол «Пирогов I» с программным обеспечением «3D атлас нормальной и топо (64-403)
6. Демонстрационные модели тела человека (64-403)
7. Демонстрационные модели мочеполовой системы (64-403)
8. Демонстрационные модели тела человека (64-402)
9. Демонстрационные модели дыхательной системы (64-402)
10. Биноккулярные микроскопы "Микромед 2" (64-303)
11. Биноккулярные микроскопы "Микромед 2" (64-304)
12. Биноккулярные микроскопы "Микромед 2" (64-305)
13. Интерактивная доска SMART SBM 685 (64-306)
14. Проектор SMART P109 (64-306)
15. Монитор Dell P2720D (64-306)
16. Веб-камера Microsoft LifeCam Cinema HD (64-306)

17. Акустическая система CBR 2.0 CMS295 (64-306)
18. Персональный компьютер: Моноблок Lenovo V540-24IWL All-In-One 23,8" i3-8145U 8Gb 256GB_SSD_M.2 Intel (64-306)
19. Compact MRT 09500-99 с набором образцов (64-306)
20. Интерактивная доска SMART SBM 685 (64-401)
21. Динамометр кистевой ДК-140 (64-302)
22. Динамометр становой ДС-200 (64-302)
23. Набор медицинских камертонов KaWe (64-302)

10. EDUCATIONAL AND METHODOLOGICAL RECOMMENDATIONS FOR STUDENTS

The discipline is taught using the following educational technologies.

Forms of organization of the educational process:

1. Lecture
2. Laboratory classes, including:
 - traditional visual aid classes;
 - study of the physiological functions of the body using a Biopack laboratory complex with the fixation of material in a notebook and the submission of laboratory work reports for verification;
 - solving situational problems;
 - execution of written works.
3. Independent work of students

The content of the discipline has both theoretical and practical orientation. Consequently, the teaching of this course is based on a close connection between the achievements of theory and practice and is accompanied by the acquisition of practical skills and abilities.

In this regard, studying the course involves a combination of complementary forms of classes such as lectures, laboratory classes, independent work with scientific and educational sources.

The discipline of Normal Physiology is provided using DOT: distance learning; lecture materials and assignments for practical work, as well as knowledge testing using tests are conducted on the Educational Portal of the National Research Nuclear University MEPhI.

Methodological recommendations on the organization of the educational process using distance learning technologies.

The development of academic discipline in full-time education using distance learning technologies occurs according to the following scheme:

The educational and methodological materials necessary for training are posted in the University's distance learning system, the Educational Portal (online.MEPhI) of the National Research Nuclear University "MEPhI".

Each student receives a username and password to log in to the OP for the entire period of mastering the educational program.

The learning process is based on the remote interaction of students, teachers and using e-mail and audio and video communication.

According to the academic schedule, the student gets access to electronic educational materials. The teaching materials are presented in the form of hypertext textbooks, which include theoretical material, examples of standard tasks in the discipline, tasks /assignments for independent performance (which must be completed and sent to the teacher for review, according to the discipline's study schedule) and materials for ongoing monitoring and self-monitoring.

The interaction of students and teachers on all academic issues (sending written papers, questions and answers related to the discipline, etc.) is carried out directly from students to the teacher and back through the MEPhI National Research Nuclear University.

11. EDUCATIONAL AND METHODOLOGICAL RECOMMENDATIONS FOR TEACHERS

Methodological recommendations on the organization of the educational process using distance learning technologies

The development of academic discipline in full-time education using distance learning technologies occurs according to the following scheme:

The educational and methodological materials necessary for training are posted in the University's distance learning system, the Educational Portal (OP) of the National Research Nuclear University "MEPhI".

Each student receives a username and password to log in to the OP for the entire period of mastering the educational program.

The learning process is based on the remote interaction of students, teachers and using e-mail and audio and video communication.

According to the academic schedule, the student gets access to electronic educational materials. The teaching materials are presented in the form of hypertext textbooks, which include theoretical material, examples of standard tasks in the discipline, tasks /assignments for independent performance (which must be completed and sent to the teacher for review, according to the discipline's study schedule) and materials for ongoing monitoring and self-monitoring.

The interaction of students and teachers on all academic issues (sending written papers, questions and answers related to the discipline, etc.) is carried out directly from students to the teacher and back through the MEPhI National Research Nuclear University.

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Дамбаевна /