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**MINISTRY OF HEALTH PROTECTION OF UKRAINE**

**ODESSA NATIONAL MEDICAL UNIVERSITY**

Department of Physiology

**I APPROVE**

Vice-rector for scientific and pedagogical work

Eduard BURYACHKIVSKY

September 1, 2023



**WORKING PROGRAM OF EDUCATIONAL DISCIPLINE**

**"PHYSIOLOGY"**

**Level of higher education:** second (master's)

**Branch of knowledge:** 22 "Health care"

**Specialty:** 222 "Medicine"

**Educational and professional program:** "Medicine"

**2023**

The work program is compiled on the basis of the educational and professional program "Medicine" for the training of specialists of the second (master's) level of higher education in the specialty 222 "Medicine" of the field of knowledge 22 "Health care", approved by the Scientific Council of ONMedU (protocol No. 8 of June 29, 2023 ).

Developers:

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The work program was approved at the meeting of the Department of  
Physiology and Biophysics

Protocol No. 1 of August 28, 2023.

Head of the Physiology and Biophysics Department, honored doctor of Science of Ukraine, Doctor of Medicine, Professor Leonid GODLEVSKY

Agreed with the guarantor of OPP "Medicine" - Valery MARICHEREDA

Approved by the subject cyclical methodical commission for medical and biological disciplines of ONMedU

Protocol No. 1 of August 28, 2023.

Head of the subject cyclic methodical commission for medical and biological disciplines, Doctor of Medicine, prof. Leonid GODLEVSKY

Reviewed and approved at the meeting of the department

Protocol No. \_\_\_ of "\_\_\_" \_\_\_\_\_ 20\_\_

Head of Department \_\_\_\_\_

(signature)

(First Name Surname)

## 1. Description of the academic discipline

Name of indicators	Field of knowledge, specialty, specialization, level of higher education	Characteristics of the academic discipline
The total number of:	Branch of knowledge (code and name) 22 "Health care"	<i>Full-time education</i> <i>Mandatory discipline</i>
Credits: 8.0		<i>Year of training 2</i>
		<i>Semester III-IV</i>
Hours: 240	Specialty (code and name) 222 "Medicine"	<i>Lectures (32 hours)</i>
		<i>Seminars (0 hours)</i>
		<i>Practical (128 hours)</i>
Content modules: 6	Level of higher education second (master's)	<i>Laboratory (0 hours)</i>
		<i>Independent work (80 hours)</i>
		<i>including individual tasks (0 hours)</i>
		<i>Final control form (according to the curriculum) Exam</i>

## 2. The purpose and tasks of the educational discipline of competence, program learning outcomes

**Goal:** formation of the acquirers of elements of professional competences and practical skills in the field of regularities of functioning of organs and systems of the human body, mechanisms of their regulation and adaptation to various conditions of the surrounding environment, as well as interpretation of modern research methods for various functional states of the body of a healthy person.

### Tasks of the discipline:

- Obtaining thorough knowledge of the regularity of functioning of the main physiological systems of the human body
- Obtaining thorough knowledge of the mechanisms of neuro-humoral regulation of functions
- The formation of general ideas about the mechanisms of adaptation of the human body to various conditions of the surrounding environment
- Formation of abilities and skills regarding the physiological bases of interpretation of the results of modern research methods for different functional states of the body of a healthy person.

The process of studying the discipline is aimed at the formation of elements the following **competencies**:

### - *general (ZK):*

GC4 - Knowledge and understanding of the subject area and understanding of professional activity.

GC 11 - Ability to search, process and analyze information from various sources

GC 12 - Determination and persistence in relation to assigned tasks and assumed

responsibilities

- ***special professional (SC):***

SP 24 - Compliance with ethical principles when working with patients and laboratory animals

SP 25 - Observance of professional and academic integrity, bear responsibility for the reliability of the obtained scientific results

SC 28 – Ability to apply fundamental biomedical knowledge at a level sufficient to perform professional tasks in the field of health care

**Program learning outcomes (PLO):**

PLO 1 - Have thorough knowledge of the structure of professional activity. To be able to carry out professional activities that require updating and integration of knowledge. To be responsible for professional development, the ability for further professional training with a high level of autonomy.

PLO 2 - Understanding and knowledge of fundamental and clinical biomedical sciences, at a level sufficient for solving professional tasks in the field of health care.

PLO 3 - Specialized conceptual knowledge, which includes scientific achievements in the field of health care and is the basis for conducting research, critical understanding of problems in the field of medicine and related interdisciplinary problems.

PLO 10 - Determine the necessary mode of work, rest and nutrition on the basis of the final clinical diagnosis, observing the relevant ethical and legal norms, by making a reasoned decision according to existing algorithms and standard schemes.

PLO 21 - Search for the necessary information in the professional literature and databases of other sources, analyze, evaluate and apply this information.

**As a result of studying the academic discipline, the student of higher education must:**

**Know:**

- the main regularities of the functioning of organs and systems of a healthy person
- peculiarities of neuro-humoral and immune regulation of functional systems of the human body
- physiological mechanisms of adaptation of the human body to various environmental conditions
- the basics of physiological research methods and assessment of basic vital signs
- basics of professional requirements, standards and ethical norms

**Be able:**

- analyze the state of physiological functions of the body, its systems and organs
- to analyze the main physiological parameters of neuro-humoral and immune regulation of the functional systems of the human body
- to explain the physiological basis of the methods of researching body functions

### **3. Content of the academic discipline**

#### **Content module 1. Physiology of excitable tissues and the general central nervous system**

**Topic 1.** The subject and tasks of physiology. Concepts of "function", "health", "norm". Methods of physiological research.

Physiology as a scientific basis of medicine about body functions, ways of maintaining health and working capacity. The value of physiology in training a doctor. Levels of the structure of the human body and its functions. The unity of the organism and the external environment. Physiological characteristics of functions, their parameters. Relationship between structure and function. Age and sex characteristics of functions. Functions of cells, tissues, organs, physiological systems of the body. Irritability, excitability as the basis of tissue response to irritation. Excitation. Modern understanding of the structure and functions of cell membranes.

**Topic 2.** Membrane potentials. Physiological mechanism of formation of resting potential.

Transport of ions through membranes. Membrane ion channels, their types, functions. Membrane ion pumps, their functions. Ion gradients of the cell - ion asymmetry. Membrane receptors, their functions. Membrane resting potential (PS) and actions, mechanisms of origin, registration methods, parameters of PS. Physiological role of PS.

**Topic 3.** Membrane potentials. Action potential research.

Physiological role of PD. Changes in cell excitability during PD development. Periods of absolute and relative refractoriness, mechanisms of their origin, physiological significance.

**Topic 4.** Study of the mechanisms of electrical stimulation and conduction of excitation by excitable tissues.

Changes in the membrane potential under the action of an electric current as a stimulus. Local response. Level of critical depolarization. Depolarization threshold as a measure of excitability. Physiological properties of nerve fibers. Mechanisms of nerve impulse conduction by myelinated and unmyelinated nerve fibers. Patterns of excitation. The speed of excitation, the factors on which it depends. Characteristics of nerve fibers of type A, B, C.

**Topic 5.** Mechanisms of conduction of excitation through the neuromuscular synapse.

Neuromuscular synapse, its structure, functions. Mechanisms of chemical transmission of excitation through the neuromuscular synapse. End plate potential (PKP). Physiological mechanisms of blockade of neuromuscular transmission.

**Topic 6.** Properties of skeletal muscles and mechanisms of their contraction, relaxation and fatigue.

Physiology of muscles. Mechanisms of contraction, relaxation and fatigue of skeletal muscles. Mechanisms of combination of excitation and contraction in muscle fibers. Functions and properties of skeletal muscles. Types of muscle fibers. Types of muscle contraction depending on the frequency of irritation: single, tetanic. Types of muscle contraction depending on the change in their

length and tension: isometric, isotonic. The relationship between the length of the muscle fiber and its tension. Properties of muscles in an intact body. Motor units. Electromyography. Energetics of muscle contraction.

**Topic 7.** Study of biological regulation. Contours of biological regulation of functions. The reflex principle of the central nervous system. CNS synapses.

Biological regulation, its types, circuits of biological regulation, regulated parameters, the role of feedback in the circuit of biological regulation. Nervous regulation of functions. Neuron as a structural and functional unit of the central nervous system. Types of neurons, their functions. Neural circuits. Reflex, reflex arc, functions of its links, mechanisms of coding and transmission of information through the reflex arc. The role of receptors. Nerve centers and their physiological properties. Principles of reflex coordination. Types of reflexes, their physiological significance. CNS synapses, their structure, information transmission mechanisms.

**Topic 8.** Excitation and inhibition in the central nervous system. Properties of nerve centers.

Neurotransmitters (acetylcholine, norepinephrine, dopamine, glycine, GABA, glutamate, serotonin, nitric oxide, others) and neuromodulators (neuropeptides, neurosteroids, others). Excitation and inhibition processes in the central nervous system. Excitatory synapses, their neurotransmitters, cytoceptors, development of the excitatory postsynaptic potential (PSP), its parameters, physiological role. Inhibitory synapses, their neurotransmitters. Postsynaptic inhibition, development of the inhibitory postsynaptic potential (IPP). Presynaptic inhibition, mechanisms of development. Central braking (I.M. Sechenov). Summation processes in central synapses: spatial summation, temporal summation. Summation of excitation and inhibition by CNS neurons. Levels of the central nervous system, their interaction in ensuring the adaptive reactions of the body

**Topic 9.** Practical skills from content module 1.

Calculate and estimate the value of the resting membrane potential, the amplitude of PD of nerve and muscle fibers, draw diagrams of their registration graphs, determine and calculate the depolarization threshold, the speed of conduction of excitation along these structures. Calculate and graphically depict the types of muscle contraction depending on the frequency of their irritation, explain the mechanisms of muscle contraction and relaxation, neuromuscular transmission of excitation and the influence of various factors on these processes. Graphically display the circuits of biological regulation, reflex arcs of motor reflexes, the development of the processes of excitation and inhibition in the central nervous system, the processes of their summation and coordination of reflexes.

**Content module 2. Physiology of the central nervous system, ANS and humoral regulation.**

**Topic 10.** The role of the spinal cord in the regulation of motor functions

of the body.

Analysis of sensory information by the spinal cord. Conductive function of the spinal cord, its role in the regulation of motor functions. Motor systems of the spinal cord, their organization and coordination mechanisms (convergence, divergence, types of motoneuron inhibition - reverse, reciprocal). Physiological characteristics of proprioceptors. Muscle spindles or stretch receptors, their structure and functions. Stretch reflexes (myotatic), their reflex arcs, functions of the gamma loop. Activation of alpha and gamma motoneurons by supraspinal motor centers. The role of stretch reflexes in the regulation of muscle tone (tonic myotatic reflexes) and muscle length (phasic myotatic reflexes). The clinical significance of the study of myotatic reflexes. Golgi tendon receptors, their functions, reflexes from tendon receptors, their reflex arcs, physiological significance. Flexion and extensor skin-muscle reflexes. Functional capabilities of the isolated spinal cord. Transverse section of the spinal cord and spinal shock. Descending motor pathways and their role in regulating the activity of alpha and gamma motoneurons.

**Topic 11.** The role of the hindbrain, midbrain and reticular formation in the regulation of motor functions of the body.

The role of the hindbrain in antigravity postures (vestibular nuclei and reticular formation), mechanisms of decerebration rigidity. Tonic labyrinthine reflexes. Vestibular receptors of the sac and uterus, their role in the regulation of tone and posture. Tonic neck reflexes. Motor reflexes of the middle brain: static and stato-kinetic. Righting reflexes (labyrinths, cervical). Head rotations and receptors of the semicircular canals, their physiological role in maintaining the equilibrium posture during movement with acceleration. Vestibular mechanisms of eyeball stabilization. The role of the midbrain in the regulation of stereotyped involuntary movements. Approximate reflexes. Descending and ascending influences of the reticular formation of the brainstem, the work of Megun and Morucci.

**Topic 12.** The role of the forebrain and cerebellum in the regulation of motor functions of the body.

Functional-structural organization of the cerebellum, its afferent and efferent connections, their physiological role. Functional organization of the cerebellar cortex. Interaction between the cerebellar cortex and the cerebellar and vestibular nuclei. The role of the cerebellum in programming, initiation and control of movements. Cerebellum and learning. Consequences of removal or damage to the cerebellum occurring in humans, their physiological mechanisms. Functional characteristics of the nuclei of the thalamus (specific: switching, associative, motor, nonspecific) in the regulation of motor functions. Functional organization and connections of basal nuclei (caudate nucleus, shell and globus pallidum). The role of the basal nuclei in the regulation of muscle tone and complex motor acts, in the organization and implementation of motor programs. their interaction with the subthalamic nucleus and substantia nigra, other structures. Neurotransmitters in the system of basal nuclei, their physiological role. Cycles of the shell and caudate body. Clinical manifestations in damaged

basal nuclei, their physiological mechanisms.

**Topic 13.** Regulation of systemic activity of the body. The role of the limbic system and the cerebral cortex in the formation of the systemic activity of the body.

Human locomotion, their regulation. Movement programming. Functional structure of voluntary movements. In The limbic system, its organization, functions, the leading role of the hypothalamus. Features of hypothalamic neuron functions: neuroreception, neurosecretion. The role of the hypothalamus in the regulation of visceral functions, the integration of somatic, autonomous and endocrine mechanisms in the regulation of homeostasis, the formation of motivations, emotions, non-specific adaptation of the body, biological rhythms. Specific functions of other structures of the limbic system - hippocampus, tonsils, limbic cortex. Physiological anatomy of the cerebral cortex. Modern ideas about the localization of functions in the cortex and its organization. Functional connections of the cerebral cortex with the structures of the central nervous system. Functions of individual cortical fields (associative, sensory, motor). The role of the cortex in the formation of the systemic activity of the body. The primary motor zone of the cortex (field 4), its functional organization and role in the regulation of motor functions. Premotor and supplementary motor areas of the cortex, their organization and role in the regulation of motor functions. Afferent connections of the motor cortex. Descending pathways: cortico-nuclear, cortico-spinal - lateral, ventral, their role in regulating the functions of the muscles of the axial skeleton, proximal and distal parts of the limbs. Maintaining the activity of the cerebral cortex. Ascending activating effects of the reticular formation of the brain stem. Neuro-hormonal control of brain activity (noradrenergic, dopaminergic, serotonergic effects). Neuro-hormonal systems of the brain. Age-related changes in motor functions.

**Topic 14.** Autonomic nervous system. Its structural and functional organization.

Structural and functional organization of the autonomic nervous system. Sympathetic, parasympathetic and metasymphathetic departments, their role in the regulation of visceral functions. Autonomic reflexes, peculiarities of the structure of the efferent link of their reflex arcs. Autonomic ganglia, their functions. Mechanisms of excitation transmission in ganglionic and nerve-organ synapses of the sympathetic and parasympathetic systems.

**Topic 15.** Autonomic nervous system. Its role in the regulation of visceral functions.

Neurotransmitters of the autonomic nervous system. Types of cytoceptors (cholinergic, adrenergic, purinergic, serotonergic and others). Blockers of transmission of excitation in synapses. Central regulation of visceral functions. Integrative centers of regulation of visceral functions. The role of the brain stem. Hypothalamus, its afferent and efferent connections. Functions of the hypothalamus in the regulation of visceral functions. Effects of sympathetic, parasympathetic and metasymphathetic departments on the functions of organs and systems of the body.



**Topic 16.** Humoral regulation, its factors, the mechanism of hormone action on target cells, regulation of hormone secretion.

Factors of humoral regulation, their characteristics and classification. Contour of humoral regulation, the role of feedback in regulation. Relationship between nervous and humoral regulation. Structural and functional organization of the endocrine system. Endocrine glands, endocrine cells, their hormones, their effects. Basic mechanisms of hormone action. Membrane receptors and intracellular receptors, secondary mediators, O-proteins, their role. Regulation of hormone secretion. Hypothalamus - pituitary system. Neurosecretions of the hypothalamus, the role of liberins and statins. Functional connection of the hypothalamus with the pituitary gland.

**Topic 17.** The role of hormones in regulating the processes of mental and physical development and body growth.

Pituitary gland, its hormones, their effects. The role of somatotropin (STH) in ensuring the processes of growth and development, somatomedins: insulin-like growth factor I (IGF-I), insulin-like growth factor II (IGF-II). Contour of regulation of secretion of STH, circadian rhythms. Metabolic effects of STH. The thyroid gland, its hormones, mechanisms of action on target cells, their effects on the state of mental functions, growth and development processes, metabolic processes, the state of visceral systems, and others. The regulation circuit of thyroxine (T<sub>4</sub>) and triiodothyronine (T<sub>3</sub>) secretion. The role of other hormones affecting normal growth processes (insulin, gonadal steroids, cortisol).

**Theme 18.** The role of hormones in the regulation of homeostasis and reproductive function.

Pancreatic hormones (insulin, glucagon, somatostatin) and their effects on metabolism and blood glucose concentration. The circuit of hormonal regulation of maintenance of constancy of glucose concentration in the blood. Calcium balance in the body and hormones that regulate calcium and phosphate homeostasis: parathyroid hormone (PTH) or parathyroid hormone, calcitonin, active form of vitamin D *with* -calcitriol. Influence of other hormones on calcium metabolism and its homeostasis (glucocorticoids, THG and IGF-1, thyroid hormones, estrogens, insulin. Gonads: development and functions of the reproductive system. Sexual differentiation and development. Puberty period. Pituitary gonadotropins and prolactin. Male genital system, its structure and functions. Spermatogenesis, erection and ejaculation, the role of the autonomic nervous system. Endocrine function of the testicles, regulation of the function of the testicles, the circuit of regulation. The female reproductive system, its structure and functions. Monthly cycle. Ovarian hormones, their role, regulation of ovarian function. Pregnancy. Hormones of the placenta. Lactation. Age-related features of endocrine gland functions.

**Topic 19.** The role of hormones in regulating the body's adaptation to stress factors.

The concept of stress and stress factors. Types of adaptation to stress factors. General adaptation syndrome (H. Selye). The role of the sympatho-adrenal system in adaptation. Hormones of the medulla of the adrenal glands -

catecholamines, regulation of their secretion, role in the regulation of the body's adaptation to stress factors. Hormones of the adrenal cortex, contours of regulation of their secretion, circadian rhythms of glucocorticoid secretion, their effects and mechanisms of action on target cells. The role of pituitary hormones, adrenal cortex (glucocorticoids, mineralocorticoids), THG, thyroid hormones (thyroxine, triiodothyronine), vago-insular system in the regulation of non-specific adaptation of the body to stress factors.

**Theme 20.** Practical skills from content module 2.

To depict schemes of reflex arcs of motor reflexes at all levels of the central nervous system and conductive pathways that ensure the interaction of different levels of the central nervous system. To explain the mechanisms of systemic activity of the body during locomotion and the role of the cerebral cortex and the limbic system in these processes. Draw diagrams and explain the structure and mechanisms of reflex arcs of autonomous reflexes, the role of integrative centers in the regulation of visceral functions. Graphically depict schemes and explain the mechanisms of action of various hormones on target cells, draw schemes of contours of regulation of hormone secretion by endocrine glands, draw schemes of contours of regulation of maintenance of homeostasis parameters with the participation of hormones. Draw diagrams and explain the interrelationships and mechanisms of excitation analysis by higher integrative centers.

**Content module 3. Physiology of the GNI, work and sports, sensory systems.**

**Topic 21.** Physiological bases of behavior. The structure of a complete behavioral act according to P.K. Anokhin. Instincts. The role of needs, motivations and emotions in the formation of behavior. Study of formation and inhibition of conditioned reflexes.

Innate and acquired forms of behavior. Typological properties of the GNI. Functional asymmetry of the cortex of the large hemispheres. Language. Thinking. Consciousness. Memory. Sleep. Concept of higher nervous activity, methods of its research. Contribution of I.M. Sechenov and I.P. Pavlov to the development of scientific research of the CIS. Physiological bases of behavior. Innate (unconditioned-reflex) forms of behavior. Instincts, their importance for adaptive activity of the organism. Functional behavior system. The structure of a complete behavioral act according to P.K. Anokhin. Needs and motivations, their physiological mechanisms, role in the formation of behavior. Emotions, their types, formation mechanisms, biological role. Theories of emotions. Acquired (conditional-reflex) forms of behavior, their importance for the adaptive activity of the organism. Patterns of formation and storage of conditioned reflexes (I.P. Pavlov).

**Topic 22.** Features of human GNI. Functional asymmetry of the cortex of the large hemispheres. Language. Thinking. Consciousness.

Functions of the new cortex of the brain and higher nervous activity of a person. Functional asymmetry of the cortex of the large hemispheres of the brain,

the concept of the dominant hemisphere, the functions of the non-dominant hemisphere, the interaction of the hemispheres. Language. Language functions. Physiological bases of its formation. Age-related aspects of higher nervous activity in humans. Types of higher nervous activity, their classification, physiological bases, research methods. The role of education. Types of the nervous system in humans, methods of their research. Thinking. The role of brain structures in the thinking process. Consciousness.

**Topic 23.** Memory, types, mechanisms of formation. The physiological role of peptides in the regulation of memory and learning. Sleep, its types, biological role.

Learning and memory, its types, mechanisms. Types and types of memory, their characteristics. Information storage and retrieval mechanisms. The physiological role of peptides in the regulation of memory and learning. Mechanisms of memorization, their dynamics. Physiological foundations of memorization research methods. Sleep, its types, phases, electrical activity of the brain. Mechanisms of sleep, its biological role.

**Topic 24.** Physiological foundations of work and sports. Optimal modes. Study of fatigue and recovery during muscle work and adaptation of the body to work. Theories of fatigue development.

Employment. Physiological foundations of work. Strength, endurance, efficiency. Peculiarities of physical and mental work. Factors that determine the rate of development of fatigue during muscle work. Methods of assessing fatigue and recovery of the human body during work. Localization and nature of human fatigue during work. General regularities of the development of fatigue and recovery (rules of H.V. Folbort). The concept of active recreation and its mechanisms (I.M. Sechenov). The concept of adaptation to physical labor and its mechanisms. Physiological bases of research methods of adaptation to physical load. Physical training and health. Hypokinesia as a risk factor. Age-related changes in human adaptation and work capacity. Basics of sports physiology. Principles of building optimal training regimes. Physiological bases and criteria of methods for assessing the biological age of a person

**Topic 25.** General characteristics of sensor systems. Research of the somatosensory system.

The concept of sensor systems or analyzers. The importance of sensory systems in learning about the world. Systemic nature of perception. Structural and functional organization of the sensory system. Receptors: classification, main properties, excitation mechanisms, functional lability. Regulation of receptor function. Concept of receptive field and reflexogenic zones. Methods of studying the excitability of receptors. Conductive department of the sensory system. Conductive paths: specific and non-specific channels of information transmission. Participation of the structures of the spinal cord, brain stem, and thalamus in the conduction and processing of afferent impulses. The thalamus is a collector of afferent pathways. Functional characteristics of specific (relay, associative) and nonspecific nuclei of the thalamus. Cortical department of the sensory system. Localization of afferent functions in the cortex. Processes of higher cortical

analysis and synthesis of afferent excitations. Interaction of sensory systems. Coding of information and its processing in various departments of the sensory system. Physiological basis of methods of research of sensory systems. Age-related changes in sensory systems. Structural and functional organization of the somato-sensory system (skin and proprioceptive sensitivities).

**Topic 26.** Physiological basis of pain and analgesia.

Physiological basis of pain. Nociception, physiological characteristics and classification of nociceptors (Ch. Sherrington). Nociceptive or pain system, its structural and functional organization, leading pathways and levels of information processing. Physiological meaning of pain. Antinociceptive or analgesic or analgesic system, its structural and functional organization, opiate and non-opiate mechanisms, physiological role. Physiological basis of analgesia.

**Theme 27.** Research of the visual sensory system.

Structural and functional organization of the visual sensory system, main and auxiliary structures. Receptor apparatus: rods and cones. Photochemical processes in receptors (rods and cones) under the action of light, receptor potential. Sight. Refraction and accommodation. Conductive and cortical departments of the visual sensory system. Analysis of information at different levels. Formation of a visual image. Modern ideas about color perception. The main forms of color perception disorders. Basic visual functions and physiological basis of their research methods. Physiological foundations of the study of visual functions.

**Topic 28.** Research of auditory and vestibular sensory system.

Structural and functional organization of the auditory sensory system, main and auxiliary structures. Sound-conducting, perceiving and analyzing structures. Conductive and cortical departments of the auditory sensory system. Central mechanisms of sound information analysis. Theory of sound perception. Binaural hearing. Structural and functional organization of the vestibular sensory system. Receptor, conductor and cortical departments, central analysis of information at different levels. Perception of the position of the head in space and the direction of movement.

**Theme 29.** Practical skills from content module 3.

To explain the role of integrative centers in the regulation of higher nervous activity. Graphically depict the contours of behavior regulation. To explain the methods of assessment of fatigue and recovery of the human body during work, research methods of adaptation to physical load, principles of construction. Draw diagrams and explain the structure and mechanisms of excitation transmission through the conductive paths of sensory systems. Explain the role of integrative centers in the regulation of sensory systems. Graphically depict the schemes of regulation contours of analyzer systems.

**Content module 4. Physiology of blood, blood circulation and lymphatic circulation.**

**Topic 30.** General characteristics of the blood system. Research of

functions, physical and chemical properties of blood.

The concept of the blood system. The main functions of blood. Composition and volume of human blood. Hematocrit index. Basic physiological constants of blood, mechanisms of their regulation. Plasma, its composition, the role of plasma proteins. Osmotic and oncotic pressures. Regulation of constancy of osmotic pressure. The acid-base state of blood, the role of buffer systems in regulating its stability.

**Topic 31.** Physiology of erythrocytes and hemoglobin.

Erythrocytes, structure, quantity, functions. Hemoglobin, its structure, properties, types, compounds. Amount of hemoglobin. Criteria for saturation of erythrocytes with hemoglobin: average concentration, color indicator. Hemolysis, its types. Erythrocyte sedimentation rate (ESR), factors affecting it. Concept of the erythron as a physiological system, regulation of the number of erythrocytes in the blood. Hematopoiesis and its regulation. Age-related changes in the blood system.

**Topic 32.** Study of protective properties of blood. Functions of leukocytes. The concept of immunity, its types.

Leukocytes, their number, types. The concept of leukocytosis and leukopenia. Leukocyte formula, its analysis and evaluation. Functions of different types of leukocytes. Regulation of the number of leukocytes. The concept of immunity, its types.

**Topic 33.** Physiological basis of blood group research methods and principles of hemotransfusion.

Types of blood groups: ABO, Rh, HLA systems, their antigenic composition. Methods of determining blood groups with standard serums and with clonal antibodies. Physiological basis of blood transfusion. Rules for working with blood. Blood substitutes.

**Topic 34.** Types and mechanisms of hemostasis. Physiology of platelets.

Hemostasis, its types. Vascular-platelet hemostasis, its role. Coagulation hemostasis, its phases, mechanisms, significance. Modern ideas about the main factors involved in coagulation hemostasis. Coagulants, anticoagulants, their types, mechanisms of action, meaning. Plasmins and fibrinolysis, its mechanisms, significance. The role of the vascular wall in the regulation of hemostasis and fibrinolysis. Regulation of blood clotting. Physiological basis of methods of research of hemostasis. Age-related changes in the hemostasis system. Platelets, their number, functions. Mechanisms of maintaining the liquid state of the blood. Extravascular fluids of the body, their role in ensuring the vital activity of body cells.

**Topic 35.** General characteristics of the circulatory system. Physiological properties of heart muscle.

General characteristics of the circulatory system, its role in the body. Structure of the heart, its functions. Heart muscle, its structure, functions. Physiological properties of the myocardium and their features. Mechanisms of contraction and relaxation of cardiomyocytes. Automatism of the heart. Action potential of atypical cardiomyocytes of the pacemaker of the heart - sinoatrial

node. The conduction system, its functional features, the speed of excitation through the structures of the heart. Action potential of typical cardiomyocytes. Periods of refractoriness.

**Topic 36.** Pumping function of the heart. Cardiac cycle, physiological methods of its research.

Cardiac cycle, its phase structure. Blood pressure in the cavities of the heart and operation of the valve apparatus during cardiac activity. Systolic and minute blood volumes, cardiac index.

**Topic 37.** Study of sound and mechanical manifestations of heart activity. Analysis of phonocardiogram indicators.

Mechanisms of origin of heart tones, their characteristics. Physiological bases of the methods of their research: auscultation, analysis and evaluation of the phonocardiogram (FCG). The mechanism of origin of the shock of the apex of the heart, its topography. Physiological bases of echocardiography, dynamocardiography, ballistocardiography.

**Topic 38.** Electrical manifestations of heart activity. Physiological basis of electrocardiography (ECG).

Study of the dynamics of excitation in the heart. Physiological basis of electrocardiography. Analysis and evaluation of a normal ECG.

**Topic 39.** Mechanisms of nervous regulation of heart activity.

Nervous regulation of cardiac activity. Dependence of heart strength on the length of cardiomyocytes (Frank-Starling's heart law), heart rate (Bowditch's ladder) and blood ejection resistance (Anrep's law). Mechanisms of effects of parasympathetic and sympathetic nerves on the physiological properties of heart muscle.

**Theme 40.** Mechanisms of humoral regulation of heart activity.

Humoral regulation of cardiac activity. Mechanisms of influence of the ionic composition of blood plasma on heart activity. Mechanisms of influence of hormones on heart activity: catecholamines, thyroxine and triiodothyronine, glucagon and others.

**Topic 41.** Systemic circulation. Laws of hemodynamics, the role of blood vessels in blood circulation.

Systemic circulation. Basic laws of hemodynamics. Mechanism of formation of vascular tone. Total peripheral vascular resistance. Factors that ensure the movement of blood through vessels of high and low pressure. Linear and volume velocity of blood movement in different sections of the vascular bed. Time of complete blood circulation. Blood pressure, its types: arterial (systolic, diastolic, pulse, average), capillary, venous. Factors determining blood pressure. Physiological basis of blood pressure measurement in experiment and clinic. Functional classification of blood vessels. Physiological characteristics of vessels of various types of vessels. Features of the structure and functions of vascular smooth muscles. Blood depot.

**Topic 42.** Study of human blood pressure and pulse. Analysis of sphygmogram and phlebogram.

Blood pressure research methods. Its types and physiological significance.

Methods of recording the human pulse. Its characteristics. The main elements of the human sphygmogram and phlebogram.

**Topic 43.** Study of regulation of blood circulation. Regulation of vascular tone.

Vascular tone and its regulation, nervous and humoral mechanisms. The role of substances secreted by the endothelium in the regulation of vascular tone. Cardiovascular center, its structure, afferent and efferent connections. The concept of a single center (V.V. Frolkis). The main reflexogenic zones, baroreceptors and chemoreceptors of the carotid sinus and aortic arch, their role. Reflexes from the receptors of the atria and large veins. Pressor and depressor reflexes. Interrelated mechanisms of nervous and humoral regulation of heart activity, vascular tone, and circulating blood volume during various adaptive reactions. Physiological prerequisites for blood pressure disorders. Blood circulation of the fetus. Changes in blood circulation after birth. Age-related features of blood circulation and its regulation. Nervous and humoral mechanisms of blood pressure regulation.

**Topic 44.** Study of microcirculation and features of regional blood circulation.

Morpho-functional characteristics of microcirculatory vessels. Movement of blood in capillaries, its features. Blood pressure in capillaries. Mechanisms of fluid and other substance exchange between blood and tissues. Peculiarities of mechanisms of microcirculatory vessel regulation. Physiological features of regional blood circulation: pulmonary, coronary, cerebral, abdominal. Regulation of local blood flow.

**Theme 45.** Study of the dynamics of lymph circulation.

Lymph, its composition, quantity, functions. Mechanisms of formation and movement of lymph through lymphatic vessels.

**Theme 46.** Practical skills from content module 4.

Assess the state of the blood system, its functions and regulation mechanisms based on the analysis of laboratory blood test indicators. Evaluate the results of the hematocrit index. Determine the amount of hemoglobin, color indicator, blood groups of the ABO system and draw conclusions. Draw diagrams of the conduction system of the heart and graphs of excitation of the pacemaker of the sinoatrial node (SA) and typical ventricular cardiomyocytes and explain the mechanisms of their development. Analyze and interpret normal ECG, FKG, SFG, blood pressure value, cardiac cycle structure. Draw diagrams of the contours of regulation of systemic blood circulation in various physiological states of the body. Interpret the role of features of regional blood circulation and its regulation (pulmonary, coronary, cerebral, abdominal) to ensure an adaptive response.

## **Content module 5. Physiology of breathing and digestion.**

**Topic 47.** General characteristics of the respiratory system. Study of the mechanism of inhalation and exhalation. Study of external breathing.

Structure and functions of the respiratory system. Importance for breathing

of the body. The main stages of the breathing process. Respiratory cycle. Physiological characteristics of respiratory tracts, their functions. Meaning of ciliated epithelium. Biomechanics of inhalation and exhalation. Pressure in the pleural cavity, its changes during breathing. Elastic properties of lungs and chest walls. Surface tension of alveoli, its mechanisms. Surfactants, their meaning.

**Theme 48.** Research of indicators of spirometry, spirometry, pneumotachometry.

Static and dynamic indicators of external breathing. Analysis and assessment of external breathing parameters according to the spirogram and the influence of external and internal factors on them.

**Theme 49.** Mechanisms of gas exchange in the lungs and transportation of gases by blood.

Composition of inhaled, exhaled, alveolar air. The relative constancy of the alveolar air composition. The tension of gases dissolved in the blood. Partial pressure of gases in alveolar air. Mechanisms of gas exchange between inhaled air and alveolar gas mixture, between alveoli and blood in pulmonary capillaries. A property of the lung membrane. Diffusion capacity of the lungs. Relationship between pulmonary circulation and lung ventilation. Anatomical and physiological "dead space". Hemoglobin. Myoglobin. Oxyhemoglobin dissociation curve, factors affecting the formation and dissociation of oxyhemoglobin. Oxygen and carbon dioxide content in arterial and venous blood. Blood oxygen capacity. Formation and dissociation of bicarbonates and carbohemoglobin. The value of carbonic anhydrase. Gas exchange between blood and tissues. Oxygen and carbon dioxide tension in tissue fluid and cells.

**Topic 50.** Research of nervous and humoral regulation of breathing.

Structures that provide respiratory periodicity. Structures of the hindbrain: the dorsal respiratory group of neurons, its role in the generation of the basic breathing rhythm and the regulation of inhalation; ventral respiratory group of neurons, its role. The role of the pneumotaxic center in the inhibition of inhalation, regulation of the volume and frequency of breathing. The apnea center, its role. Lung stretch receptors, their importance in breathing regulation. Breyer's reflex. The role of other receptors in the regulation of breathing: irritant receptors, proprioceptors. Protective respiratory reflexes. Voluntary regulation of breathing. Regulation of the first breath of a newborn child. Age-related features of breathing. Influence of gas composition and pH of arterial blood on frequency and depth of breathing. Central and peripheral chemoreceptors, their importance in ensuring gas homeostasis. Regulation of airway resistance. Breathing during physical work, with increased and decreased barometric pressure.

**Topic 51.** General characteristics and functions of the digestive system. Digestion in the oral cavity. The role of the taste and smell sensory system in the digestion process.

Structure and functions of the digestive system. Alimentary canal and digestive glands. The main functions of the digestive system: secretion, motility, absorption. Digestion: its types (cavity, membrane, intracellular), main stages. Digestion in the oral cavity. Mechanical and chemical processing of food.



Salivation. The amount, composition and properties of saliva, its importance in digestion, mechanisms of secretion (primary, secondary saliva). Regulation of saliva secretion. Chewing, its features depending on the type of food, regulation of chewing. Swallowing, its phases, regulation.

**Theme 52.** Digestion in the stomach. Methods of studying digestion in the stomach.

Secretory activity of gastric glands. Features of secretory cells, mechanisms of secretion, the role of calcium ions and cellular mediators in the secretory process. Research methods. Composition and properties of gastric juice. Mechanisms of secretion of hydrochloric acid, enzymes, mucus and their regulation. Nervous and humoral regulation of gastric gland secretion, phases of secretion regulation: cephalic, gastric, intestinal. Adaptive changes in gastric secretion. Motor function of the stomach, its regulation. Basic principles and mechanisms of digestion regulation. Gastrointestinal hormones. Phases of secretion of the main digestive glands. Periodic activity of digestive organs. Motility of the alimentary canal. Features of the structure and functions of the smooth muscles of the alimentary canal. Physiological basis of the methods of researching the functions of the alimentary canal.

**Topic 53.** Digestion in the duodenum. The role of pancreatic juice and bile in digestion processes.

External secretory activity of the pancreas. Amount, composition and properties of pancreatic juice, its role in digestion. Nervous and humoral regulation of pancreatic secretion. Phases of secretion regulation: cephalic, gastric, intestinal. The role of the liver in digestion. Formation of bile, its composition and properties. Research methods. Hepatic and cystic bile. Participation of bile in digestion. Regulation of the formation of bile and its release into the duodenum.

**Topic 54.** Digestion in the intestines. Physiological basis of hunger and satiety.

Intestinal secretion, composition and properties of intestinal juice, its role in digestion. Research methods. Regulation of intestinal secretion. Cavity and membrane hydrolysis of food substances. The role of the metasymphathetic system in the regulation of the secretory functions of the intestines. Digestion in the colon. The role of gut microflora. Food motivation. Physiological basis of hunger and satiety. The idea of a food center. The contour of the regulation of maintaining the stability of the content of nutrients in the internal environment.

**Theme 55.** Motor activity of the stomach and intestines. Absorption processes.

Features of the structure and functions of the smooth muscles of the alimentary canal. Motor activity of the stomach and small intestine, its role in digestion. Types of motility, its regulation. The role of the metasymphathetic system in the regulation of the motor functions of the intestines. Colon motility, its regulation. Act of defecation. Absorption processes. Research methods. Absorption of substances in different departments of the alimentary canal, its mechanisms. Features of absorption of water, salts, carbohydrates, proteins, fats,

vitamins, and other substances. Adjustment of suction.

**Topic 56.** Practical skills from content module 5.

Assess the state of each of the breathing stages and regulation mechanisms based on the analysis of the parameters characterizing the functions of the breathing stages. Evaluate indicators of spirometry, spirometry, pneumotachometry. Assess the state of the secretory, motor, and absorption functions in different departments of the alimentary canal. Draw schemes of reflex arcs of autonomous reflexes and the influence of hormones that regulate the secretory, motor, and absorptive functions of the digestive system.

## **Content module 6. Physiology of metabolism and energy and excretion.**

**Topic 57.** Energy and basic exchange and methods of their assessment.

General concepts about metabolism in the body. The exchange of substances between the body and the external environment as the basic conditions of life and preservation of homeostasis. Balance of input and output of substances. The main exchange, value, conditions of its study. Direct and indirect calorimetry (study of energy expenditure using complete and incomplete gas analysis). Physical calorimetry. Respiratory rate. Calorific value of one liter of oxygen. Energy exchange. The body as an open thermodynamic system. Energy balance of the body. Labor exchange. Energy expenditure of the body during various types of work. Age characteristics.

**Topic 58.** Physiological foundations of rational nutrition.

Plastic and energetic role of food substances. Specific dynamic action of food substances. Caloric value of various food substances (physical and physiological). Physiological norms of nutrition. The need for proteins, fats, carbohydrates depending on age, type of work and body condition (pregnancy, lactation period, etc.).

**Theme 59.** Body temperature and regulation of its stability. Physiological bases of hardening.

Stability of the temperature of the internal environment as a necessary condition for the normal course of metabolic processes. Poikilothermia, homoiothermia. Human body temperature, its daily fluctuations. The temperature of different areas of the skin and internal organs of a person. Physical and chemical thermoregulation. Metabolism as a source of heat generation. The role of individual organs in heat production. Heat transfer. Methods of heat transfer from the body surface (radiation, conduction, convection, evaporation). Physiological mechanisms of heat transfer (blood movement in skin vessels, sweating, etc.). Thermoregulation center. Peripheral and central thermoreceptors. Nervous and humoral mechanisms of thermoregulation. Regulation of body temperature during changes in the temperature of the external environment. Physiological bases of hardening. Age and sex characteristics of thermoregulation.

**Topic 60.** Allocation system. The role of kidneys in excretion processes, the mechanism of urine formation.

The allocation system, its structure, functions. Excretory organs (kidneys, skin, lungs, alimentary canal), their participation in maintaining body homeostasis. Kidneys as the main organs of the excretory system. Nephron as a structural and functional unit of the kidney. Blood circulation in the kidney, its features. The main processes of urine formation: filtration, reabsorption, secretion. Filtering mechanisms, composition of primary urine. Filter speed adjustment. Reabsorption in tubules, its mechanisms. Reversible - countercurrent - multiple system, its role. Secretory processes in proximal and distal tubules and collecting tubules. Final urine, its composition, quantity. Physiological basis of methods of research of kidney function. The coefficient of purification (clearance) and determination of the speed of filtration, reabsorption, secretion, the amount of renal plasma circulation and blood circulation.

**Theme 61.** Regulation of kidney functions.

Nervous and humoral regulation of kidney functions. Regulation of urination. Mechanisms of regulation of the speed of filtration, reabsorption, secretion. Influence of external and internal factors. Urination and its regulation. Age-related changes in urine formation and urination.

**Theme 62.** The role of kidneys in maintaining homeostasis. Mechanisms of maintenance of acid-alkaline and water-salt balance.

Involvement of kidneys in maintenance of nitrogen balance, parameters of homeostasis. Regulation of constancy of internal osmotic pressure, role of vasopressin. Mechanisms of thirst. Regulation of the constancy of the concentration of sodium, potassium ions, volumes of water and circulating blood in the body with the participation of the kidneys: the role of the renin-angiotensin-aldosterone system, atrial natriuretic hormone. Regulation of the constancy of the concentration of calcium and phosphate ions with the involvement of the kidneys. The role of the kidneys in the regulation of the acid-base state of the internal environment.

**Topic 63.** Practical skills from content module 6.

Calculate the proper and actual basic metabolism of substances and energy and the body's energy expenditure during various types of work. To explain the results of energy expenditure research with the help of complete and incomplete gas analysis, the value of the respiratory and caloric coefficient. Explain the physiological principles of food ration and its correction in a healthy person depending on age, physical load, physiological state of the body. Explain the nervous and humoral mechanisms of thermoregulation. To assess the state of filtration, reabsorption, and secretory functions in different departments of the kidney. Draw schemes of reflex arcs of autonomous reflexes and the influence of hormones that regulate the filtration, reabsorption, and secretory functions of the excretory system.

**Topic 64.** Final test control.

Solutions to situational and test tasks on topics of the discipline Physiology.

#### **4. The structure of the academic discipline**

Name of sections and topics	Number of hours					
	That's all	Including				
		Lectures	Seminary	Practical	laboratory	SR S
<b>Content module 1. Physiology of excitable tissues and the general central nervous system</b>						
Topic 1. The subject and tasks of physiology. Concepts of "function", "health", "norm". Methods of physiological research.	3	0	0	2	0	1
Topic 2. Membrane potentials. Physiological mechanism of formation of resting potential.	4	1	0	2	0	1
Topic 3. Membrane potentials. Action potential research.	4	1	0	2	0	1
Topic 4. Study of the mechanisms of electrical irritation and conduction of excitation by excitable tissues.	3	0	0	2	0	1
Topic 5. Mechanisms of excitation through the neuromuscular synapse.	3	0	0	2	0	1
Topic 6. Properties of skeletal muscles and mechanisms of their contraction, relaxation and fatigue.	4	0	0	2	0	2
Topic 7. Study of biological regulation. Contours of biological regulation. The reflex principle of the central nervous system. CNS synapses.	4	1	0	2	0	1
Topic 8. Excitation and inhibition in the central nervous system. Properties of nerve centers	4	1	0	2	0	1
Topic 9. Practical skills from content module 1.	3	0	0	2	0	1
<i>Together according to content module 1</i>	<i>32</i>	<i>4</i>	<i>0</i>	<i>18</i>	<i>0</i>	<i>10</i>
<b>Content module 2. Physiology of the central nervous system, ANS and humoral regulation.</b>						
Topic 10. The role of the spinal cord in the regulation of motor functions of the body.	4	1	0	2	0	1
Topic 11. The role of the hindbrain, midbrain and reticular formation in the regulation of motor functions of the body.	3	0	0	2	0	1
Topic 12. The role of the forebrain and cerebellum in the regulation of motor functions of the body.	3	0	0	2	0	1
Topic 13. Regulation of systemic activity of the body. The role of the limbic system and the cerebral cortex in the formation of the	5	1	0	2	0	2

systemic activity of the body.						
Topic 14. Autonomic nervous system. Its structural and functional organization.	5	1	0	2	0	2
Topic 15. Autonomic nervous system. Its role in the regulation of visceral functions.	4	1	0	2	0	1
Topic 16. Humoral regulation, its factors, mechanism of action of hormones on target cells, regulation of hormone secretion.	4	1	0	2	0	1
Topic 17. The role of hormones in regulating the processes of mental and physical development and body growth.	4	1	0	2	0	1
Topic 18. The role of hormones in the regulation of homeostasis and reproductive function.	3	0	0	2	0	1
Topic 19. The role of hormones in regulating the body's adaptation to stress factors.	3	0	0	2	0	1
Topic 20. Practical skills from content module 2.	3	0	0	2	0	1
<i>Together according to content module 2</i>	<i>41</i>	<i>6</i>	<i>0</i>	<i>22</i>	<i>0</i>	<i>13</i>
<b>Content module 3. Physiology of GNI, work and sports, sensory systems</b>						
Topic 21. Physiological bases of behavior. The structure of a complete behavioral act according to P.K. Anokhinim. Instincts. The role of needs, motivations and emotions in the formation of behavior. Study of formation and inhibition of conditioned reflexes.	4	1	0	2	0	1
Topic 22. Features of human GNI. Functional asymmetry of the cortex of the large hemispheres. Language. Thinking. Consciousness.	4	1	0	2	0	1
Topic 23. Memory, types, mechanisms of formation. The physiological role of peptides in the regulation of memory and learning. Sleep, its types, biological role.	4	0	0	2	0	2
Topic 24. Physiological foundations of work and sports. Optimal modes. Study of fatigue and recovery during muscle work and adaptation of the body to work. Theories of fatigue development.	3	0	0	2	0	1
Topic 25. General characteristics of sensor systems. Research of the somatosensory system.	4	1	0	2	0	1
Topic 26. Physiological bases of pain and	4	1	0	2	0	1

analgesia.						
Topic 27. Research of the visual sensory system.	4	0	0	2	0	2
Topic 28. Research of the auditory and vestibular sensory system.	4	0	0	2	0	2
Topic 29. Practical skills from content module 3.	3	0	0	2	0	1
<i>Together according to content module 3</i>	<i>34</i>	<i>4</i>	<i>0</i>	<i>18</i>	<i>0</i>	<i>12</i>
<b>Content module 4. Physiology of blood, blood circulation and lymphatic circulation.</b>						
Topic 30. General characteristics of the blood system. Research of functions, physical and chemical properties of blood.	4	1	0	2	0	1
Topic 31. Physiology of erythrocytes and hemoglobin.	4	1	0	2	0	1
Topic 32. Study of protective properties of blood. Functions of leukocytes. The concept of immunity, its types.	3	0	0	2	0	1
Topic 33. Physiological bases of blood group research methods and principles of hemotransfusion.	3	0	0	2	0	1
Topic 34. Types and mechanisms of hemostasis. Physiology of platelets.	3	0	0	2	0	1
Topic 35. General characteristics of the circulatory system. Physiological properties of heart muscle.	4	1	0	2	0	1
Topic 36. Pumping function of the heart. Cardiac cycle, physiological methods of its research.	4	1	0	2	0	1
Topic 37. Study of sound and mechanical manifestations of heart activity. Analysis of phonocardiogram indicators.	4	0	0	2	0	2
Topic 38. Electrical manifestations of heart activity. Physiological basis of electrocardiography (ECG).	5	1	0	2	0	2
Topic 39. Mechanisms of nervous regulation of heart activity.	4	1	0	2	0	1
Topic 40. Mechanisms of humoral regulation of heart activity.	3	0	0	2	0	1
Topic 41. Systemic blood circulation. Laws of hemodynamics, the role of blood vessels in blood circulation.	4	1	0	2	0	1
Topic 42. Study of human blood pressure and pulse. Analysis of sphygmo- and	5	1	0	2	0	2

phlebogram.						
Topic 43. Study of blood circulation regulation. Regulation of vascular tone.	4	0	0	2	0	2
Topic 44. Study of microcirculation and features of regional blood circulation.	3	0	0	2	0	1
Topic 45. Study of the dynamics of lymph circulation.	3	0	0	2	0	1
Topic 46. Practical skills from content module 4.	3	0	0	2	0	1
<i>Together according to content module 4</i>	<i>63</i>	<i>8</i>	<i>0</i>	<i>34</i>	<i>0</i>	<i>21</i>
<b>Content module 5. Physiology of respiration and digestion</b>						
Topic 47. General characteristics of the respiratory system. Study of the mechanism of inhalation and exhalation. Study of external breathing.	5	1	0	2	0	2
Topic 48. Research of indicators of spirometry, spirometry, pneumotachometry.	3	0	0	2	0	1
Topic 49. Mechanisms of gas exchange in the lungs and transportation of gases by blood.	4	1	0	2	0	1
Topic 50. Research of nervous and humoral regulation of breathing.	3	0	0	2	0	1
Topic 51. General characteristics and functions of the digestive system. Digestion in the oral cavity. The role of the taste and smell sensory system in the digestion process.	5	1	0	2	0	2
Topic 52. Digestion in the stomach. Methods of studying digestion in the stomach.	5	1	0	2	0	2
Topic 53. Digestion in the duodenum. The role of pancreatic juice and bile in digestion processes.	3	0	0	2	0	1
Topic 54. Digestion in the intestines. Physiological basis of hunger and satiety.	3	0	0	2	0	1
Topic 55. Motor activity of the stomach and intestines. Absorption processes.	3	0	0	2	0	1
Topic 56. Practical skills from content module 5.	3	0	0	2	0	1
<i>Together according to content module 5</i>	<i>37</i>	<i>4</i>	<i>0</i>	<i>20</i>	<i>0</i>	<i>13</i>
<b>Content module 6. Physiology of metabolism and energy and excretion</b>						
Topic 57. Energy and basic exchange and methods of their assessment.	4	1	0	2	0	1
Topic 58. Physiological foundations of rational nutrition.	4	0	0	2	0	2

Topic 59. Body temperature and regulation of its stability. Physiological bases of hardening.	5	1	0	2	0	2
Topic 60. Allocation system. The role of kidneys in excretion processes, the mechanism of urine formation.	5	1	0	2	0	2
Topic 61. Regulation of kidney functions.	3	0	0	2	0	1
Topic 62. The role of kidneys in maintaining homeostasis. Mechanisms of maintenance of acid-alkaline and water-salt balance.	4	1	0	2	0	1
Topic 63. Practical skills from content module 6.	4	1	0	2	0	1
Topic 64. Final test control.	4	1	0	2	0	1
<i>Together according to content module 6</i>	<i>33</i>	<i>6</i>	<i>0</i>	<i>16</i>	<i>0</i>	<i>11</i>
<b>Together for discipline</b>	<b>240</b>	<b>32</b>	<b>0</b>	<b>128</b>	<b>0</b>	<b>80</b>

## 5. Topics of lectures/seminars/practical/laboratory classes

### 5.1 Topics of lectures

№	The name of the pace	H
1.	Topics 1-6. Introduction to the course of physiology. Irritable tissues. Biopotentials. Neuromuscular physiology.	2
2.	Topic 7-9. General principles of biological regulation. The reflex principle of the central nervous system. Excitation and inhibition in the central nervous system. Principles of coordination of reflex activity	2
3.	Topic 10-11. The role of different levels of the central nervous system in the regulation of body functions. Functions of the spinal cord, brain stem, reticular formation and cerebellum.	2
4.	Topic 12-13. The role of the forebrain, the limbic system and the cerebral cortex in shaping the systemic activity of the body. Pyramidal and extrapyramidal systems.	2
5.	Topic 14-15. Structural and functional organization of the ANS and its role in the regulation of visceral functions.	2
6.	Topic 16-20. Humoral regulation of visceral functions. Factors, mechanisms of hormone action on target cells. The role of endocrine glands in the regulation of processes of growth, development, homeostasis, adaptation of the body.	2
7.	Topic 21-24. Higher nervous activity, its typical features and research methods. Functional systems (P.K. Anokhin). Innate and acquired forms of behavior. The first and second signal systems. Memory, sleep. Physiology of adaptation processes.	2



8.	Topics 25-29. Physiology of sensory systems. Somato-sensory, visual, auditory, vestibular analyzers, their structure and functions. Research methods.	2
9.	Topics 30-34. General characteristics of the blood system. Composition and functions of blood. Physiological blood constants. Physiology of formed blood elements. The concept of immunity, its types. System of regulation of aggregate state of blood (RASK).	2
10.	Topics 35-37. Circulatory system. Physiological properties of heart muscle. Cardiac cycle and its phase structure. Mechanical and sound manifestations of cardiac activity.	2
11.	Topics 38-40. Electrical manifestations of cardiac activity. Electrocardiography. Regulation of cardiac activity.	
12.	Topic 41-46. The role of blood vessels in hemodynamics. Basic principles of hemodynamics. Blood pressure, its types, measurement methods. Regulation of blood flow through vessels. Regulation of systemic blood circulation	2
13.	Topic 47-50. Respiratory system. The main stages of breathing. Gas exchange, transport of gases by blood. Regulation of breathing.	2
14.	Topics 51-55. Digestive system. Digestion in the oral cavity, stomach, small and large intestines. Functions of the liver, bile and pancreas. Physiology of absorption processes, their regulation. Physiological mechanisms of hunger and satiety.	2
15.	Topic 57-59. Balance of substances and energy. Basic exchange. Labor exchange. Physiological norms of nutrition. Thermoregulation system.	2
16.	Topic 60-64. Allocation system. The mechanism of urine formation. Neurohumoral regulation of urination. Methods of research of kidney function. The role of kidneys in maintaining homeostasis. Physiological mechanisms of water-salt and acid-base balance and its regulation.	2
	<b>Together</b>	<b>32</b>

## 5.2. Topics of seminar classes

Seminar classes are not provided.

## 5.3 Topics of practical classes

<b>№</b>	<b>Topic name</b>	<b>H</b>
1.	Topic 1. Subject and tasks of physiology. Concepts of "function", "health", "norm". Methods of physiological research	2
2.	Topic 2. Membrane potentials. Physiological mechanism of formation of resting potential.	2
3.	Topic 3. Membrane potentials. Action potential research.	2
4.	Topic 4. Study of the mechanisms of electrical irritation and	2

	conduction of excitation by excitable tissues.	
5.	Topic 5. Mechanisms of excitation through the neuromuscular synapse.	2
6.	Topic 6. Properties of skeletal muscles and mechanisms of their contraction, relaxation and fatigue.	2
7.	Topic 7. Study of biological regulation. Contours of biological regulation of functions. The reflex principle of the central nervous system. CNS synapses.	2
8.	Topic 8. Excitation and inhibition in the central nervous system. Properties of nerve centers.	2
9.	<i>Topic 9. Practical skills from content module 1.</i>	2
10.	Topic 10. The role of the spinal cord in the regulation of motor functions of the body.	2
11.	Topic 11. The role of the hindbrain, midbrain and reticular formation in the regulation of motor functions of the body.	2
12.	Topic 12. The role of the forebrain and cerebellum in the regulation of motor functions of the body.	2
13.	Topic 13. Regulation of systemic activity of the body. The role of the limbic system and the cerebral cortex in the formation of the systemic activity of the body.	2
14.	Topic 14. Autonomic nervous system. Its structural and functional organization.	2
15.	Topic 15. Autonomic nervous system. Its role in the regulation of visceral functions.	2
16.	Topic 16. Humoral regulation, its factors, mechanism of action of hormones on target cells, regulation of hormone secretion.	2
17.	Topic 17. The role of hormones in regulating the processes of mental and physical development and body growth.	2
18.	Topic 18. The role of hormones in the regulation of homeostasis and reproductive function.	2
19.	Topic 19. The role of hormones in regulating the body's adaptation to stress factors.	2
20.	<i>Topic 20. Practical skills from content module 2.</i>	2
21.	Topic 21. Physiological bases of behavior. The structure of a complete behavioral act according to P.K. Anokhin. Instincts. The role of needs, motivations and emotions in the formation of behavior. Study of formation and inhibition of conditioned reflexes.	2
22.	Topic 22. Features of human GNI. Functional asymmetry of the cortex of the large hemispheres. Language. Thinking. Consciousness.	2
23.	Topic 23. Memory, types, mechanisms of formation. The physiological role of peptides in the regulation of memory and learning. Sleep, its types, biological role.	2
24.	Topic 24. Physiological foundations of work and sports. Optimal modes. Study of fatigue and recovery during muscle work and	2

	adaptation of the body to work. Theories of fatigue development.	
25.	Topic 25. General characteristics of sensor systems. Research of the somatosensory system.	2
26.	Topic 26. Physiological bases of pain and analgesia.	2
27.	Topic 27. Research of the visual sensory system.	2
28.	Topic 28. Research of the auditory and vestibular sensory system.	2
29.	<i>Topic 29. Practical skills from content module 3.</i>	2
30.	Topic 30. General characteristics of the blood system. Research of functions, physical and chemical properties of blood.	2
31.	Topic 31. Physiology of erythrocytes and hemoglobin.	2
32.	Topic 32. Study of protective properties of blood. Functions of leukocytes. The concept of immunity, its types.	2
33.	Topic 33. Physiological bases of blood group research methods and principles of hemotransfusion.	2
34.	Topic 34. Types and mechanisms of hemostasis. Physiology of platelets.	2
35.	Topic 35. General characteristics of the circulatory system. Physiological properties of heart muscle.	2
36.	Topic 36. Pumping function of the heart. Cardiac cycle, physiological methods of its research.	2
37.	Topic 37. Study of sound and mechanical manifestations of heart activity. Analysis of phonocardiogram indicators.	2
38.	Topic 38. Electrical manifestations of heart activity. Physiological basis of electrocardiography (ECG).	2
39.	Topic 39. Mechanisms of nervous regulation of heart activity.	2
40.	Topic 40. Mechanisms of humoral regulation of heart activity.	2
41.	Topic 41. Systemic blood circulation. Laws of hemodynamics, the role of blood vessels in blood circulation. Study of human blood pressure and pulse.	2
42.	Topic 42. Study of the arterial and venous pulse of a person. Analysis of sphygmo- and phlebogram.	2
43.	Topic 43. Study of blood circulation regulation. Regulation of vascular tone.	2
44.	Topic 44. Study of microcirculation and features of regional blood circulation.	2
45.	Topic 45. Study of the dynamics of lymph circulation.	2
46.	<i>Topic 46. Practical skills from content module 4</i>	2
47.	Topic 47. General characteristics of the respiratory system. Study of the mechanism of inhalation and exhalation. Study of external breathing.	2
48.	Topic 48. Research of indicators of spirometry, spirometry, pneumotachometry.	2
49.	Topic 49. Mechanisms of gas exchange in the lungs and transportation of gases by blood.	2

50.	Topic 50. Research of nervous and humoral regulation of breathing.	2
51.	Topic 51. General characteristics and functions of the digestive system. Digestion in the oral cavity. The role of the taste and smell sensory system in the digestion process.	2
52.	Topic 52. Digestion in the stomach. Methods of studying digestion in the stomach.	2
53.	Topic 53. Digestion in the duodenum. The role of pancreatic juice and bile in digestion processes.	2
54.	Topic 54. Digestion in the intestines. Physiological basis of hunger and satiety.	2
55.	Topic 55. Motor activity of the stomach and intestines. Absorption processes.	2
56.	<i>Topic 56. Practical skills from content module 5.</i>	2
57.	Topic 57. Energy and basic exchange and methods of their assessment.	2
58.	Topic 58. Physiological foundations of rational nutrition.	2
59.	Topic 59. Body temperature and regulation of its stability. Physiological bases of hardening.	2
60.	Topic 60. Allocation system. The role of kidneys in excretion processes, the mechanism of urine formation.	2
61.	Topic 61. Regulation of kidney functions.	2
62.	Topic 62. The role of kidneys in maintaining homeostasis. Mechanisms of maintenance of acid-alkaline and water-salt balance.	2
63.	<i>Topic 63. Practical skills from content module 6.</i>	2
64.	Topic 64. Final test control.	2
	<b>Together</b>	<b>128</b>

#### 5.4. Topics of laboratory classes

Laboratory classes are not provided.

### 6. Independent work of a student of higher education

№	Name of the topic/types of tasks	H
<b>Content module 1. Physiology of excitable tissues and the general central nervous system</b>		
1.	Topic 1. Preparation for lectures and practical classes on topic 1.	1
2.	Topic 2. Preparation for lectures and practical classes on topic 2.	1
3.	Topic 3. Preparation for lectures and practical classes on topic 3.	1
4.	Topic 4. Preparation for lectures and practical classes on topic 4.	1
5.	Topic 5. Preparation for lecture and practical class on topic 5.	1
6.	Topic 6. Preparation for lecture and practical class on topic 6. Study of muscle strength and work. Dynamometry.	2
7.	Topic 7. Preparation for lecture and practical class on topic 7.	1
8.	Topic 8. Preparation for lectures and practical classes on topic 8.	1

9.	Topic 9. Preparation for practical skills of content module 1	1
<b>Content module 2. Physiology of the central nervous system, autonomic and endocrine systems</b>		
10.	Topic 10. Preparation for lectures and practical classes on topic 10.	1
11.	Topic 11. Preparation for lecture and practical class on topic 11.	1
12.	Topic 12. Preparation for lectures and practical classes on topic 12.	1
13.	Topic 13. Preparation for lecture and practical class on topic 13. Physiological bases of methods of research of electrical activity of the central nervous system. EEG analysis.	2
14.	Topic 14. Preparation for lectures and practical classes on topic 14. Study of the influence of the autonomic nervous system on the functions of internal organs.	2
15.	Topic 15. Preparation for lecture and practical class on topic 15.	1
16.	Topic 16. Preparation for lectures and practical classes on topic 16.	1
17.	Topic 17. Preparation for lecture and practical class on topic 17.	1
18.	Topic 18. Preparation for lecture and practical class on topic 18.	1
19.	Topic 19. Preparation for lecture and practical class on topic 19.	1
20.	Topic 20. Preparation for practical skills of content module 2	1
<b>Content module 3. Physiology of GNI, labor and sports activities and analyzers</b>		
21.	Topic 21. Preparation for lecture and practical class on topic 21.	1
22.	Topic 22. Preparation for lecture and practical class on topic 22.	1
23.	Topic 23. Preparation for a lecture and practical session on topic 23. Study of the dynamics of memorization.	2
24.	Topic 24. Preparation for lecture and practical class on topic 24.	1
25.	Topic 25. Preparation for lecture and practical class on topic 25.	1
26.	Topic 26. Preparation for lecture and practical class on topic 26.	1
27.	Topic 27. Preparation for lecture and practical class on topic 27. Study of acuity, fields of vision, and color perception.	2
28.	Topic 28. Preparation for a lecture and practical session on topic 28. Hearing analyzer research: Weber's test, Rinne.	2
29.	Topic 29. Preparation for practical skills of content module 3.	1
<b>Content module 4. Physiology of blood, blood circulation and lymph circulation</b>		
30.	Topic 30. Preparation for lectures and practical classes on topic 30.	1
31.	Topic 31. Preparation for lecture and practical class on topic 32.	1
32.	Topic 32. Preparation for lecture and practical class on topic 32.	1
33.	Topic 33. Preparation for lecture and practical class on topic 34.	1
34.	Topic 34. Preparation for lecture and practical class on topic 34.	1
35.	Topic 35. Preparation for lecture and practical class on topic 35.	1
36.	Topic 36. Preparation for lectures and practical classes on topic 36.	1
37.	Topic 37. Preparation for lecture and practical classes on topic 37. Research of sound and mechanical manifestations of heart activity. FCG analysis.	2

38.	Topic 38. Preparation for lecture and practical class on topic 38. Analysis of ECG indicators.	2
39.	Topic 39. Preparation for lecture and practical classes on topic 39.	1
40.	Topic 40. Preparation for lecture and practical class on topic 41.	1
41.	Topic 41. Preparation for lectures and practical classes on topic 41.	1
42.	Topic 42. Preparation for lectures and practical classes on topic 42. Research of the arterial and venous pulse of a person. Analysis of SFG, FG.	2
43.	Topic 43. Preparation for lecture and practical class on topic 43. Mechanisms of blood return to the heart and their regulation.	2
44.	Topic 44. Preparation for lecture and practical class on topic 44.	1
45.	Topic 45. Preparation for lecture and practical class on topic 45.	1
46.	Topic 46. Preparation for practical skills of content module 3	1
<b>Content module 5. Physiology of respiration and digestion</b>		
47.	Topic 47. Preparation for lecture and practical classes on topic 47. Analysis of spirometry, spirometry and pneumotachometry indicators.	2
48.	Topic 48. Preparation for lecture and practical class on topic 48.	1
49.	Topic 49. Preparation for lecture and practical class on topic 49.	1
50.	Topic 50. Preparation for lecture and practical class on topic 50.	1
51.	Topic 51. Preparation for lecture and practical class on topic 51. Study of the role of taste and smell sensory systems in the physiology of digestion.	2
52.	Topic 52. Preparation for lecture and practical class on topic 52. Evaluation of indicators of the results of the study of gastric juice.	2
53.	Topic 53. Preparation for lecture and practical class on topic 53.	1
54.	Topic 54. Preparation for lecture and practical class on topic 54.	1
55.	Topic 55. Preparation for lecture and practical class on topic 55.	1
56.	Topic 56. Preparation for practical skills of content module 5	1
<b>Content module 6. Physiology of metabolism, thermoregulation and excretion</b>		
57.	Topic 57. Preparation for lecture and practical class on topic 57.	1
58.	Topic 58. Preparation for lecture and practical training on topic 58. Basic principles of food rations.	2
59.	Topic 59. Preparation for lecture and practical class on topic 59. Physiological principles of the basis of hardening.	2
60.	Topic 60. Preparation for lecture and practical class on topic 60. Evaluation of indicators of urine formation research.	2
61.	Topic 61. Preparation for lectures and practical classes on topic 61.	1
62.	Topic 62. Preparation for lecture and practical class on topic 62.	1
63.	Topic 63. Preparation for practical skills of content module 6.	1
64.	Topic 64. Preparation for final test control	1
<b>Together</b>		<b>80</b>

## 7. Teaching methods

### **Lectures:**

- explanatory and illustrative methods: conversation, explanation, discussion, discussion of problem situations;
- visual methods: illustrative, presentational (including multimedia presentations);
- practical methods: demonstration of solving sample test and situational tasks

### **Practical training:**

- practical methods: case method, business game, partial search method (heuristic), performance of test tasks, solution of situational tasks (including calculation).
- verbal methods: conversation, explanation, discussion, discussion of problem situations;
- visual methods: illustration (including multimedia presentations);

### **Independent work:**

- independent work with methodical developments, schemes, tables, recommended basic and additional literature, information resource of the department, preparation for classroom classes;
- independent performance of an additional (bonus) scientific research task of the recipient, preparation of a scientific report at a meeting of a scientific circle, conferences, preparation and publication of theses of the recipient's scientific work, participation in an interuniversity Olympiad, a competition of scientific works.

## 8. Forms of control and assessment methods (including criteria for evaluating learning outcomes)

### **Current control:**

- oral control of theoretical knowledge: individual survey on questions of the relevant topic (including questions for independent preparation on the topic), on questions of topics of the content module;
- control of practical tasks: assessment of the solution of situational tasks (including calculation) on the subject of the lesson, according to the topics of the content module;
- written test control: evaluation of the performance of test tasks according to the subject of the lesson, according to the topics of the content module.

### **Final control:** exam.

### **Evaluation of the current educational activity in a practical session:**

1. Evaluation of oral theoretical knowledge on the subject of the lesson, on the topics of the content module:
  - methods: individual survey on questions of the relevant topic (including questions for independent preparation on the topic), topics of the relevant content module, participation of applicants in discussing problem situations
  - maximum score – 5, minimum score – 3, unsatisfactory score – 2.

2. Evaluation of written tasks by the subject of the lesson, from the topics of the content module:
  - methods: evaluation of the performance of test tasks according to the relevant topic, from the topics of the content module
  - maximum score – 5, minimum score – 3, unsatisfactory score– 2.
3. Evaluation of practical tasks on the subject of the lesson, on the topics of the content module:
  - methods: evaluating the solution of situational tasks (including calculation tasks) according to the relevant topic, from the topics of the content module
  - maximum score – 5, minimum score – 3, unsatisfactory score– 2.

The grade for one practical session is the arithmetic average of all components and can only have a whole value (5, 4, 3, 2), which is rounded according to the statistical method.

### **Current evaluation criteria in practical training**

<b>Rating</b>	<b>Evaluation criteria</b>
Perfectly «5»	<p>The applicant takes an active part in practical training; demonstrates deep knowledge, gives complete and detailed answers to questions; actively participates in the discussion of problem situations, uses additional educational and methodological and scientific literature; knows how to form his attitude to a certain problem; expresses his own reasoning, gives appropriate examples; knows how to find the most adequate forms of conflict resolution.</p> <p>The test tasks are completed in full, all 100% of the answers to the questions are correct, the answers to the open questions are complete and justified.</p> <p>The student freely solves situational tasks (including calculations), confidently demonstrates practical skills on the topic of the lesson and correctly interprets the data obtained, expresses his own creative opinion on the topic of the task, demonstrates creative thinking.</p>
Okay «4»	<p>The applicant participates in a practical session; knows the material well; demonstrates the necessary knowledge, but gives answers to questions with some errors; participates in the discussion of problem situations, uses basic educational and methodological and scientific literature; expresses his own opinion on the subject of the lesson.</p> <p>The test tasks are completed in full, at least 70% of the answers to the questions are correct, the answers to the open questions are generally correct, but there are some errors in the definitions.</p> <p>The student correctly solves situational tasks (including calculations), but allows minor inaccuracies and demonstrates more standardized practical skills on the subject of the lesson</p>



	with the correct interpretation of the received data, expresses his own opinion on the topic of the task, demonstrates critical thinking.
Satisfactorily «3»	The acquirer sometimes participates in practical training; partially speaks and asks questions; makes mistakes when answering questions; shows passive work in seminar classes; shows fragmentary knowledge of the conceptual apparatus and literary sources. The testing was carried out in full, at least 50% of the answers are correct, the answers to the open questions are not logical, with obvious significant errors in the definitions. The applicant does not have sufficient knowledge of the material to solve situational tasks (including calculations), shows unconfidently practical skills on the subject of the lesson and interprets the obtained data with significant errors, does not express his opinion on the topic of the situational task.
Unsatisfactorily «2»	The acquirer does not participate in the practical session, is only an observer; never speaks or asks questions, disinterested in learning the material; gives incorrect answers to questions, shows unsatisfactory knowledge of conceptual apparatus and literary sources. Testing not done. Situational task not completed.

Only those applicants who have fulfilled the requirements of the training program in the discipline, have no academic debt, their average score for the current educational activity in the discipline is at least 3.00 and they have passed the test control according to the tests "STEP - 2" are admitted to the final control in the form of an exam. » at least 90% (50 tasks).

The test control is conducted in the Educational and Production Complex of Innovative Technologies of Learning, Informatization and Internal Monitoring of the Quality of Education of the University in the last class before the exam.

#### **Evaluation of learning results during the final control**

<b>The content of the evaluated activity</b>	<b>Scores</b>
Test control of the "Step-1" tests	1
Answer to 3 theoretical questions	3
Practical situational task (evaluation of electrocardiogram, spirogram, etc.)	1

#### **Criteria for evaluating the learning outcomes of education seekers in the exam:**

<b>Rating</b>	<b>Evaluation criteria</b>
Perfectly	The student correctly, accurately and completely fulfilled all the

«5»	<p>tasks of the examination ticket, clearly and logically answered the questions posed by the examiners. Thinks logically and constructs an answer. During the exam, he showed versatile and deep knowledge of the program material, was able to successfully perform the situational tasks provided for by the program, mastered the content of the main and additional literature, realized the interrelationship of individual sections of the discipline, their importance for the future profession, showed creative abilities in understanding and using educational - program material, demonstrated the ability to independently update and replenish knowledge; freely uses the acquired theoretical knowledge in the analysis of practical tasks, could propose and justify an alternative version of the decision on certain issues, the level of competence is high (creative);</p>
Okay «4»	<p>The student of education sufficiently completed all the tasks of the examination ticket of the ticket, clearly and logically answered the questions posed by the examiners. He knows the content of theoretical issues deeply and comprehensively, and has professional and scientific terminology. Thinks logically and constructs an answer, uses acquired theoretical knowledge when analyzing situational tasks. But when teaching some questions, there is not enough depth and argumentation, it makes insignificant mistakes, which are eliminated by the applicant himself when the examiner points them out. When solving the situational task, he assumed insignificant errors or inaccuracies in the interpretation of research results, answered all the questions without significant errors, fully substantiated his point of view, but the proposal of an alternative option caused difficulties. When solving a practical task, he made minor mistakes in the algorithm and technique of performing skills, which were corrected at the instruction of the teacher; the level of competence is sufficient (constructive and variable);</p>
Satisfactorily «3»	<p>The student of education incompletely completed all the tasks of the examination ticket, the answers to additional and leading questions are vague and vague. Possesses a basic amount of theoretical knowledge, uses professional and scientific terminology inaccurately. Experiences significant difficulties in constructing an independent logical answer, in applying theoretical knowledge in the analysis of practical tasks. There are significant errors in the answers. When solving a situational task, he interpreted the results of research with errors, did not know individual details, made inaccuracies in the answers to questions, did not sufficiently justify his answers and interpret the wording correctly, experienced difficulties in completing tasks and proposing alternative options. When solving a practical task, significant errors were made in the algorithm and skill performance technique; the level of competence</p>

	is average (reproductive);
Not satisfactory y «2»	The student of education did not complete the task of the examination ticket, in most cases did not answer the additional and leading questions of the examiners. He did not master the basic amount of theoretical knowledge, he showed a low level of mastery of professional and scientific terminology. Answers to questions are fragmentary, inconsistent, illogical, cannot apply theoretical knowledge when analyzing practical tasks. There are a significant number of gross errors in the answers. When solving a clinical problem, he could not interpret the obtained research results, answer the questions, or made significant mistakes in the answers; could not justify his decisions or did it unconvincingly. He did not offer alternative options. When solving a situational task, he did not demonstrate or made gross errors and mistakes in the algorithm and skill performance technique; the level of competence is low (receptive-productive).

### 9. Distribution of points received by students of higher education

The obtained average score for the academic discipline for applicants who have successfully mastered the work program of the academic discipline is converted from a traditional four-point scale to points on a 200-point scale, as shown in the table:

#### Conversion table of a traditional assessment into a multi-point scale

National assessment for discipline	The sum of points for the discipline
Excellent ("5")	185 – 200
OK («4»)	151 – 184
Satisfactory ("3")	120 – 150
Unsatisfactory ("2")	Below 120

A multi-point scale (200-point scale) characterizes the actual success of each applicant in learning the educational component. The conversion of the traditional grade (average score for the academic discipline) into a 200-point grade is performed by the information and technical department of the University.

According to the obtained points on a 200-point scale, the achievements of the applicants are evaluated according to the ECTS rating scale. Further ranking according to the ECTS rating scale allows you to evaluate the achievements of students from the educational component who are studying in the same course of the same specialty, according to the points they received.

The ECTS scale is a relative-comparative rating, which establishes the applicant's belonging to the group of better or worse among the reference group of fellow students (faculty, specialty). An "A" grade on the ECTS scale cannot be equal to an "excellent" grade, a "B" grade to a "good" grade, etc. When converting

from a multi-point scale, the limits of grades "A", "B", "C", "D", "E" according to the ECTS scale do not coincide with the limits of grades "5", "4", "3" according to the traditional scale. Acquirers who have received grades of "FX" and "F" ("2") are not included in the list of ranked acquirers. The grade "FX" is awarded to students who have obtained the minimum number of points for the current learning activity, but who have not passed the final examination. A grade of "F" is assigned to students who have attended all classes in the discipline, but have not achieved a grade point average (3.00) for the current academic activity and are not admitted to the final examination.

Applicants who study in one course (one specialty), based on the number of points scored in the discipline, are ranked on the ECTS scale as follows:

**Conversion of the traditional grade from the discipline and the sum of points on the ECTS scale**

<b>Evaluation on the ECTS scale</b>	<b>Statistical indicator</b>
A	Top 10% achievers
IN	The next 25% of earners
S	The next 30% of earners
D	The next 25% of earners
Well	The next 10% of earners

**10. Methodical support**

- Working program of the academic discipline
- Syllabus of the academic discipline
- Methodological developments for lectures
- Multimedia presentations
- Situational tasks
- Methodical developments for practical classes
- Methodical instructions for the independent work of acquirers
- The electronic bank of test tasks by subdivisions of the discipline on the information website of the department - <https://app.odmu.edu.ua/chair/program/#/13/files/219>
- Educational and methodical literature

**11. Questions for preparing for the final control**

1. Biopotentials - definitions, mechanisms, significance for excitable tissues.
2. Formulate the laws of stimulation of excitable tissues. Their biological significance.
3. Characteristics of refractoriness during action potential. Types, mechanisms.
4. Regularities and mechanisms of excitation by nerve fibers.
5. Mechanisms of neuromuscular excitation transmission. Mediators, blockers.
6. Mechanisms of contraction and relaxation of skeletal and smooth muscles, their differences.

7. Morphofunctional differences of smooth muscles from skeletal muscles.
8. Describe biological regulation, its types. Definition of reflex.
9. Receptors, their types, functions, mechanisms of excitation. Muscle and tendon receptors.
10. Central synapses, their receptors, mediators, blockers. Transmission features.
11. Inhibition in the central nervous system, its types, mechanisms of development and physiological role.
12. Name the properties of nerve centers. Describe the specified properties.
13. Functions and motor reflexes of the spinal cord. Bell-Majandi law.
14. Ascending and descending pathways of the spinal cord. Their meaning. Spinal shock.
15. Motor reflexes of the hindbrain, their physiological role.
16. Motor nuclei and reflexes of the midbrain, their significance.
17. Characteristics and features of the functioning of the cerebellum. Symptoms of damage.
18. Afferent and efferent connections of the cerebellum. Their function.
19. Characteristics of extra- and pyramidal systems. What is the difference between their functions?
20. The role of the motor zone of the cerebral cortex and its functions. Characteristics of EEG.
21. Characteristics of centers of the autonomic nervous system (ANS). ANS reflexes.
22. Sympathetic reflexes, their reflex arcs, mediators, receptors.
23. Parasympathetic reflexes, their reflex arcs, mediators, receptors.
24. Internal organs are regulated by para- and sympathetic nervous systems.
25. Explain the role of the hypothalamus in regulating the activity of internal organs and homeostasis.
26. General principles of structural and functional organization of analyzers.
27. Structural and functional organization of the somatosensory analyzer.
28. General characteristics of the visual analyzer. Mechanism of accommodation.
29. Mechanisms of color vision. The central part of the visual analyzer.
30. Auditory system, its structure and functions. Central auditory pathways.
31. Structural and functional organization of the taste and smell analyzer.
32. Projection and associative areas of the cortex - connections, functions, differences.
33. Characteristics of higher nervous activity.
34. Mechanisms of formation of conditioned reflexes, differences from unconditioned ones.
35. Inhibition of conditioned reflexes, types, mechanisms, physiological significance.
36. The first and second signal systems. Centers of speech, symptoms of speech disorders.
37. Memory, classification, neuronal and molecular mechanisms of memory.
38. Sleep, its types, phases, mechanisms.
39. Characteristics of humoral regulation, its factors, differences from nervous

regulation.

40. Properties of hormones, their main effects. Mechanisms of hormone action on cells.
41. Hormone types. cytoceptors, intra/cellular signaling pathways, secondary mediators.
42. Functions of the hypothalamic-pituitary system.
43. The role of somatotropin, T<sub>3</sub>, T<sub>4</sub>, insulin in the regulation of growth and development processes.
44. The role of thyroid hormones in the regulation of body functions.
45. Humoral regulation of the level of calcium and phosphorus ions in the blood.
46. The role of pancreatic hormones in the regulation of body functions.
47. The role of adrenal cortical hormones in the regulation of body functions.
48. Adaptation of the body to stressful effects. The role of hormones in adaptation.
49. The structure and role of the sympatho-adrenal system in the regulation of body functions.
50. General characteristics of the blood system. The special role of the blood system in homeostasis.
51. Osmo- and oncotic pressure of blood plasma, their indicators. The concept of isosmium.
52. Blood plasma proteins, their characteristics and functions.
53. Acid-base status (AOS) of blood, meaning and mechanisms. Regulation of KOS.
54. Morphofunctional characteristics of erythrocytes. Erythropoiesis and its regulation.
55. Hemoglobin: structure, functions, types. Characteristics of hemoglobin compounds.
56. Leukocytes, types, functions. Name the leukocyte formula of a healthy adult.
57. Morphofunctional characteristics of platelets. Role in hemostasis.
58. Vascular-platelet hemostasis, its characteristics, mechanisms, significance.
59. Coagulation hemostasis, its phases, mechanisms, physiological significance.
60. Fibrinolysis, stages, regulation.
61. Physiological characteristics of the AB0 blood group system and the Rh blood system.
62. Characterization of the action potential of typical ventricular cardiomyocytes.
63. Modern ideas about the nature and gradient of heart automation.
64. Action potential of atypical cardiomyocytes of the sino-atrial node.
65. The mechanism of contraction and relaxation of the myocardium.
66. Cardiac cycle, its phases, their physiological role. Cardiac output.
67. Function of heart valves. Heart tones, mechanisms of their origin, FKG.
68. Describe the human ECG. How is an ECG recorded? Einthoven's law.
69. Describe the myogenic mechanisms of heart activity regulation.
70. Nature and mechanisms of influence of sympathetic nerves on heart activity.
71. Parasympathetic regulation of cardiac activity, mechanisms, effects.
72. Humoral regulation of heart activity. The influence of the ionic composition of blood on it.

73. The role of various blood vessels in hemodynamics. Poiseuille's law. Bernoulli's law.
74. The speed of blood flow in different parts of the vascular bed. Influencing factors.
75. Characteristics of blood pressure, registration methods. Factors influencing it.
76. Factors that ensure the movement of blood through the veins. Venous return of blood.
77. Resistance of vessels and vascular areas. Effect of viscosity on hemodynamics.
78. Hemodynamic center. Baroreceptor mechanism of blood circulation regulation.
79. Capillary blood flow. Starling equilibrium. Vascular permeability factors.
80. The mechanism of fluid exchange between tissues and blood in the capillary bed.
81. Basal vascular tone. Myogenic and humoral regulation of vascular tone.
82. Arteriole and venule tone. The influence of nerves on vascular tone, mechanisms.
83. Features of blood circulation in the vessels of the heart and brain, its regulation.
84. Systemic blood circulation and blood flow in muscles during exercise.
85. Mechanisms of lymph formation and movement of lymph through lymphatic vessels.
86. The concept of the respiratory system, its functions. Five stages of the respiratory process. Physiological role of respiratory tracts, regulation of their lumen.
87. Indicators of external respiration and their average values, methods of their determination.
88. Name the non-gas exchange functions of the lungs. The role of the chest in breathing.
89. Gas diffusion and blood perfusion in the lungs, mechanisms and regulation of these processes.
90. Mechanisms of O<sub>2</sub> transport in blood. Blood oxygen capacity.
91. Binding and delivery of oxygen by blood. Oxyhemoglobin dissociation curve.
92. Transport of CO<sub>2</sub> by blood. Differences from O<sub>2</sub> transport. Bohr and Haldane effects.
93. The respiratory center, its structure and role in regulating the rhythmicity of breathing.
94. Reflex regulation of breathing. The receptor apparatus of the lungs. Central and peripheral chemoreceptors in the regulation of respiration.
95. Humoral factors affecting breathing, mechanism of action.
96. Mechanisms of regulation of external breathing during physical exertion.
97. Characteristics of the digestion process. Types and types of digestion.
98. Digestion in the oral cavity. Saliva, salivation, chewing, swallowing.
99. Characteristics of gastric juice. Mechanisms of HCl secretion and its functions.

100. Stomach motility and its regulation.
101. Phases and mechanisms of gastric secretion. Stimulation and inhibition of secretion.
102. Composition, functions of pancreatic juice. Mechanisms and regulation of its release.
103. Composition and functions of bile. Mechanisms and regulation of its allocation.
104. Composition and functions of intestinal juice. Mechanisms and regulation of its release.
105. Characteristics of the motor function of the intestines. Methods of studying gastrointestinal motility.
106. Mechanisms of absorption of nutrients in different departments of the gastrointestinal tract.
107. Physiological mechanisms of hunger and satiety.
108. Characteristics and methods of studying energy exchange. Respiratory rate.
109. Characteristics of the main exchange and methods of its determination.
110. Physiological principles of dietary composition.
111. Structure and functions of the thermoregulation system: mechanisms of heat transfer and heat production. Cold and heat adaptation. The role of hardening.
112. Characteristics of the allocation system. Functions and features of kidney blood supply
113. Glomerular filtration. Its mechanisms and regulation. Composition of primary urine.
114. Describe tubular reabsorption in the kidneys, mechanisms, regulation.
115. The counter-flow system of the kidneys, dilution and concentration of urine.
116. Features of the functioning of Henle's loop and distal tubules.
117. The process of urination, its regulation.
118. Regulation of osmotic pressure and fluid volume in the body. Mechanisms of craving.
119. Characteristics of the endocrine function of the kidneys. Angiotensin-aldosterone system.
120. The role of the kidneys in the long-term regulation of Bp and pH.

**List of practical skills, the acquisition of which is controlled during the final control**

1. Draw a diagram of MPP and mark its parameters.
2. Draw a PD scheme and mark its parameters.
3. Draw a diagram of changes in cell excitability during PD development.
4. Draw a diagram of a myoneural synapse and label its parts.
5. Draw a graph of the coupling of excitability and contraction in a muscle fiber.
6. Draw a diagram of single contraction of skeletal and smooth muscles.
7. Draw a diagram of smooth (complete) and serrated (incomplete) tetanus.
8. Draw the Goorweg-Lapik-Weiss "force-time" curve and label its parameters.



9. Draw a diagram of divergence, convergence, spatial and temporal summation.
10. Draw a diagram of presynaptic, postsynaptic, lateral, rotary and reciprocal inhibition.
11. Draw a diagram of a somatic reflex and label its parts.
12. Draw diagrams of sympathetic and parasympathetic autonomic reflexes and label their parts.
13. Describe the elements of the EEG and their parameters under the conditions of different functional states.
14. Describe the methodology for researching skin sensitivity thresholds using Weber's compass.
15. Describe the method of visual field research using Forster's perimeter.
16. Describe the method of central vision research using Sivtsev's tables.
17. Describe the method of color vision research using Rabkin's polychromatic tables.
18. Describe the method of researching bone conduction of sound in humans. Weber's experiment.
19. Describe the method of comparing bone and air conduction in humans. Ryne's experiment.
20. Draw a diagram of the optical imperfection of the eye in correction using lenses.
21. Describe the rules for the formation of conditioned reflexes.
22. Draw a diagram of the functional system according to Anokhin P.K.
23. Describe the methodology of visual memory research in humans.
24. Describe the methodology of studying auditory memory in humans.
25. Describe the method of studying associative memory in humans.
26. Rules for taking blood from a person and preparing a blood smear.
27. Determination of the volume ratio of plasma and formed elements and its evaluation.
28. Determination of the number of erythrocytes in the blood using a counting chamber.
29. Determination of the amount of hemoglobin in the blood according to the Sali method.
30. Calculation of the color indicator of blood and its evaluation.
31. Analysis and assessment of indicators of human hemograms.
32. Determination of the number of leukocytes in a liter of blood using a counting chamber.
33. Determination of the leukocyte formula in a blood smear and its evaluation.
34. Analysis and assessment of coagulogram and thromboelastogram.
35. Determination of blood coagulation time and its evaluation.
36. Determination of duration of bleeding according to Duke.
37. Determination of blood group according to the ABO system using standard serums and tsoliclons.
38. Determination of the blood group according to the Rh(D) system using anti-D monoclonal antibodies.
39. Express method of determining blood groups according to the ABO+D system

using monoclonal antibodies.

40. Measures carried out before blood transfusion.
41. Draw diagrams graphs of PD of the pacemaker of the sinoatrial node (SA) and typical cardiomyocytes of the working myocardium of the ventricles of the heart.
42. Analyze indicators: electrocardiograms (ECG); phonocardiograms (FCG); sphygmograms (SFG); echocardiograms (EchoCG); cardiac cycle structures; cardiac output (SV, IOC); rheograms (RG); blood pressure; venous pressure.
43. Interpret the role of features of regional blood flow and its regulation (pulmonary, coronary, cerebral, abdominal) to ensure adaptive reactions
44. Assess the state of each of the breathing stages and regulation mechanisms based on the analysis of the parameters that characterize the functions of the breathing stages.
45. Assess the state of the body by spirometry, spirometry and pneumotachometry.
46. Calculate the level of basic metabolism in a person according to tables and nomograms.
47. Evaluate the results of the study of gastric juice.
48. Calculate the level of filtration, reabsorption and secretory function of the kidneys using clearance indicators.
49. Calculate the daily volume of primary urine and reabsorbed water in the body, if it is known that the daily diuresis is 1.5 liters, 1 liter of blood passes through the kidneys in 1 minute and 20% of primary urine is filtered from the plasma.
50. Evaluate indicators of urine analysis according to Zimnytsky, Kakovsky-Addis, Ambyurzhe, Nechyporenko.

## 12. Recommended Books

### Basic

1. Grzegotsky M. R. Physiology: a teaching and methodical guide to practical classes and independent work / M. R. Grzegotsky [and others].– Vinnytsia: Nova kniga.– 2019.- 464 p.
2. Physiology. Short course. 2nd edition / Moroz V.M., Yoltukhivskiy M.V., Shandra O.A. [etc.] - edited by Moroz V.M., Yoltukhivskiy M.V.– Vinnytsia: Nova kniga.– 2020.- 408 p.
3. Physiology [textbook] /V. M. Moroz, O.A. Shandra. – 5th ed. - Vinnytsya: Nova Kniga. - 2020. - 728 p.
4. Filimonov V. I. Human physiology: a textbook / V. F. Filimonov. – 4th ed., K.: Medicine, 2021. - 488 p.
5. Physiology: a textbook for students. higher honey. education closing / V. G. Shevchuk [and others], edited by V. G. Shevchuk. - Kind. 5, ex. and additional – Vinnytsia: New book. - 2021. - 448 p.

### Additional

1. Costanzo L. S. Physiology / L. S. Costanzo. - Elsevier Health Sciences. - 7th

- ed., 2021. - 528 p.
2. Ganong's Review of Medical Physiology / K. E. Barrett, S. M. Barman, H. L. Brooks., J. Yuan, - McGraw Hill Medical. – 26th edition, 2019. –752 p.
  3. Guyton A. Textbook of Medical Physiology / A. Guyton, J. E. Hall. - Elsevier. - 14th Edition, 2021. – 1820 p.
  4. Koeppen B. M. Berne and Levy Physiology / B. M. Koeppen, B. A. Stanton. - Elsevier Health Sciences. - 8th edition, 2023. - 864 p.
  5. Sembulingam K. Essentials of Medical Physiology / K. Sembulingam, P. Sembulingam. – Jaypee Brothers Medical Publishers. – 9th ed., 2022. –1022 p.

### **13. Electronic information resources**

1. The official site of the Department of Physiology and Biophysics of ONMedU <https://app.odmu.edu.ua/chair/program/#/13/files>
2. The testing center is a database of "Step-1" license test tasks <https://www.testcentr.org.ua/uk/>
3. National Scientific Medical Library of Ukraine <http://library.gov.ua/>
4. National Library of Ukraine named after V.I. Vernadskyi <http://www.nbuv.gov.ua/>
5. Ministry of Health of Ukraine: official website. URL: <https://moz.gov.ua/>.
6. National Health Service of Ukraine: official website. URL: <https://nszu.gov.ua/pro-nszu>
7. National Academy of Medical Sciences of Ukraine. URL: [www.amnu.gov.ua](http://www.amnu.gov.ua).
8. Official web portal of the Verkhovna Rada (legislation on higher medical education) <http://zakon4.rada.gov.ua/laws>
9. World Health Organization - [www.who.int](http://www.who.int)
10. European Regional Office of the World Health Organization. URL: [www.euro.who.int](http://www.euro.who.int)
11. Branch classifier "Directory of medical procedures (services) and surgical operations". URL: <http://www.garvis.com.ua/dovidnyk/nsi/help/ru.html>.
12. Department of Management and Quality Control of Medical Services of the Ministry of Health of Ukraine: official website. URL: <https://moz.gov.ua/en/struktura>.
13. European base "Health for all". URL: <http://medstat.gov.ua/ukr/statreports.html>.
14. Medical information system: the official website of the Med-expert company. URL: <http://medexpert.ua/ua/medichni-j-zaklad/31-medichni-j-zaklad/pro-rynku-v-iznoho-medychnoho-turyzmu-v-ukraini>
15. Ukrainian medical journal: medical journal. URL: [www.umj.com.ua](http://www.umj.com.ua).
16. Medical world: professional newspaper. URL: [www.medsvit.org](http://www.medsvit.org).
17. Ukrainian Medical Council. URL: <http://www.medicalcouncilukraine.org>.
18. Global Health Expenditure Database. URL: <https://apps.who.int/nha/database/ViewData/Indicators/en>
19. Health Strategy. European Commission: official web-site. URL: <https://ec.europa.eu/health/policies/background/review/strategy>.

20. Global health security Index. URL: <https://www.ghsindex.org/about/>