

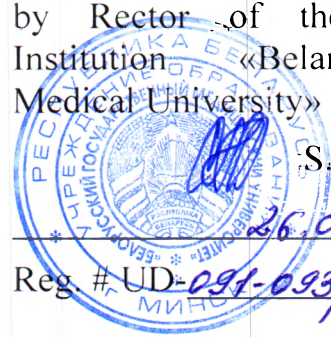
MINISTRY OF HEALTH OF THE REPUBLIC OF BELARUS
Educational Institution
BELARUSIAN STATE MEDICAL UNIVERSITY

**Контрольный
экземпляр**

APPROVED

by Rector of the Educational
Institution «Belarusian State
Medical University»

S.P.Rubnikovich


26.06.2024
Reg. # UD-091-093/24025/edu.

NORMAL PHYSIOLOGY

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

7-07-0911-01 «General Medicine»

Curriculum is based on the educational program «Normal Physiology», approved 26.06.2024, registration # УД-091-093/2425/уч; on the educational plan in the specialty 1-79 01 01 «General Medicine», approved 15.05.2024, registration # № 7-07-0911-01/2425/mf.

COMPILERS:

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RECOMMENDED FOR APPROVAL:

by the Department of Normal Physiology of the educational institution «Belarusian State Medical University»

(protocol # 20 of 23.05.2024);

by the Scientific and Methodical Council of the educational institution «Belarusian State Medical University»

(protocol # 18 of 26.06.2024)

EXPLANATORY NOTE

«Normal Physiology» is the academic discipline of the module «Biomedical Module # 1», which contains a systematized scientific knowledge of the vital functions of a healthy body and its individual parts (cells, tissues, organs, and functional systems), the mechanisms of these functions and the laws of their regulation.

The aim of the discipline «Normal Physiology» is the formation of basic professional competencies to solve problems of professional activity on the basis of knowledge about the regularities of functioning and regulation of the vital functions of the whole human body, its organs and systems.

The objectives of the discipline «Normal Physiology» are to form students' scientific knowledge about the principles of organization of physiological functions and the interaction of functional systems of the human body, the basic patterns of functioning of cells, tissues, organs and systems of a healthy human body and the mechanisms of their regulation, as well as the most important indicators characterizing the normal state of physiological functions of the human body and its systems; abilities and skills necessary for:

- systemic analysis of indicators of physiological state of a healthy and sick person, his organs and systems;

- interpretation of the results of laboratory and instrumental methods of examination;

- the formation of a healthy lifestyle.

The knowledge, abilities, and skills acquired in the academic discipline «Normal physiology» are necessary for the successful study of the academic discipline «General Surgery», modules: «Medical-prophylactic Module», «Biomedical Module # 2», «Therapy Module # 1», «Therapy Module # 2», «Surgical Module # 2», «Mental Health Module», «Internal Diseases Module», «Therapy Module # 3», «Surgical Module # 3», «Obstetrics and Gynecology Module», «Clinical Pathology and Clinical Diagnosis Module», «Pediatric Module».

Studying the educational discipline «Normal Physiology» should ensure the formation of students' basic professional competence: assess the indicators of a healthy and sick person physiological state on the basis of knowledge about the patterns of functioning and regulation of the human body vital activity, its organs and systems.

As a result of studying the discipline «Normal Physiology» the student should **know:**

- basic concepts of physiology;

- basic regularities of functioning of cells, tissues, organs and systems of a healthy person, and mechanisms of their regulation;

- the main indicators characterizing the physiological state of the organs and systems of a healthy person;

- the physiological foundations of a healthy lifestyle;

- rules of medical ethics and deontology;

be able to:

conduct clinical and physiological examination of the human body;
 give physiological interpretation of the indicators obtained as a result of the examination of individual functions of the body of a healthy person;
 assess the normal state of human body functions and their reserve capacities, taking into account age;

master:

methods of examination of basic physiological functions;
 a systematic approach to the assessment of physiological functions and their characterizing indicators.

Total number of hours for the study of the discipline is 324 academic hours, of which 182 are classroom hours and 142 hours of independent student work. Classroom hours according to the types of studies: lectures – 42 hours (including 12 hours of supervised student independent work (SSIW)), practical classes – 140 hours.

Intermediate assessment is carried out according to the curriculum of the specialty in the form of a credit (3 semester) and examination (4 semester).

Form of higher education – full-time.

ALLOCATION OF ACADEMIC TIME ACCORDING TO SEMESTERS OF STUDY

Code, name of the specialty	semester	Number of academic hours						Form of intermediate assessment
		total	in-class	including			out-of-class self-studies	
				lectures	supervised student independent work	practical classes		
7-07-0911-01 «General Medicine»	3	180	93	15	6	72	87	credit
	4	144	89	15	6	68	55	exam

THEMATIC PLAN

Section (topic) name	Number of class hours	
	lectures (including SSIW)	practical
1. Introduction. Homeostasis. The Internal Environment of the Human Body	3	16
2. Humoral Regulation of Physiological Functions	3	12
3. Physiology of Excitable Tissues	6	20
4. Nervous Regulation of Physiological Functions	4,5	12
5. Physiology of Sensory Systems	3	12
6. Physiology of Circulation	6	20
7. Physiology of Respiration	4,5	20
8. Physiology of Digestion	3	8
9. Substance and Energy Metabolism. Thermoregulation. Excretion	3	12
10. Integrative Brain Activity	6	8
Total hours	42	140

CONTENT OF THE EDUCATIONAL MATERIAL

1. INTRODUCTION. HOMEOSTASIS. THE INTERNAL ENVIRONMENT OF THE HUMAN BODY

Normal physiology as the science of vital functions of a healthy human body and its individual parts (cells, tissues, organs, functional systems), the mechanisms of these functions and patterns of their regulation.

The concept of the human body and its components. Levels of structural and functional organization of the human body. The concept of physiological functions and processes.

The systemic principle of organization and regulation of functions. Nervous and humoral mechanisms of regulation of human body functions. Local mechanisms of regulation of physiological functions. Levels of regulation: cellular, tissue, organ, organism. Types of regulation (in response to perturbation and to deviation).

The systemic approach to the study of the processes of vital activity of the human body. Functional system (according to P.K.Anokhin), principle of self-regulation. Systemogenesis.

The concept of the unity of the organism and its environment.

Relationship of physiology to other sciences. Physiology as the scientific basis of medicine. Stages of physiology development.

The period of individual discoveries (the principal role of the works of W.Harvey, R.Descartes).

Formation and development of physiology in XIX-XX centuries (I.Muller, C.Bernard, C.Ludwig, E.Dubois-Reymond, H.Helmholtz, C.Sherrington,

W.B.Cannon, F.V.Ovsyannikov, I.M.Sechenov, N.A.Mislavsky, I.P.Pavlov, N.E.Vvedensky, A.A.Ukhtomsky, A.F.Samoilov, L.A.Orbeli, P.K.Anokhin, V.V.Parin, V.N.Chernigovsky, L.S.Stern and others).

Contribution of domestic physiologists to the development of physiological science (I.A. Vetohin, I.A. Bulygin, G.S. Yunev, G.A. Feshchenko, A.S. Dmitriev, N.I. Arinchin, V.N. Gurin, A.I. Kubarko and others).

Peculiarities of the modern period of development of physiology. Development of molecular-biological, analytical and integrative directions. Human physiology and scientific and technological progress. Use of engineering achievements in physiology – telemetry, computer engineering, physiological cybernetics, computer simulation of physiological functions, modern methods of visualization of physiological functions (functional magnetic resonance tomography, dispersive electrocardiographic mapping (ECG mapping), echocardiography, computer electroencephalography (EEG) and others).

Homeostasis. Mechanisms of homeostasis regulation. Fluid media of the human body (intracellular fluid, interstitial fluid, blood, lymph, cerebrospinal fluid and others), their volume distribution in the human body. The concept of the internal environment of the human body.

Carrying out measures to prevent infection with viral hepatitis and human immunodeficiency virus during testing of blood and other biological materials. Capillary blood taking technique.

Blood. The concept of the blood system (G.F.Lang), its age features. Composition, quantity, properties, main functions of blood. Basic physiological constants of blood that characterize homeostasis. Organic and inorganic components of blood plasma. Blood osmotic pressure and its regulation, its role in the exchange of water and electrolytes between blood and tissues. The concept of the state of hyper- and dehydration of tissues. Blood plasma proteins, their classification and significance. Plasma oncotic pressure and its role. Rheological properties of blood. Acid-base state of blood. Physical-chemical and physiological mechanisms ensuring blood pH constancy. The concept of acidosis and alkalosis, the mechanisms of their development. Changes in physiological functions in acidosis and alkalosis.

Lymph, mechanisms of its formation, quantity, composition, physical and chemical properties, functions.

Liquor (cerebrospinal fluid, CSF). Composition, physical and chemical properties, functions of cerebrospinal fluid, its dynamics. Significance of the study of CSF for diagnosis. Other transcellular fluids (pleural, pericardial, synovial and others), their composition, physical-chemical properties and physiological role.

Hemopoiesis (hemocytopoiesis): stem cell theory. Age peculiarities of hematopoiesis (in embryo, fetus, adult). The role of stem cell microenvironment in hematopoiesis. Properties and functions of polypotent hematopoietic stem cell and other precursor cells of mature blood cells. The concept of the possibilities of differentiation of embryonic and hematopoietic stem cells into other cell types. Age-related features of hematopoiesis. Nervous and humoral mechanisms of hematopoiesis regulation. Signal molecules important for hematopoiesis regulation (main groups of cytokines (hematopoietic cell growth factors, interleukins,

interferons, nonhematopoietic cell growth factors), hormones, neurotransmitters and others), their origin. The role of cytokines and other signaling molecules in the regulation of self-maintenance, differentiation, proliferation and apoptosis of these cells. The importance of cell adhesion molecules.

Nutrients, vitamins and trace elements, which are essential for normal hematopoiesis, their importance and the body's need for them. General concept of disorders of hematopoiesis in case of deficiency of these substances in the human body.

Erythron. Erythrocytopoiesis and erythrocyte destruction, their age-related features. Erythropoietin and its role in the regulation of erythropoiesis. Features of the structure and properties of red blood cells to ensure their functions. The number of red blood cells in the blood, methods of counting. Hemoglobin, its amount, functions, methods of determination. Features of the structure and properties that ensure the performance of the functions of hemoglobin. Types and compounds of hemoglobin. Color index and its calculation. Erythrocytic indices (mean hemoglobin content in an erythrocyte (MCH), mean hemoglobin concentration in an erythrocyte (MCHC), mean red blood cell volume (MCV), red blood cell distribution curve width (RDW)). The concept of anemia. Hemolysis, types and causes. Osmotic resistance of red blood cells. Products of red blood cells destruction, their physiological role, ways of utilization. Sedimentation rate of red blood cells (Erythrocyte Sedimentation Rate) and factors affecting it.

Thrombocytopoiesis. Blood plates (platelets), their number, structure, functions, life span. Regulation of thrombocytopoiesis, role of thrombopoietin.

The hemostasis system. Primary (vascular-platelet) and secondary (coagulation) hemostasis and its significance. The role of platelets in the mechanisms of primary and secondary hemostasis. Schmidt's enzymatic theory of hemostasis. Modern concepts of the main factors involved in blood coagulation (tissue, plasma, platelet, erythrocytic, leukocytic). Phases of blood coagulation. Fibrinolysis. The anti-coagulation system of the blood. The role of the vascular wall in the regulation of blood coagulation and fibrinolysis. Coagulogram indices.

Leukopoiesis. Leukocytes, their types, number, functions, methods of calculation. Features of the structure and properties that ensure their functions. The concept of leukocytosis and leukopenia. Leukocyte formula: granular and agranular leukocytes, their types, number, functions, life span. The concept of T- and B-lymphocytes, leukocyte cluster differentiation (CD) markers. The concept of mechanisms of nonspecific and specific defense system of the human body. The concept of defensins.

The main indicators of the Complete Blood Count (CBC), the principles of its performance using modern methods of investigation. Physiological evaluation of the results of the CBC. The concept of age norms of the basic blood parameters. Diagnostic value of the Complete Blood Count.

Blood types systems. AB0, Rh, HLA and other systems. Blood typing in AB0 and Rh system. Inheritance of blood types. Basic principles of donor blood selection. Risk factors in working with blood for health care workers, donors and recipients. Consequences of mismatched blood transfusion. Significance of HLA system for

transplantation of donor organs and tissues. Blood components and preparations. Blood substitute solutions, physiological requirements for them, and their classification according to the type of function they perform in the human body.

Blood typing in ABO and Rh (D-antigen) systems using standard sera and monoclonal antibodies.

2. HUMORAL REGULATION OF PHYSIOLOGICAL FUNCTIONS

Information exchange between the cell and the environment. Information, signal. Types of information signals.

Chemical signaling. The main ways of intercellular communication involving chemical signals, their characteristics. Classification and properties of signaling molecules (ligands). Molecular (cellular) receptors. Classification according to structure and localization in the cell. Structure and functions of transmembrane and intracellular receptors. Metabotropic and ionotropic receptors. Receptors associated with G-proteins.

Ligand-receptor interactions. Main pathways of intracellular signal transmission involving seven-segment transmembrane receptors (G-protein-coupled receptors; 7-TMS). First and second messengers and their functions. Ligands interacting with 7-TMS receptors and physiological functions controlled involving these receptors. 1-transmembrane segment receptors (1-TMS), their structure, features of the mechanism of action. Ligands interacting with 1-TMS receptors and physiological functions controlled by these receptors.

Ion channels, their classification. Structure and mechanism of action of ligand-gated ion channels by the example of n-cholinergic receptor and other types of receptors. Their ligands. Role of hormones and second messengers in regulation of permeability of ligand-dependent ion channels. The notion of other mechanisms of ion channels permeability regulation.

Intracellular signal transmission involving intracellular receptors. Ligands acting through intracellular receptors. Mechanism of action and main physiological effects. The main physiological effects of ligand-receptor interaction at the cell level.

The significance of the endocrine system for the vital functions of the human body. Modern ideas about the functions of the endocrine system. General characteristics of the endocrine system. Morphological and functional classification of endocrine glands. Hormones as signal molecules: definition of the concept, classification according to the chemical structure and the function performed. Mechanisms of action of hormones. General principles of regulation of synthesis and secretion of hormones. Multilevel system of regulation of hormone secretion. Links between endocrine glands and nervous system. Participation of endocrine system in homeostasis regulation. Notion of methods of endocrine system function evaluation in humans.

Pituitary gland, its functions, morphological and functional connections with hypothalamus. Hormones of hypophysis and hypothalamus, their role in regulation of endocrine and non-endocrine organs activity. Interaction of nervous and humoral mechanisms of regulation of functions on hypothalamic level. The most frequent manifestations of disorders of endocrine function of pituitary gland and hypothalamus.

Epiphysis, its endocrine functions.

Thyroid gland. Iodine-containing thyroid hormones, mechanisms of their action and effects caused by them. The influence of thyroid hormones on the processes of growth and development of the central nervous system (CNS). Consequences for the CNS functions of hypothyroidism in the fetus and newborns. Participation of thyroid hormones in the processes of adaptation. Regulation of hormones secretion. Characteristic manifestations of excess or insufficient secretion of hormones. Calcitonin.

Parathyroid glands. Parathyroid hormone.

Regulation of calcium and phosphorus homeostasis in the human body. Influence of calcitonin, parathormone and vitamin D on calcium and phosphorus metabolism. Daily requirement for calcium and sources of calcium in the human body.

Adrenal glands. Hormones of the adrenal glands cortex and medulla. Mechanisms of action of hormones and effects caused by them. Regulation of hormones secretion. Characteristic manifestations of excess or insufficient hormones secretion. Regulation of endocrine function of the adrenal glands.

Sex glands. Sex hormones. Mechanisms of action of hormones and the effects caused by them. Mechanisms of regulation of hormones secretion. Characteristic manifestations of excess or insufficient secretion of hormones. Age peculiarities of endocrine function of the reproductive glands. Hormonal regulation of puberty. Endocrine function of the placenta. The concept of the reproductive system of the human body.

Pancreas, its endocrine function. Pancreatic hormones and their role in the regulation of carbohydrate, fat and protein metabolism. Mechanisms of action of hormones. Regulation of hormones secretion. The concept of hypo- hyperglycemia, and their causes.

The thymus gland and its role in different age periods. The importance of the thymus in the development of the human immune system. Regulatory peptides. The concept of the diffuse endocrine system (APUD-system) of the intestine. Endocrine function of heart, vessels, adipose tissue, liver, and kidneys. Hormonal mechanisms to maintain water-electrolyte balance in human body (antidiuretic hormone, renin-angiotensin-aldosterone system, natriuretic peptides, prostaglandins). Hormonal mechanisms of body weight regulation (leptin, ghrelin, insulin, cholecystokinin, orexins and others). Adipose tissue as an endocrine organ, lipokines. Endocrine function of skeletal muscles, myokines. Prostaglandins. Involvement of endocrine glands in adaptive activity of the body. General adaptation syndrome, stress. Distress and eustress. The concept of stress-realizing and stress-limiting systems of the human body.

Age-related changes in endocrine functions. Differences in the consequences of dysfunction of the endocrine glands in a child and an adult.

Assessment of the functions of the endocrine system (measurement and assessment of height, body weight, temperature, basal metabolic rate, carbohydrate metabolism indicators, etc.).

3. PHYSIOLOGY OF EXCITABLE TISSUES

Electrical signaling and its role in the regulation of physiological functions.

The concept of irritability and excitability as the basis of tissue (cell) response to stimulation. Excitation and forms of its manifestation.

Classification of stimuli. Characteristics of stimuli that are important for the occurrence of excitation. Indices (parameters) of excitability (threshold of force, threshold of time, minimal gradient of stimulation). The concept of rheobase and chronaxia. Relationship between the force of a stimulus and the time of its action on the excitable tissue, which is important for the excitation occurrence. Force-duration curve. The concept of lability (N.E.Vvedensky).

Laws of response of excitable tissues to stimulation (the law of force, duration, «all or nothing», stimulus gradient and others). Reaction of excitable tissues to the action of direct electric current (polar law).

Modern concepts of the structure of the membranes of excitable cells, providing their functions. The concept of passive (leakage channels), voltage-gated, ligand-gated and other types of ion channels. The concept of ion pumps, exchange mechanisms of ion transport. Ionic gradients and their role in the generation of electrical potentials of the cells.

Bioelectrogenesis. Biopotentials as carriers of information in living organisms. Types of biological potentials, their comparative characteristics.

Resting membrane potential, its origin, mechanism of resting potential maintenance (selective permeability of cell membrane, ionic gradients, K-Na pump functioning and others).

Modern ideas about the mechanisms and phases of action potential development. Changes in excitability during excitation. Refractory period, its causes and significance.

Sensory receptors, their role, classification, and basic properties (high sensitivity to the action of an adequate stimulus, background activity and others). Mechanisms of transformation of stimulus energy into nervous impulses in primary and secondary-sensitive sensory receptors. Mechanisms of adaptation of sensory receptors. The concept of the principles of analog and discrete encoding in receptors. Receptive field and reflexogenic zone.

Generation of nerve impulses in sensory receptors and axon hillocks. Nerve fiber. Physiological role of the structural elements of the nerve fiber. Mechanism and laws of nerve impulse conduction along a nerve fiber. Axonal transport of substances, its characteristic and importance. Growth factors. Characteristics of nerve fibers of type A, B, C (Erlanger-Hasser classification of nerve fibers in warm-blooded organisms). Principles of classification of afferent nerve fibers of warm-blooded animals by Lloyd-Hunt.

Synapse. Structure and classification of synapses, their physiological role. Modern concepts of the mechanisms of signal transmission in synapses. Characteristics of electrical and chemical synapses. Neurotransmitters, their classification, synthesis, mechanism of secretion into synaptic cleft, interaction with ionotropic receptors of postsynaptic membrane. Cotransmitters and neuromodulators. Processes that ensure restoration of synapse readiness to conduct the next signal.

Postsynaptic potentials. Summation of potentials. General properties of synapses (with the example of neuromuscular junction). Participation of synapses in regulation of intracellular processes. The concept of metabotropic receptors. Notion of the possibilities of pharmacological influence on signal transmission processes in synapses (influence on neurotransmitter secretion, on postsynaptic membrane receptors, on neurotransmitter or its precursors reuptake, on synaptic cleft enzymes and other).

Skeletal muscles. Physical and physiological properties of skeletal muscles. Types and regimes of contraction. Single muscle twitch and its phases. Summation of contractions, tetanus. Dependence of amplitude of contraction on frequency of stimulation. Optimum and pessimum (N. E. Vvedensky). Muscle tone. Force and work of muscles. Muscle fatigue. The law of medium-level loads. Types of muscle fibers. Motor units and their peculiarities in different muscles. Changes in the muscle following denervation. Physiological rationale for the use of methods that delay the development of muscle atrophy and contribute to the restoration of muscle function (electrical stimulation, massage and others). Mechanism of contraction and relaxation of single muscle fiber and muscle. Excitation-contraction coupling. Electromyography.

Physiological assessment of electromyography results.

Ensuring the metabolism of muscle as an organ under conditions of relative rest and at different levels of physical activity (blood flow, oxygen and nutrient consumption, energy expenditure).

Carrying out dynamometry (manual and of back muscles, ergometry) and physiological assessment of the obtained results.

Smooth muscles. Physiological properties and peculiarities of smooth muscles in comparison with skeletal muscles. Transmission of signals from nerve fiber to smooth muscle. Types of neurotransmitters. Receptors of smooth muscle fibers (α - and β -adrenoreceptors, M-cholinoreceptors and others). Mechanisms of contraction and relaxation of smooth muscle cells. Features of regulation of contraction (force, duration, tone) of smooth muscles. The role of calcium ions in the function of smooth muscles. The concept of the nature of smooth muscle tone and the possibilities of its regulation through the influence on the processes of transmission and perception of signals by receptors of smooth myocytes.

The concept of changes in the peripheral nervous system, synaptic transmission and muscle tissue at different ages.

4. NERVOUS REGULATION OF PHYSIOLOGICAL FUNCTIONS

Functions of the CNS and its role in ensuring the vital activity of the integral human organism and its relationship with the external environment. The concept of the central and peripheral nervous system. Methods of studying the nervous system.

Neuron. Functional classification of neurons. Physiological properties of nerve cells and functions of neuron structural elements (soma, axon, dendrites). Morphological and biophysical features of neurons, providing their specific functions (perception, integration, information transfer). Peculiarities of emergence and propagation of excitation in a neuron.

Combining neurons into neural circuits. Types and functions of nerve circuits.

Basic principles of excitation distribution in nerve circuits (divergence, convergence, reverberation, etc.). Neuron connections and the formation of neural networks. The concept of the connectome. Determinism and variability of neural circuits. Notion of plasticity mechanisms. Concept of conductive pathways and their functions. Role of neuroglia.

Features of the structure and functions of CNS synapses in comparison with peripheral synapses. Neurotransmitters in CNS. Physiological concept of the nerve center. Functions of nerve centers, their properties (spatial and temporal summation, transformation of excitation rhythm, tone, plasticity, fatigue of nerve centers). Afferent and efferent nervous pathways, their varieties and functions.

Reflex principle of nervous system functioning (R.Descartes, J.G.Prochazka, I.M.Sechenov, I.P.Pavlov, P.K.Anokhin). Reflex as a stereotypic adaptive response of the human body to the action of stimuli, which occurs with the participation of the nervous system. Types of reflexes. Reflex arc, classification. Feedback and its significance. Multilevel organization of reflex. Substrate, mechanism and forms of manifestation of excitation on the neuron, in the nerve center.

Inhibition in the nervous system (I.M.Sechenov, F.Goltz). Modern concepts of the mechanisms of central inhibition (J.Eccles, B.Renshaw). Inhibition in CNS: primary (postsynaptic and presynaptic), secondary (pessimal and inhibition after excitation).

The interaction of excitation and inhibition processes as the basis of CNS coordination activity. Basic principles of coordination: principle of conjugate (reciprocal) inhibition, principle of common final pathway (Ch.Sherrington), dominance principle (A.A.Ukhtomsky), feedback principle (P.K.Anokhin). Interaction between the various levels of the CNS in the process of function regulation. The concept of integrative activity of the CNS.

Peculiarities of brain metabolism and its provision by the cerebral circulation system. Duration of brain neurons survival under conditions of hypoxia, anoxia, hypothermia, hyperthermia. Possibilities of restoration of brain functions. Resuscitation time. The concept of the structure and function of the blood-brain barrier (BBB). Features of the barrier function of the BBB in different parts of the brain and in different states of the human body. The role of cerebrospinal fluid in the brain's vital functions.

The spinal cord. Structural and functional organization. Reflex activity of the spinal cord. Sensory functions of the spinal cord. Perception and processing of signals from skin receptors, proprio- and interoreceptors. Motor functions. Spinal mechanisms of regulation of muscle tone, posture and movements. Conduction functions of the spinal cord. Afferent and efferent conductive pathways of the spinal cord. Autonomic functions. Spinal mechanisms of autonomic functions regulation (regulation of vascular tone, internal organs functioning, sweat glands activity etc.). Integrative functions. Distribution of muscle tone, organization of complex movements. Spinal mechanisms of integration of somatic and autonomic functions. Clinically important spinal reflexes in humans (somatic and vegetative).

Brain stem. The medulla oblongata. Structural and functional organization. Sensory functions of medulla oblongata. Perception and processing of signals from

skin receptors, proprio- and interoreceptors, from taste, hearing receptors and vestibular receptors. Motor functions. Regulation of muscle tone, posture and movements. Conduction functions. Afferent and efferent conductive pathways. Autonomic functions. Bulbar mechanisms of regulation of vascular tone. Vasomotor center. Reflex regulation of cardiac activity. The respiratory center. Regulation of the functions of the digestive system and other internal organs. Integrative functions. Distribution of the muscle tone, posture maintenance, organization of complex movements. Integration of autonomic functions. Integration of autonomic and somatic functions. Protective reflexes.

Investigation of the main tendon reflexes (knee, Achilles and others), physiological assessment of the results obtained.

The midbrain and the pons. Structural and functional organization. Sensory functions. Perception and processing of signals from skin receptors, proprioceptors. Processing of visual and auditory information. Conductive functions. Afferent and efferent conductive pathways. Motor functions. Regulation of muscle tone, posture and movements. Relationship with cerebellum. Oculomotor functions. Autonomic functions. Autonomic nervous system pathways. Pupillary and other reflexes. Integrative functions. Organization of visual and auditory orientative reflexes. Organization of complex movements, integration of autonomic and somatic functions (chewing, swallowing, etc.), regulation of breathing.

Examination of pupillary reflexes, physiological assessment of the obtained results.

Reticular formation of the brainstem. Structural and functional organization. Descending and ascending influences of reticular formation on CNS activity. Participation of reticular formation in maintenance and redistribution of muscle tone, in regulation of autonomic functions, in integrative activity of CNS.

Cerebellum. Structural and functional organization. Participation in realization of sensory functions. Perception and processing of information from skin receptors, proprioceptors, receptors of the vestibular apparatus, visual and auditory systems and from the large hemisphere cortex. Motor functions. Participation in distribution of muscle tone, posture organization, involvement in purposeful slow and fast ballistic movements, correction of motor programs. Autonomic functions. Participation of the cerebellum in regulation of functions of the cardiovascular, respiratory, digestive and other systems. Integration of sensory and motor functions.

Examination of the state of cerebellar functions, physiological assessment of the obtained results.

Diencephalon. Thalamus. Structural and functional organization of thalamus. The main sensory and motor conducting pathways. Functional characteristics of thalamic nuclei. Participation of thalamus in formation of pain sensations and in realization of higher integrative brain functions.

Hypothalamus. Structural and functional organization. Participation in realization of sensory functions. Connections of hypothalamus with the cerebral cortex and other parts of the brain. Neurosecretory cells. Hypothalamic sensory neurons (thermo-, osmosensitive and others). Polysensory neurons. Endocrine functions (hypothalamic hormones and releasing factors). Autonomic functions. The

higher centers of autonomic nervous system. Integrative functions of the autonomic nervous system. Integration of the neuroendocrine functions, somatic and autonomic functions, participation in realization of the higher integrative functions of the brain.

Telencephalon. The cortex of the large hemispheres of the brain, its structural and functional organization. Modules (columns) as examples of structural and functional units. The role of the cerebral cortex in the formation of organism's systemic activity. Modern ideas about localization of functions in the cortex. Plasticity of the cortex.

Assessment of EEG rhythms in various functional states of the central nervous system.

Limbic system. Structural and functional organization of limbic system. Its role in formation of motivations, emotions, memory organization. Participation of limbic structures in integrative activity of CNS.

Basal nuclei. Structural and functional organization of the basal nuclei. Integrating function of basal nuclei in organization and realization of complex movements and integrative brain functions (motor, limbic, oculomotor and cognitive loops). Role of dopamine, acetylcholine and other mediator systems.

Age peculiarities of CNS functions.

Structural and functional bases of the multilevel system of regulation of muscle tone, posture maintenance and organization of movements. Intrinsic mechanisms of the spinal cord providing regulation of muscle tone. The spinal cord as a common final pathway for supraspinal CNS divisions in the mechanisms of regulation of muscle tone, posture maintenance, and movement organization. Changes in muscle structure and function in hypodynamy, denervation and other conditions. The most characteristic changes of muscle tone and movements in disorders of the spinal cord, brain stem, cerebellum, basal nuclei, and large cerebral cortex. Theoretical basis of correction of disorders of tone, trophics of muscles and movements. Significance of electrodiagnostics and electrical stimulation in prevention of muscle atrophy and restoration of their functions in case of innervation disorders, hypodynamy and other conditions.

The concept of changes in muscle tone, posture maintenance and movement organization at different ages.

The role of the autonomic (vegetative) nervous system (ANS) in ensuring the vital functions of the integral organism. Functions of the ANS. Comparative description of the general structure and physiological properties of the ANS and somatic nervous system (afferent, central, efferent sections). Comparative characteristics of the structure and physiological properties of the sympathetic and parasympathetic sections of the ANS. The concept of metasympathetic nervous system. Autonomic ganglia, their functions (transmissive, reflexive, integrative). Preganglionic and ganglionic neurons and their axons: morphological, functional and neurochemical differences. Neurotransmitters, receptors of ANS and its effector cells. Factors determining the response of effector cells to neurotransmitter action. The concept of principles of autonomic functions correction by influence on transmitters-receptor interaction mechanisms.

General characteristic of the influence of sympathetic and parasympathetic

parts of ANS on effector organs, their sensory functions. Synergism and relative antagonism of their influences. Autonomic reflexes. ANS centers, their tone. Interaction of somatic and ANS in regulation of body functions. Adaptation and trophic function of the ANS. Participation of the ANS in integration of functions in forming behavioral acts. Tone of the autonomic centers, methods of its examination. Autonomic reactivity and autonomic provision of somatic functions. Age-related changes in the ANS.

Assessment of the tone and reactivity of the sympathetic and parasympathetic divisions of the ANS (conducting clinostatic and orthostatic tests, cold tests, studying the Hering's respiratory-cardiac reflex, the Danini-Aschner reflex and others, and physiological assessment of the obtained results).

5. PHYSIOLOGY OF SENSORY SYSTEMS

The concept of sense organs, analyzers, sensory systems. I.P.Pavlov's teaching about analyzers. General principles of the structure of sensory systems, their role in maintaining the functional state of the human body, classification of sensory systems.

Mechanisms of perception of action of stimuli of external and internal environment of a human body by receptors. Coding, recoding, decoding, transmission, processing of information in receptors, conductive pathways and central parts of sensory systems. The role of sensory systems in brain development and cognition of the world.

The visual system. The structure and functions of the visual system. Features of the structure and properties of the eye, providing the function of vision. Structure and functional significance of the retina. Photochemical processes in retinal receptors under the action of light and in the dark. Functions of photoreceptor, horizontal, bipolar, amacrine and ganglion cells of the retina. Role of the pigment epithelium. Blood supply to the eye and retina. Information transmission and processing in conductive pathways and central parts of the visual system. Theories of color perception. Basic forms of color perception disorders. Field of vision. Visual acuity. Refraction and accommodation. Basics of correction of refractive errors. Adaptation, mechanisms and levels of adaptation. Eye movements. Central and peripheral mechanisms of coordination of visual and oculomotor functions. Age features of vision.

Assessment of the functions of the visual sensory system (visual acuity testing, perimetry, campimetry, color vision testing and others).

The auditory system. Peculiarities of the structure and properties of the sound-conducting and sound-perceiving apparatuses that provide the hearing function. Mechanisms of perception and analysis of sounds. Transmission and processing of information in the conductive pathways and central parts of the auditory system. Adaptation. Protective reflexes. Binaural hearing. Age-specific features of hearing. Basics of hearing impairment correction.

Assessment of the functions of the auditory sensory system (audiometry, tests (experiments) of Weber and Rinne and others).

Vestibular system. Peculiarities of structure and properties of receptor division providing perception and estimation of body position and its movement in space. Transmission and processing of information in the conductive pathways and central

sections of the vestibular system. Reactions of the human body to the vestibular system stimulation. Possibilities of their correction.

Assessment of the functions of the vestibular system (examination of vestibulo-autonomic reactions, determination of the duration of post-rotational nystagmus, etc.).

The taste system. Taste reception. Conduction pathways and central parts of the gustatory system. Perception of taste. Classification of taste sensations. Reactions of the human body to gustatory stimuli.

Determination of taste sensitivity thresholds.

Olfactory system. Reception of smells. Conductive pathways and central parts of the olfactory system. Perception and classification of smells. Human body reactions to stimulation of the olfactory system. Protective reflexes.

The somatovisceral sensory system. Skin sensitivity. Mechanoreception. Types of receptors. Transmission and processing of information in conductive pathways and central sections.

Thermoreception. Role of skin, internal organs, vessels and CNS in thermoreception. Information transmission and processing in conductive pathways and central sections. Reactions of human body to heat and cold.

Proprioceptive sensitivity. Receptor mechanisms. Peculiarities of the structure of conductive pathways and central departments. Role in perception and evaluation of body position in space, in the formation of muscle tone, posture and movement.

Interoceptive sensitivity. Receptor mechanisms. Types of interoceptive sensitivity. Reactions of the human body to irritation of interoceptors. The role of interoception in the maintenance of homeostasis.

System of pain sensitivity. Nociception. Classification of pain. Reception of pain stimuli. Peculiarities of structure and properties of conductive pathways and central departments. Central mechanisms of pain. Antinociceptive systems. Neurochemistry of antinociception. The concept of principles of pain management. Projective and reflected pain.

Assessment of the functions of the somatosensory system (study of tactile, pain, temperature, proprioceptive sensitivity). Esthesiometry and other methods for studying the functions of the somatosensory system.

6. PHYSIOLOGY OF CIRCULATION

The role and place of the circulatory system in the human body as a system serving metabolic processes. Structural and functional characteristics of the circulatory system.

Basic laws of hemodynamics. Morphological and functional classification of blood vessels. The concept of systemic, organ and local blood flow. Factors causing blood flow through vessels. Volumetric and linear velocities of blood flow in different parts of the vascular bed; factors that determine them. Peripheral resistance to blood flow, its significance. Blood pressure, its types: arterial (systolic, diastolic, pulse, mean), venous pressure. The role of blood pressure; factors determining its value. Blood pressure in different parts of the vascular bed. Arterial pressure (BP) in different functional states of human body. The concept of normal values of BP, age-related changes in BP. Methods of measuring blood pressure. The concept of 24-hour blood pressure monitoring. Arterial pulse, its origin and characteristics.

Sphygmogram. Pulse wave propagation velocity, methods of investigation and recording. Blood flow in the venous vessels, venous return of blood. Blood pressure in the veins. Central venous pressure. Venous pulse, methods of investigation and recording. Blood movement in the vessels of the microcirculation system. Methods for studying microcirculation vessels and blood flow in them.

Measurement of blood pressure and physiological assessment of the obtained results.

Assessment of the properties of the arterial pulse by palpation and according to sphygmography data, and physiological assessment of pulse properties.

Calculation and physiological assessment of pulse wave velocity of propagation.

Peculiarities of organ (regional) blood flow. Blood circulation in brain, myocardium, lungs and other organs, its regulation. Influence of nervous, hormonal, metabolic, myogenic mechanisms and factors secreted by endothelium on smooth muscle cells tone of vascular wall. The concept of methods of studying organ blood flow.

Microcirculation and the main physiological processes occurring at the level of the microcirculatory bed. Structural and functional characteristics of the main components of the microcirculatory system. Capillary blood flow and its peculiarities. Pre- and post-capillary resistance, blood pressure in capillaries of various organs. Transcapillary exchange of fluids and various substances between blood and tissues and its mechanisms. Starling's equation. Factors affecting the processes of microcirculation and transcapillary exchange (indices of hemodynamics, blood properties, state of vascular wall, lymph flow, properties of interstitial fluid). The concept of mechanisms of oxygen, nutrients and other substances delivery to cells from interstitial spaces and removal of carbon dioxide and other metabolites from cells.

Calculation of the filtration/reabsorption ratio in various parts of the vascular bed.

Lymphatic system, its structure and functions. Lymph formation and lymph outflow, mechanisms of their regulation.

Physiological properties and characteristics of the heart muscle. Blood supply to the myocardium. Blood flow in coronary vessels in systole and diastole. Consumption of oxygen and nutrients by the heart at relative rest and during physical activity. The concept of determinants that determine myocardial oxygen consumption.

Structure, physiological properties and functions of the cardiac conductive system. Current understanding of the substrate, nature and gradient of the heart automaticity. Propagation of excitation through the cardiac conductive system. Interaction of the cardiac conductive system with typical cardiomyocytes. Excitation of contractile cardiomyocytes and its mechanisms. Propagation of excitation in myocardium. Excitation-contraction coupling. Cardiomyocyte contraction, role of calcium ions. Structure, physiological properties and functions of contractile myocardium. Laws of cardiac contraction. Myocardial contractility and its indices.

Functions of the atria, ventricles and valves of the heart. Direction of blood flow. Connection of the systemic and pulmonary circles of the circulation.

Structure of cardiac cycle, sequence of phases and periods. Position of valves,

changes of pressure and blood volumes in heart chambers during different phases of cardiac cycle. The concept of preload and afterload. Comparative characteristics of pumping function of right and left ventricles. Systolic and minute volumes of blood flow at relative rest and at physical load. Methods of their determination. Ejection fraction and cardiac index. Cardiac performance. Reserves of the heart functioning and coronary blood flow, their realization during physical activity.

Calculation of ejection fraction, physiological assessment of heart pumping function indicators.

External manifestations of cardiac activity. Electrical manifestations of cardiac activity. Electrocardiography (ECG). Formation of ECG components. General plan of analysis and criteria of ECG norm, its diagnostic value. The concept of extrasystole, ECG-signs of myocardial ischemia. The concept of daily ECG monitoring. Sound manifestations of cardiac activity. Heart sounds, their origin. Heart auscultation and phonocardiography, their diagnostic value. Mechanical manifestations of cardiac activity. The apex beat of the heart, arterial and venous pulse. Sphygmography and its diagnostic value. Ultrasound heart investigation (echocardiography). Invasive techniques of the heart examination. Polycardiography, timing of periods and phases of cardiac cycle, matching of electrical (ECG), sound (phonocardiography) and mechanical (sphygmogram) manifestations of cardiac activity.

Age-related changes in cardiac activity.

Carrying out electrocardiography. ECG analysis (calibration, rhythm, heart rate (heart excitation rate), waves, intervals, segments, complexes).

Physiological assessment of phonocardiography results.

Physiological assessment of polycardiography results (ECG, phonocardiography, sphygmography).

Regulation of heart functioning (intracardial and extracardial mechanisms). Regulated indexes of cardiac pumping function: heart rate, stroke volume, cardiac output (minute blood flow volume). Effector mechanisms of regulatory influences on cardiac function. Adjustment of cardiac activity to the needs of the human body.

Regulation of blood circulation as a system of maintenance of metabolic processes of the human body. Regulated parameters of the circulatory system: cardiac activity, vascular tone, circulating volume of blood, its composition and properties.

Vascular tone and its nature. The regulation of vascular tone as one of the main mechanisms of maintaining blood pressure in the systemic and local blood flow. Reflex regulation of vascular tone. The vasomotor center, its afferent connections and efferent influences. Humoral regulation of vascular tone. Vasoconstricting and vasodilating endogenous substances. Mechanisms of fast and slow response regulation.

Local mechanisms of blood circulation regulation. The role of local metabolic factors in the regulation of arteriolar tone, factors secreted by vascular endotheliocytes (endothelin, nitric oxide, angiotensin II and others). Significance of gaseous transmitters system (CO, NO, H₂S and others) in regulation of blood circulation and respiration. Myogenic regulation of arterioles tone.

Functional system that provides regulation of systemic arterial pressure. Physiological prerequisites of arterial pressure disturbances and theoretical basis for

the correction of these disturbances. Age peculiarities of hemodynamics.

7. PHYSIOLOGY OF RESPIRATION

The role and place of the respiratory system in the human body as a system that serves metabolic processes. The main stages of respiration (external respiration, transport of gases by blood, gas exchange, cellular respiration).

External respiration. Physiology of the respiratory airways. Significance of the airways ciliated epithelium. Respiratory cycle. Ventilation of the lungs, its unevenness in different parts. Elastic properties of the thorax. Surfactant. Pressure in pleural cavity, its role and change during breathing. Biomechanics of inspiration and expiration. Work of the respiratory muscles. Relationship between pulmonary blood flow, ventilation and gravity.

Indices of external respiration (vital capacity, minute lung ventilation, flow indices of external respiration, «flow-volume» curve) and their changes in obstructive and restrictive lung disorders; age-related changes. Spirometry, spirometry, peakflowmetry (pneumotachometry).

Carrying out spirometry and spirometry, calculating the proper values, physiological assessment of the obtained indicators.

Carrying out peakflowmetry (pneumotachometry), calculating the proper values, physiological assessment of the obtained indicators.

Physiological assessment of the flow-volume curve. Calculation of the Tiffeneau index and its physiological assessment.

Measurement of the strength of the respiratory muscles.

Gas exchange in the lungs. Composition of atmospheric, expired and alveolar air. Partial pressures of oxygen and carbon dioxide in alveolar air and in blood. Relative constancy of alveolar air composition. Diffusion capacity of the lungs. Factors that influence the processes of oxygen and carbon dioxide diffusion between alveolar air and blood, blood and tissues.

Gas exchange between blood and tissues. Oxygen utilization coefficient of tissues at rest and during physical activity.

Cellular respiration. The concept of aerobic and anaerobic methods of energy production and their contribution to the metabolism of cells of different tissues depending on their functional state.

Transport of gases by the blood. Binding of gases by hemoglobin. Mechanisms of regulation of oxygen-binding blood properties inside erythrocytes. The importance of gas transmitters (nitrogen monoxide, hydrogen sulfide, carbon monoxide, etc.). Hemoglobin oxygen binding and oxyhemoglobin dissociation curve. Factors affecting hemoglobin affinity for oxygen and carbon dioxide. Oxygen capacity of the blood. Carbon dioxide transport. Indices that allow evaluation of blood oxygen saturation and carbon dioxide removal.

Calculation of blood oxygen capacity and oxygen utilization coefficient, their physiological assessment.

Carrying out pulse oximetry and physiological assessment of the hemoglobin oxygen saturation curve.

Respiration regulation as a way to meet the needs of cellular respiration and maintain blood gas constants (pO_2 , pCO_2 , pH). Receptors of pH, CO_2 and O_2 in the

human body and their role. Regulated indices of external respiration: respiration rate, depth of breathing (tidal volume). The respiratory center, its parts. Mechanisms providing respiratory periodicity. Receptors of the airways, lungs and respiratory muscles. Reflex reactions to their stimulation. Hering-Breyer reflexes. Regulation of the airways diameter.

Relationship between gas exchange and acid-base balance. Functional system of maintenance of relative constancy of partial pressure of gases in blood. Changes of external respiration indices under changes of pH and gas composition of blood. Relation between ventilation of alveoli and blood flow in the pulmonary circulation, mechanisms ensuring its constancy under changes in gas composition and blood pH. External respiration during muscular work, increased and decreased atmospheric pressure. Breathing and phonation. The first inspiration of a newborn. Hypoxia and its signs. Theoretical basis of various types of artificial respiration. Age-related changes in breathing.

Interaction of respiratory, cardiovascular and blood systems in gas exchange, their functional reserves in oxygen delivery. Indices of reserves of hemocardiorespiratory system: ECG indices, maximal oxygen consumption (MOC), oxygen debt, anaerobic threshold and others. Age-related changes in the reserves of the cardiovascular and respiratory systems.

Determination of functional reserves of the hemocardiorespiratory system according to bicycle ergometry and ECG data.

8. PHYSIOLOGY OF DIGESTION

General characteristics of the functional system of nutrition, the role and place of digestive processes in it. Nutritional motivations. Physiological mechanisms of hunger and satiety. Appetite. Modern concepts of the feeding centers. Role of neurohumoral factors, eating habits in regulation of feeding behavior.

Types of digestion depending on the features of hydrolysis and its localization. Digestive-transport conveyor system. Features of nervous and humoral regulation of various parts of the gastrointestinal tract. Experimental and clinical methods of investigating the functions of the gastrointestinal tract. The significance of I.P. Pavlov's works in the development of ideas about the functions and mechanisms of regulation of the secretory function of the digestive glands. Digestive and non-digestive functions of the gastrointestinal tract.

Digestion in the oral cavity. Mechanical and chemical processing of food. Salivation, chewing, swallowing. Mechanisms of their regulation. The amount, composition and properties of saliva. The role of saliva in digestion.

Carrying out sialometry and physiological assessment of the obtained results.

Digestion in the stomach. The composition and properties of gastric juice. Formation and role of hydrochloric acid and mucus of gastric juice. Phases and mechanisms of regulation of gastric glands secretion on an empty stomach and after meals. Motor and evacuation functions of the stomach on an empty stomach and after a meal, their regulation. Hungry contractions of the stomach. Gastric emptying.

The role of the pancreas in digestion. Composition and properties of pancreatic juice. Mechanisms of regulation of pancreatic juice secretion on an empty stomach and after a meal. The role of the liver in digestion. Bile formation and bile secretion.

The composition and properties of bile, its participation in the processes of digestion. Mechanisms of regulation of bile formation and secretion in a fasting state and after meals.

Digestion in the duodenum, jejunum and ileum. The role of pancreatic juice and bile. Composition and properties of intestinal juice. Mechanisms of regulation of intestinal secretion. Luminal and membrane hydrolysis of nutrients. Motor function of the small intestine and its regulation.

Digestion in the large intestine. The importance for the human body of the microbiota of the large intestine. Motor activity of the large intestine. Defecation.

Absorption of hydrolysis products of food substances, water, electrolytes, vitamins in different parts of the digestive tract, its mechanisms. The conjunction of hydrolysis and absorption (digestive-transport conveyor). Regulation of absorption. Age features of digestion. Nervous, humoral and local mechanisms of regulation of digestive functions and their relationship in different parts of the gastrointestinal tract. Gastrointestinal reflexes. The importance of blood flow in the gastrointestinal tract for its vital functions.

9. SUBSTANCE AND ENERGY METABOLISM. THERMOREGULATION. EXCRETION

The concept of integral indices of metabolism and energy. The exchange of substances between the human body and the external environment as a basic condition of life. Characteristics of the processes of anabolism and catabolism, their relationship, the ratio of these processes in different conditions of life activity. The plastic role of metabolism. Essential substances for the human body. General concepts of fat, carbohydrate and protein metabolism. Nitrogen balance. Positive and negative nitrogen balance. The energy role of metabolism. Sources of energy.

Energy balance of the human body. Methods of determining the energy expenditure of the human body (direct and indirect calorimetry). Caloric value of nutrients. Caloric equivalent of oxygen. Respiratory quotient. Basal Metabolic Rate (BMR), the value and its determining factors. Energy expenditure of the human body under conditions of basal metabolism. The value of the BMR measurement. Energy expenditure of the human body under different types of labor activity (according to the degree of physical labor intensity). Specific dynamic (thermogenic) effect of food. Total energy expenditure of the human body.

Calculation of the proper values of basal metabolic rate and total energy expenditures of the human body.

Determination of energy consumption by indirect calorimetry with complete and incomplete gas analysis.

Determination of the respiratory coefficient and its physiological assessment.

The principles of a healthy diet. The balance of energy intake and expenditure. The use of data on the body's energy expenditure and the human body's need for plastic substances to compose nutritional diets. The concept of the body weight norm. Overweight (obesity) and underweight. Excessive consumption of carbohydrates and fats as risk factors for diseases. Processes of deposition and use of deposited nutrients (glycogen depot in the liver and muscles, fat depot). Daily norms of consumption of fats, proteins, carbohydrates, the most important vitamins, microelements. Ballast

substances, their role. Mechanisms of regulation of metabolism in the human body. Humoral mechanisms of body weight regulation (leptin, ghrelin, insulin, cholecystokinin, neuropeptide Y, orexins, dopamine, serotonin and others). Integration of metabolic processes. The concept of the peculiarities of metabolism in children. Peculiarities of nutrition in the elderly and old age.

Body weight assessment. Calculation of body mass index. Physiological assessment of the obtained results and the formation of scientifically based recommendations for body weight correction.

Drawing up a diet based on data on the body's total energy expenditure

Thermoregulation. Role and place of thermoregulation as a system providing optimal conditions for metabolic processes. The importance of the temperature constancy of the human body internal environment for the normal course of the vital activity processes. The concept of thermodynamics. Primary and secondary heat in the body. The concept of homoiothermy, poikilothermy and heterothermy. Human body temperature and its daily fluctuations. Temperature of different parts of the skin and internal organs. Thermometry.

Measurement of axial body temperature using mercury (or similar) and electronic thermometers, assessment of possible errors during execution, physiological assessment of the obtained results.

Physical and chemical thermoregulation. The role of behavior in maintaining temperature homeostasis in the human body. Sources of heat production in the body. Regulation of heat production processes.

Heat loss of the body. Physical processes of heat loss. Physiological mechanisms of regulation of heat loss processes. Heat balance equation.

The functional system that maintains the temperature of the human body internal environment. Nervous and humoral mechanisms of thermoregulation. The role of peripheral and central receptors in thermoregulation processes. Age peculiarities of thermoregulation. Hyperthermia and fever. Protective role of fever. The concept of endo- and exopyrogens. Hypothermia.

Role and place of excretion as a system serving metabolic processes. Organs of excretion (kidneys, skin, lungs, digestive tract). Their participation in the maintenance of the human body homeostasis.

Kidney. Excretory and non-excretory functions of the kidney. Nephron as a structural and functional unit of the kidney. Blood flow in the kidney, peculiarities of its regulation.

Basic processes of urine formation (glomerular filtration, tubular reabsorption and secretion). Mechanisms of glomerular filtration, composition of primary urine. Reabsorption in tubules and collecting tubes. Features and mechanisms of reabsorption of various substances. Concept of aquaporins. The countercurrent-multiplying system. Secretory processes in the tubules. Processes of synthesis in the kidney. Urine formation and urination. Final urine and its composition. The importance of quantitative and qualitative analysis of urine for evaluation of the state of human body functions.

Calculation of glomerular filtration rate based on inulin (creatinine) clearance.

Neurohumoral regulation of urine formation (filtration, reabsorption, secretion)

processes). Regulated parameters (renal hemodynamics; volumetric filtration rate; reabsorption of water, glucose, Na^+ , K^+ , Ca^{2+} , P_i , H^+ , HCO_3^- , urea and others). The role of the kidneys in the maintenance of acid-base balance, osmotic pressure, ionic composition of blood, blood volume, in the regulation of systemic blood flow, hematopoiesis, water-electrolyte balance. Indices of urinary system functions (frequency, volume of urination, nocturnal and daily diuresis). Bladder function. The process of urination and its regulation. Clinical and physiological methods of investigation of renal function. The concept of the consequences of kidney removal. The concept of an artificial kidney and blood dialysis. Physiological basis of the possibility of the transplanted kidney regulation. Age-related changes in urine formation and urine excretion.

Physiological assessment of the composition and properties of final urine.

10. INTEGRATIVE BRAIN ACTIVITY

Integrative functions of the brain that ensure the integrity of the human organism (integration of somatic, autonomic, endocrine functions). Levels of integration. Integrative functions of the brain that provide interaction of the human organism with the environment and adaptation of the human organism to the changing conditions of existence (behavioral and mental functions).

Innate forms of behavior (unconditioned reflexes and instincts), their importance for the adaptive activity of the human body, dynamics of their change in onto- and phylogenesis.

The concept of higher nervous activity (I.P. Pavlov). Acquired forms of behavior. The role of environmental conditions in the formation of integrative activity of the human brain. Importance of learning and neuronal memory in their formation. Types of learning. Conditioned reflex as a form of adaptation of animals and humans to changing conditions of existence. Classification of conditioned reflexes. Terms for the formation of conditioned reflexes. Mechanisms of formation of the temporary connection. Long-term potentiation. Mechanisms of facilitation of nerve impulse conduction through a synapse (E. Kandel). Dynamic stereotype.

Inhibition in higher nervous activity. Types of inhibition and its role. Modern understanding of the mechanisms of inhibition.

Memory, its types and mechanisms. The role of different parts of the brain in memorizing, storing and reproducing information. Forgetting. Reserves and ways to improve memory.

Types of higher nervous activity of animals and humans (I.P. Pavlov), their classification, characteristics, methods of determination. I.P. Pavlov's doctrine of the first and second signal systems.

Higher mental functions of the brain. Neurophysiological basis of human mental functions (attention, perception, memory, motivations, emotions, thinking, consciousness, speech). Significance of functional state of CNS for realization of mental functions.

Parity in activity of the cerebral cortex, functional asymmetry of the human cerebral hemispheres and its role in realization of mental functions (speech, thinking and others). Functions of the associative cortex of the cerebral cortex. Functions of the frontal cortex areas.

Attention and its physiological mechanisms. The role of attention in the

processes of memory and learning.

Sleep and wakefulness states. Modern understanding of the role and mechanisms of sleep. Somatic, autonomic and endocrine functions during sleep.

Emotions and their neurophysiological mechanisms. The role of needs and motivations in the formation of emotions. The role of emotional states. Behavioral, autonomic and endocrine manifestations of emotions. Emotional tension as a risk factor for health.

Thinking and speech, their neurophysiological mechanisms. The development of abstract thinking in humans. Functional asymmetry of the cerebral cortex related to the development of speech in humans.

Purposeful behavior, its systemic mechanisms (on the example of eating or other behavior). Architecture of integral behavioral act from the position of functional systems theory (P.K. Anokhin). Motivation and dominance, their neurophysiological mechanisms and role in goal-directed behavior.

The concept of the physiological bases of consciousness and their neurophysiological mechanisms. Medical criteria for assessing human consciousness.

Age-related changes in human higher nervous activity.

Assessment of integrative functions of the brain (assessment of indicators of attention and speed of information processing based on the results of a correction test, assessment of the manifestation of emotions, memory, functional asymmetry of the cerebral hemispheres, etc.).

ACADEMIC DISCIPLINE CURRICULAR CHART

Section , topic #	Section (topic) name	Number of hours		supervised independent work of students	Practical skill	Form of control	
		lectures	practical			of practical skill	of current / intermediate certification
3rd semester							
	Lectures	15	-	6			
1.	The subject and tasks of Normal Physiology. Homeostasis. Physical and chemical constants of blood	1,5	-	-			
2.	Hemostasis system. Blood types	-	-	1,5			Electronic test
3.	Bases of information exchange of the cell with the environment. Chemical signaling. General physiology of endocrine system	1,5	-	-			
4.	Physiology of the endocrine system	1,5	-	-			
5.	Electrical signaling. Biological potentials. Excitation conduction by nerve fibers	1,5	-	-			
6.	Synaptic transmission. Neuromuscular junction	1,5	-	-			
7.	Physiology of muscles	1,5	-	-			
8.	Physiology of the Central Nervous System. Physiology of the spinal cord	-	-	1,5			Electronic test
9.	Physiology of the Central Nervous System. Physiology of the brainstem	-	-	1,5			Electronic test
10.	Physiology of the Central Nervous System. Physiology of the diencephalon and telencephalon	-	-	1,5			Electronic test
11.	Physiology of the Central Nervous System. The systemic mechanisms of muscle tone and movement regulation	1,5	-	-			
12.	Physiology of visual sensory system	1,5	-	-			

13.	Physiology of auditory and vestibular systems	1,5	-	-			
14.	Hemodynamics. Functional indices of blood circulation	1,5	-	-			
	Practical classes						
1.	<p>Introduction. The subject and tasks of Normal Physiology Homeostasis. Physical and chemical constants of blood</p> <p>Practical works: Learning methods of working in the computer room. Acquaintance with basic indices of blood homeostasis, cardiovascular and respiratory systems of the organism. Hemolysis and its types. Determination of blood plasma osmotic pressure.</p>	-	4	-	<p>Carrying out measures to prevent infection with viral hepatitis and human immunodeficiency virus during studies of blood and other biological materials. Technique of taking capillary blood. Physiological evaluation of the results of the Complete Blood Count, obtained using manual and semi-automatic counting methods.</p>	<p>Defense of practical work. Solving situational problems</p>	<p>Electronic tests; reports on practical work with their oral defense; interviews; test papers; essays</p>
2.	<p>Physiological functions of Red Blood Cells. Hemopoiesis. Erythrocytopoiesis. Physiological functions of platelets. Thrombopoiesis. Hemostasis system</p> <p>Practical works: Technique of taking capillary blood. Counting red blood cells in the counting chamber under a microscope. Determination of the amount of hemoglobin by Sali's method. Calculation of color index and other indices of red blood cells. Determination and physiological assessment of primary hemostasis indices. Appearance of red blood cells and platelets under the microscope Studying the needs in vitamins, trace elements and essential food substances necessary for normal hemopoiesis</p>	-	4	-	<p>Physiological evaluation of the results of the Complete Blood Count, obtained using manual and semi-automatic counting methods. Assessment of primary hemostasis indicators</p>	<p>Defense of practical work. Solving situational problems</p>	<p>Electronic tests; reports on practical work with their oral defense; interviews; test papers; essays</p>

3.	<p>Physiological functions of White Blood Cells. Leukopoiesis. Non-specific and specific resistance of the human body. Physiological evaluation of the complete blood count</p> <p>Practical works: Counting white blood cells in a counting chamber under the microscope. Calculation of the percentage of white blood cells different types in a blood smear (leukocyte formula). Determination of ESR by Panchenkov's method. Physiological evaluation of the complete blood count test.</p>	-	4	-	Physiological evaluation of the results of the Complete Blood Count, obtained using manual and semi-automatic counting methods	Defense of practical work. Solving situational problems	Electronic tests; reports on practical work with their oral defense; interviews; test papers; essays
4.	<p>Blood types. ABO, Rh and other systems. Physiological bases of blood matching for the transfusion</p> <p>Practical works: Blood typing in the ABO system using standard sera. Blood typing in Rhesus system. Blood typing in the ABO and Rh system using monoclonal sera.</p>	-	4	-	Blood typing in ABO and Rh (D-antigen) systems using standard sera and monoclonal antibodies	Defense of practical work. Solving situational problems	Electronic tests; reports on practical work with their oral defense; interviews; test papers; essays
5.	<p>Bases of information exchange of the cell with the environment. Chemical signaling. General physiology of endocrine system.</p> <p>Practical works: Studying the receptor mechanism of the effect of adrenalin on the heart rate. Human height evaluation. Studying hormones of anterior and posterior pituitary gland and their action on peripheral endocrine glands.</p>	-	4	-	Assessment of the functions of the endocrine system	Defense of practical work. Solving situational problems	Electronic tests; reports on practical work with their oral defense; interviews; test papers; essays
6.	<p>Special physiology of the endocrine system. Essential hormones, their mechanisms of action and effects.</p> <p>Practical works: Parts of adrenal gland and their hormones. Studying the mechanisms of peripheral endocrine gland hormones regulation and their negative feedback influence on hypothalamic and pituitary hormone</p>	-	4	-	Assessment of the functions of the endocrine system	Defense of practical work. Solving situational problems	Electronic tests; reports on practical work with their oral defense; interviews; test papers; essays

7.	Concluding lesson on the sections «Introduction. Homeostasis. The internal environment of the human body. Humoral regulation of physiological functions»	-	4	-	Technique of taking capillary blood*. Physiological evaluation of the results of the Complete Blood Count, obtained using manual and semi-automatic counting methods*. Assessment of primary hemostasis indicators*. Blood typing in ABO and Rh (D-antigen) systems using standard sera and monoclonal antibodies *. Assessment of the functions of the endocrine system*		Colloquium; electronic test*
8.	Electrical signaling. Laws of excitable tissues. Biological potentials. Excitability changes during excitation. Practical works: The effect of Na ⁺ and K ⁺ ions on the resting membrane potential and action potential. Studying the resting membrane potential, types of its changes and their effect on membrane excitability. Studying the action membrane potential mechanisms.	-	4	-	Physiological assessment of electromyography results. Assessment of the influence of shifts in the extracellular concentration of Na ⁺ and K ⁺ ions on the resting membrane potential	Defense of practical work. Solving situational problems	Electronic tests; reports on practical work with their oral defense; interviews; test papers; essays
9.	Excitation conduction by nerve fibers. Synaptic transmission. Practical works: Demonstration of local anesthetics effect development depending on the duration of action. Comparison of the structure of central (interneuronal) synapse and peripheral synapse (neuromuscular junction).	-	4	-	Physiological assessment of electromyography results. Possibilities of pharmacological influence on signal transmission processes in synapses (using the example of the neuromuscular junction)	Defense of practical work. Solving situational problems	Electronic tests; reports on practical work with their oral defense; interviews; test papers; essays

10.	<p>Physiology of muscles</p> <p>Practical works: Dynamometry of hands and back muscles. Contraction of motor units and of a whole muscle. Studying the structure of sarcomere, skeletal muscle filaments and their proteins.</p>	-	4	-	Carrying out dynamometry and physiological assessment of the obtained results	Defense of practical work. Solving situational problems	Electronic tests; reports on practical work with their oral defense; interviews; test papers; essays
11.	<p>General physiology of the Central Nervous System.</p> <p>Practical works: Schemes of reflex arches consisting of 2 neurons (tendon reflex) and 3 neurons (reflex from skin receptors). Studying of knee and Achilles reflexes. Determination of the Achilles reflex time. Electromyography. The study of reciprocal inhibition of motor acts by electromyography.</p>	-	4	-	Study of the main tendon reflexes, physiological assessment of the results obtained. Physiological assessment of electromyography results	Defense of practical work. Solving situational problems	Electronic tests; reports on practical work with their oral defense; interviews; test papers; essays
12.	<p>The concluding lesson on the section «Physiology of Excitable Tissues»</p>	-	4	-	Carrying out dynamometry and physiological assessment of the obtained results*. Study of the main tendon reflexes, physiological assessment of the results obtained (with graphic representation of reflex arcs)*. Physiological assessment of electromyography results*. Assessment of the influence of shifts in the extracellular concentration of Na ⁺ and K ⁺ ions on the resting membrane potential *. Possibilities of		Colloquium; electronic test*

					pharmacological influence on signal transmission processes in synapses (using the example of the neuromuscular junction).		
13.	<p>The role and functions of the spinal cord, brainstem, and cerebellum.</p> <p>Practical works: Studying of some tendon reflexes (mandibular, upper limb flexor and extensor reflexes). Studying of pupillary reflexes. Studying of tactile sensitivity. Studying of muscle-joint sensation. Studying of the cerebellum functions</p>	-	4	-	<p>Study of the main tendon reflexes, physiological assessment of the results obtained.</p> <p>Studying of pupillary reflexes, physiological assessment of the results obtained.</p> <p>Studying of the cerebellum functions, physiological assessment of the results obtained.</p> <p>Study of the functions of the somatosensory system</p>	<p>Defense of practical work.</p> <p>Solving situational problems</p>	<p>Electronic tests; reports on practical work with their oral defense; interviews; test papers; essays</p>
14.	<p>The role and functions of the diencephalon and telencephalon. Systemic mechanisms of muscle tone and movements regulation</p> <p>Practical works: Electroencephalography</p>	-	4	-	<p>Assessment of EEG rhythms in various functional states of the Central Nervous System</p>	<p>Defense of practical work.</p> <p>Solving situational problems</p>	<p>Electronic tests; reports on practical work with their oral defense; interviews; test papers; essays</p>
15.	<p>Physiology of the autonomic nervous system.</p> <p>Practical works: Description of spinal reflexes of the autonomic (sympathetic) and somatic nervous system. Clinostatic reflex. Orthostatic reflex. Hering's respiratory-cardiac reflex. Assessment of neurotransmitter mechanisms of the effect of sympathetic and parasympathetic parts of ANS on the heart functioning.</p>	-	4	-	<p>Assessment of the tone and reactivity of the sympathetic and parasympathetic divisions of the ANS, physiological assessment of the results obtained.</p>	<p>Defense of practical work.</p> <p>Solving situational problems</p>	<p>Electronic tests; reports on practical work with their oral defense; interviews; test papers; essays</p>

16.	<p>General physiology of sensory systems. Visual system</p> <p>Practical works: Evaluation of visual acuity. Studying the color vision. Determination of visual field bounds (perimetry). Determination of the retina's central regions sensitivity (computer campimetry). Optic pathways general scheme. Evaluation of the simple sensorimotor reaction velocity</p>	-	4	-	Assessment of visual sensory system functions	Defense of practical work. Solving situational problems	Electronic tests; reports on practical work with their oral defense; interviews; test papers; essays
17.	<p>Physiology of auditory, vestibular, taste, olfactory and somatosensory systems.</p> <p>Practical works: Studying of some mechanisms of the sound source direction determination. Studying of bone and air conduction. Studying the dependence of auditory sensitivity on sound frequency (audiometry). Studying of tactile sensitivity. Esthesiometry (measurement of spatial thresholds). Studying the functional state of the vestibular system. Studying of taste sensitivity</p>		4		Assessment of the functions of the auditory sensory system. Assessment of the functions of the vestibular sensory system. Assessment of the functions of the somatosensory system. Assessment of the functions of the gustatory sensory system	Defense of practical work. Solving situational problems	Electronic tests; reports on practical work with their oral defense; interviews; test papers; essays
18.	<p>The concluding lesson on the sections "Nervous regulation of physiological functions", "Physiology of sensory systems"</p>	-	4	-	Study of the main tendon reflexes, physiological assessment of the results obtained*. Studying of pupillary reflexes, physiological assessment of the results obtained*. Studying of the cerebellum functions, physiological assessment of the results obtained*. Assessment of EEG rhythms in various		Colloquium; electronic test* Credit

functional states of the Central Nervous System*.
 Assessment of the tone and reactivity of the sympathetic and parasympathetic divisions of the ANS, physiological assessment of the results obtained*.
 Assessment of visual sensory system functions*.
 Assessment of the functions of the auditory sensory system*.
 Assessment of the functions of the vestibular sensory system*.
 Assessment of the functions of the somatosensory system*.
 Assessment of the functions of the gustatory sensory system*

4th semester

	Lectures	15	-	6		
1.	Physiological properties and features of the myocardium	1,5	-	-		
2.	Regulation of blood circulation	1,5	-	-		
3.	Methods for studying cardiac activity. Electrocardiography	-	-	1,5		Electronic test
4.	Physiology of respiration. External respiration	1,5	-	-		
5.	Gas exchange in the lungs and tissues. Transport of gases by the blood	1,5	-	-		
6.	Regulation of respiration. Functional reserves of hemocardiorespiratory system in gas exchange	1,5	-	-		

7.	Physiology of digestion. Regulation of eating behavior	1,5	-	-			
8.	Digestion in the duodenum. The role of bile in digestion. Digestion in the small and large intestine	-	-	1,5			Electronic test
9.	Substance and energy metabolism. Thermoregulation	1,5	-	-			
10.	Physiology of excretion	1,5	-	-			
11.	Innate and acquired forms of adaptation reactions of the human organism to the changing conditions of existence	1,5	-	-			
12.	Memory. Types of higher nervous activity	-	-	1,5			Electronic test
13.	Higher integrative functions of the brain as the physiological basis of human mental functions	1,5	-	-			
14.	Thinking and speech. Pairing and functional asymmetry of the hemispheres	-	-	1,5			Electronic test
Practical classes							
1.	Hemodynamics. Functional indices of blood circulation. Microcirculation Practical works: Studying of the arterial pulse properties by palpation. Arterial blood pressure measurement by Korotkoff's auscultatory method. Pulse assessment by sphygmogram analysis. Analysis of arterial blood pressure changes under the action of adrenaline and noradrenaline. Studying of blood flow in the vessels of the microcirculatory bed using video "microcirculation"	-	4	-	Arterial blood pressure measurement and physiological assessment of the results obtained. Assessment of the properties of the arterial pulse. Calculation and physiological assessment of pulse wave propagation speed*. Calculation of the filtration/reabsorption ratio in various parts of the vascular bed	Defense of practical work. Solving situational problems	Electronic tests; reports on practical work with their oral defense; interviews; test papers; essays
2.	Physiological properties and peculiarities of the heart muscle Practical works: Heart automaticity and various factors affecting it. Studying of the mechanisms of action potentials (AP) generation by pacemaker cells (sinoatrial node) and ventricular contractile myocardium cells	-	4	-	ECG analysis. Calculation of ejection fraction. Assessment of endocrine system functions	Defense of practical work. Solving situational problems	Electronic tests; reports on practical work with their oral defense; interviews; test papers; essays

3.	<p>Cardiac cycle. Methods of the heart investigation</p> <p>Practical works: Recording an ECG and its analysis. Bases of phonocardiography. Recording and analysis of phonocardiogram (recorded synchronously with ECG) Studying the basics of ultrasound examination of the heart (echocardiography)</p>	-	4	-	<p>Carrying out electrocardiography. ECG analysis (calibration, rhythm, heart rate, conductivity, waves, intervals, segments, complexes). Physiological assessment of the results of polycardiography (ECG, phonocardiography, sphygmography). Calculation of ejection fraction, physiological assessment of heart pumping function indicators.</p>	<p>Defense of practical work. Solving situational problems</p>	<p>Electronic tests; reports on practical work with their oral defense; interviews; test papers; essays</p>
4.	<p>Regulation of the circulation 1 (regulation of the heart function)</p> <p>Practical works: Oculocardiac reflex (Dagnini–Aschner reflex). Orthostatic reflex. Effect of some substances on the function of a frog's isolated heart. Effect of parasympathetic and sympathetic parts of the autonomic nervous system on heart function</p>	-	4	-	<p>Assessment of the tone and reactivity of the sympathetic and parasympathetic divisions of the ANS. Assessment of endocrine system functions</p>	<p>Defense of practical work. Solving situational problems</p>	<p>Electronic tests; reports on practical work with their oral defense; interviews; test papers; essays</p>
5.	<p>Regulation of blood circulation</p> <p>Practical works: Analysis of receptor and ion mechanisms of blood pressure and heart function regulation.</p>	-	4	-	<p>Arterial blood pressure measurement and physiological assessment of the results obtained. Assessment of the tone and reactivity of the sympathetic and parasympathetic divisions of the ANS.</p>	<p>Defense of practical work. Solving situational problems</p>	<p>Electronic tests; reports on practical work with their oral defense; interviews; test papers; essays</p>

6.	<p>Lung ventilation</p> <p>Practical works: Spirometry. Spirography. Peakflowmetry. Studying of lung ventilation indices using an automatic spirometer</p>	-	4	-	<p>Carrying out spirometry and spirometry, calculating the proper values, physiological assessment of the obtained indicators. Carrying out peakflowmetry, calculating the proper values, physiological assessment of the obtained indicators. Physiological assessment of the flow-volume curve, calculation of the Tiffeneau index and its physiological assessment</p>	<p>Defense of practical work. Solving situational problems</p>	<p>Electronic tests; reports on practical work with their oral defense; interviews; test papers; essays</p>
7.	<p>Gas exchange in the lungs and tissues. Transport of gases by blood</p> <p>Practical works: Determination of alveolar and expired air content. Calculation of functional dead space volume. Oxyhemometry, oxyhemography, pulse oxymetry. Modeling of ventilation and blood flow mismatch In the lungs, its effect on respiration and gas exchange. Study of the oxyhemoglobin dissociation curve</p>	-	4	-	<p>Carrying out pulse oximetry and physiological assessment of the hemoglobin oxygen saturation curve. Calculation of blood oxygen capacity and oxygen utilization coefficient, their physiological assessment</p>	<p>Defense of practical work. Solving situational problems</p>	<p>Electronic tests; reports on practical work with their oral defense; interviews; test papers; essays</p>
8.	<p>Regulation of respiration</p> <p>Practical works: Testing the strength of the respiratory muscles. Effect of CO₂ content in inspired air On lung ventilation. Chemoreceptors and other receptors influence on lung ventilation</p>	-	4	-	<p>Determination of the strength of respiratory muscle</p>	<p>Defense of practical work. Solving situational problems</p>	<p>Electronic tests; reports on practical work with their oral defense; interviews; test papers; essays</p>
9.	<p>Functional reserves of the hemocardiorespiratory system in gas exchange</p>	-	4	-	<p>Calculation of blood oxygen capacity and</p>	<p>Defense of practical work.</p>	<p>Electronic tests; reports on</p>

	<p>Practical works: Test of a 6-minute walk. Test PW_{C170} (bicycle ergometry). Revealing the hierarchy of homeostatic indices of respiration and circulation. Calculation of maximal oxygen consumption using maximal oxygen pulse and calculated maximal heart rate</p>				<p>oxygen utilization coefficient, their physiological assessment. ECG analysis. Determination of functional reserves of the hemocardiorespiratory system according to bicycle ergometry and ECG data</p>	<p>Solving situational problems</p>	<p>practical work with their oral defense; interviews; test papers; essays</p>
10.	<p>The concluding lesson on the sections «Physiology of blood circulation» and «Physiology of Respiration»</p>	-	4	-	<p>Arterial blood pressure measurement and physiological assessment of the results obtained*. Assessment of the properties of the arterial pulse*. Carrying out electrocardiography*. ECG analysis (calibration, rhythm, heart rate, conductivity, waves, intervals, segments, complexes)*. Calculation and physiological assessment of pulse wave propagation speed*. Calculation of ejection fraction, physiological assessment of heart pumping function indicators*. Calculation of the filtration/reabsorption ratio in various parts of</p>		<p>Colloquium; electronic test*</p>

the vascular bed*.
Assessment of the tone and reactivity of the sympathetic and parasympathetic divisions of the ANS*.
Carrying out spirometry and spirometry, calculating the proper values, physiological assessment of the obtained indicators*.
Carrying out peakflowmetry, calculating the proper values, physiological assessment of the obtained indicators*.
Physiological assessment of the flow-volume curve, calculation of the Tiffeneau index and its physiological assessment*.
Calculation of blood oxygen capacity and oxygen utilization coefficient, their physiological assessment*.
Carrying out pulse oximetry and physiological assessment of the hemoglobin oxygen saturation curve*.
Determination of

					functional reserves of the hemocardiorepiratory system according to bicycle ergometry and ECG data*		
11.	General characteristics of digestion. Regulation of eating behavior. Digestion in the oral cavity and stomach Practical works: Sialometry. Digestion of starch by human saliva enzymes. Studying of the enzymatic properties of gastric juice	-	4	-	Carrying out sialometry and physiological assessment of the obtained indicators	Defense of practical work. Solving situational problems	Electronic tests; reports on practical work with their oral defense; interviews; test papers; essays
12.	Digestion in the small and large intestine. The role of the pancreas and liver in digestion Practical works: The effect of bile on fats. Parietal digestion. Amylase activity of blood plasma. Evaluation of body mass	-	4	-	Assessment of human height and body weight, calculation of body mass index, physiological assessment of the obtained indicators and the formation of scientifically based recommendations for body weight correction	Defense of practical work. Solving situational problems	Electronic tests; reports on practical work with their oral defense; interviews; test papers; essays
13.	Substance and energy metabolism. Principles of healthy nutrition. Thermoregulation Practical works: Calculation of the basal metabolic rate due values by tables and formulas. Measurement of the metabolic rate using method of the indirect calorimetry by gas analysis. Measurement of the axillary body temperature. Studying the role of blood circulation in heat transfer process in the superficial tissues using the method of color thermography. Diet composition and assessment (optional)	-	4	-	Calculation of the proper values of basal metabolic rate and total energy expenditure of the body. Determination of energy consumption by the method of indirect calorimetry with complete and incomplete gas analysis, calculation of the respiratory coefficient and its physiological assessment. Drawing up a diet based	Defense of practical work. Solving situational problems	Electronic tests; reports on practical work with their oral defense; interviews; test papers; essays

					on data on the body's total energy expenditure. Measurement of axillary body temperature using glass (liquid) and electronic thermometers, assessment of possible errors during execution, physiological assessment of the obtained results. Assessment of endocrine system functions.		
14.	<p>Physiology of excretion</p> <p>Practical works: Performing a common urine analysis using the express method. Studying of some renal functions on a model</p>	-	4	-	<p>Calculation of glomerular filtration rate based on inulin (creatinine) clearance, physiological assessment of the results obtained.</p> <p>Physiological assessment of the composition and properties of final urine</p>	<p>Defense of practical work. Solving situational problems</p>	<p>Electronic tests; reports on practical work with their oral defense; interviews; test papers; essays</p>
15.	<p>The concluding lesson on the sections "Physiology of digestion" and "Substance and Energy Metabolism. Thermoregulation. Excretion "</p>	-	4	-	<p>Carrying out sialometry and physiological assessment of the obtained indicators*.</p> <p>Calculation of the proper values of basal metabolic rate and total energy expenditure of the body*.</p> <p>Determination of energy consumption by the method of indirect calorimetry with complete and incomplete gas analysis, calculation of the respiratory</p>		<p>Colloquium; electronic test*</p>

					<p>coefficient and its physiological assessment*.</p> <p>Assessment of human height and body weight, calculation of body mass index, physiological assessment of the obtained indicators and the formation of scientifically based recommendations for body weight correction*.</p> <p>Drawing up a diet based on data on the body's total energy expenditure*.</p> <p>Measurement of axillary body temperature using glass (liquid) and electronic thermometers, assessment of possible errors during execution, physiological assessment of the obtained results*.</p> <p>Calculation of glomerular filtration rate based on inulin (creatinine) clearance, physiological assessment of the results obtained*.</p> <p>Physiological assessment of the composition and properties of final urine*</p>		
16.	Innate and acquired adaptive reactions of the organism to changing environmental conditions. Types of higher nervous activity	-	4	-	Assessment of integrative brain functions	Defense of practical work. Solving situational	Electronic tests; reports on practical work

	Practical works: Assessment of the associative memory volume. Evaluation of a short-term auditory memory volume using letter and digit complexes in the human.					problems	with their oral defense; interviews; test papers; essays
17.	Higher integrative functions of the brain as the physiological basis of human mental functions Practical works: Identification of hemispheres functional asymmetry. Assessment of attention indices using a correction test.		4		Assessment of integrative brain functions	Defense of practical work. Solving situational problems	Electronic tests; reports on practical work with their oral defense; interviews; test papers; essays
	Total	30	140	12			Examination

* is a mandatory form of current certification

INFORMATION AND INSTRUCTIONAL UNIT

LITERATURE

Basic:

1. Нормальная физиология : учебник = Normal Physiology : textbook / В. В. Зинчук [и другие] ; под редакцией В. В. Зинчука. – Минск : Вышэйшая школа, 2020. – 496 p.

Additional:

2. Hall, J. E. Guyton and Hall Textbook of Medical Physiology / J. E. Hall. – 13th ed., Elsevier Inc., 2015. – 1168 p.

3. Ganong's Review of Medical Physiology / К. E. Barret [at al.] –25th ed., McGraw-Hill Companies, 2016. – 726 p.

4. Fox, S. I. Human Physiology / S. I. Fox. – 14th ed. – New York : McGrawHill, 2016. – 832 p.

5. Северина, Т. Г. Физиология возбудимых тканей = Physiology of Excitable Tissues : пособие / Т. Г. Северина. – Минск : БГМУ, 2024. – 51 p.

6. Constanzo, L. S. Physiology / L. S. Constanzo – 6th ed., Elsevier Inc., 2016. – 520 p.

7. Rhoades, R. A. Medical Physiology: Principles for Clinical Medicine / R. A. Rhoades, D. R. Bell. – 4th ed. – LWW, 2018. – 968 p.

8. Physiology : textbook / edited by V. M. Moroz, O. A. Shandra. – 2nd edition. – Vinnitsia: Nova Knyha, 2016. – 728 p.

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

The time allocated for independent work can be used by students for:

- preparation for lectures and practical classes;
- preparation for colloquia, credit and exam in the academic discipline;
- elaboration of topics (questions) submitted for independent study;
- problem solving;
- performing research and creative tasks;
- preparation of thematic reports, abstracts, presentations;
- performing practical tasks;
- taking notes of educational literature;
- preparation of reports;
- compiling a review of scientific literature on a given topic;
- design of information and demonstration materials (stands, posters, graphs, tables, newspapers, etc.);
- production of models, laboratory and teaching aids;
- compiling a thematic selection of literary and Internet sources;
- production of flash cards;
- preparation of tests for the organization of mutual assessment.

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

Sample list of tasks for supervised student independent work:

summarizing primary sources, compiling a literature review,
compiling tests for self-control.

Form of SSIW control:

electronic test.

LIST OF AVAILABLE TEACHING METHODS

Traditional method;

active (interactive) methods:

PBL (Problem-Based Learning);

TBL (Team-Based Learning);

CBL (Case-Based Learning);

RBL (Research-Based Learning);

learning based on simulation technologies.

LIST OF PRACTICAL SKILLS

Name of practical skill	Form of control of practical skill
1. Technique of taking capillary blood	Defense of practical work. Solving situational problems
2. Physiological evaluation of the results of the Complete Blood Count, obtained using manual and semi-automatic counting methods	Defense of practical work. Solving situational problems
3. Assessment of primary hemostasis indicators	Defense of practical work. Solving situational problems
4. Blood typing in ABO and Rh (D-antigen) systems using standard sera and monoclonal antibodies	Defense of practical work. Solving situational problems
5. Assessment of the influence of shifts in the extracellular concentration of Na ⁺ and K ⁺ ions on the resting membrane potential	Defense of practical work. Solving situational problems
6. Possibilities of pharmacological influence on signal transmission processes in synapses (using the example of the neuromuscular junction)	Defense of practical work. Solving situational problems
7. Physiological assessment of electromyography results	Defense of practical work. Solving situational problems
8. Carrying out dynamometry and physiological assessment of the obtained results	Defense of practical work. Solving situational problems

9. Assessment of the functions of the endocrine system	Defense of practical work. Solving situational problems
10. Study of the main tendon reflexes, physiological assessment of the results obtained	Defense of practical work. Solving situational problems
11. Studying of pupillary reflexes, physiological assessment of the results obtained	Defense of practical work. Solving situational problems
12. Studying of the cerebellum functions, physiological assessment of the results obtained	Defense of practical work. Solving situational problems
13. Assessment of EEG rhythms in various functional states of the Central Nervous System	Defense of practical work. Solving situational problems
14. Assessment of the tone and reactivity of the sympathetic and parasympathetic divisions of the ANS, physiological assessment of the results obtained	Defense of practical work. Solving situational problems
15. Assessment of visual sensory system functions	Defense of practical work. Solving situational problems
16. Assessment of the functions of the auditory sensory system	Defense of practical work. Solving situational problems
17. Assessment of the functions of the vestibular sensory system	Defense of practical work. Solving situational problems
18. Assessment of the functions of the gustatory sensory system	Defense of practical work. Solving situational problems
19. Assessment of the functions of the somatosensory system	Defense of practical work. Solving situational problems
20. Arterial blood pressure measurement and physiological assessment of the results obtained	Defense of practical work. Solving situational problems
21. Assessment of the properties of the arterial pulse	Defense of practical work. Solving situational problems
22. Carrying out electrocardiography. 23. ECG analysis (calibration, rhythm, heart rate, conductivity, waves, intervals, segments, complexes)	Defense of practical work. Solving situational problems

24. Physiological assessment of the results of polycardiography (ECG, phonocardiography, sphygmography)	Defense of practical work. Solving situational problems
25. Calculation and physiological assessment of pulse wave propagation speed	Defense of practical work. Solving situational problems
26. Calculation of ejection fraction, physiological assessment of heart pumping function indicators	Defense of practical work. Solving situational problems
27. Calculation of the filtration/reabsorption ratio in various parts of the vascular bed	Defense of practical work. Solving situational problems
28. Carrying out spirometry and spirometry, calculating the proper values, physiological assessment of the obtained indicators	Defense of practical work. Solving situational problems
29. Carrying out peakflowmetry, calculating the proper values, physiological assessment of the obtained indicators	Defense of practical work. Solving situational problems
30. Physiological assessment of the flow-volume curve, calculation of the Tiffeneau index and its physiological assessment	Defense of practical work. Solving situational problems
31. Determination of the strength of respiratory muscle	Defense of practical work. Solving situational problems
32. Calculation of blood oxygen capacity and oxygen utilization coefficient, their physiological assessment	Defense of practical work. Solving situational problems
33. Carrying out pulse oximetry and physiological assessment of the hemoglobin oxygen saturation curve	Defense of practical work. Solving situational problems
34. Determination of functional reserves of the hemocardiorespiratory system according to bicycle ergometry and ECG data	Defense of practical work. Solving situational problems
35. Carrying out sialometry and physiological assessment of the obtained indicators	Defense of practical work. Solving situational problems
36. Calculation of the proper values of basal metabolic rate and total energy expenditure of the body	Defense of practical work. Solving situational problems
37. Determination of energy consumption by the method of indirect calorimetry with complete and incomplete gas analysis, calculation of the respiratory coefficient and its physiological assessment	Defense of practical work. Solving situational problems

38. Assessment of human height and body weight, calculation of body mass index, physiological assessment of the obtained indicators and the formation of scientifically based recommendations for body weight correction	Defense of practical work. Solving situational problems
39. Drawing up a diet based on data on the body's total energy expenditure	Defense of practical work. Solving situational problems
40. Measurement of axillary body temperature using glass (liquid) and electronic thermometers, assessment of possible errors during execution, physiological assessment of the obtained results	Defense of practical work. Solving situational problems
41. Calculation of glomerular filtration rate based on inulin (creatinine) clearance, physiological assessment of the results obtained	Defense of practical work. Solving situational problems
42. Physiological assessment of the composition and properties of final urine	Defense of practical work. Solving situational problems
43. Assessment of integrative brain functions	Defense of practical work. Solving situational problems

LIST OF EQUIPMENT USED

1. A set of containers for disinfection of biological materials and equipment, small (100-300 ml) and large (1-5 l)
2. A set of disposable mouthpieces, masks, connecting hoses for spirometry and pneumotachometry
3. A set of laboratory glassware and equipment (graduated and non-graduated test tubes, flasks, pipettes, burettes, funnels; tripods, rubber and ground glass stoppers, cups, pen for glass, cotton wool, tweezers, round glass rods, glass rods with a spatula, dissecting needle, scissors surgical, eye scissors, glass tubes, rubber tubes; litmus paper), gauze, cotton wool
4. A set of monoclonal reagents for blood typing in AB0 and Rh systems
5. A set of standard sera for blood typing in AB0 system and a reagent for blood typing in Rh system
6. A set of tuning forks
7. Adaptometer
8. Aesthesiometer (Weber compasses)
9. Alcohol lamp
10. Audiometer (sound generator)
11. Automatic tonometer
12. Barani chair
13. Bicycle ergometer

14. Biological material of an experimental animal (rat): blood, blood plasma, intestines
15. Biological potentials amplifier
16. Body composition monitor
17. Capillaroscope (with video adapter)
18. Chamber for collecting alveolar air
19. Couch
20. Deadlift dynamometer (for back muscles)
21. Donders model
22. Dry air spirometer
23. Electrically conductive paste
24. Electrocardiograph
25. Electrodes (push-button metal; plate metal; disposable surface; "crocodile" type; bridge-shaped for EEG recording)
26. Electroencephalograph
27. Electromyograph
28. Electromyoreflexometer
29. Electronic thermometer
30. Eye shield
31. Filter paper
32. Floor scales
33. Forster perimeter
34. Gas analyzer
35. Glucometer
36. Harris-Benedict tables
37. Headphones
38. Height meter
39. Hourglass at 5 minutes
40. Infrared thermometer with the ability to determine body temperature and surface temperature
41. Ionometer (pH meter)
42. Laboratory dynamometer
43. Lancet device
44. Magnifier
45. Manual dynamometer
46. Maximum medical glass thermometer
47. Mechanical tonometer with phonendoscope
48. Microscope
49. Mixer for leukocytes
50. Mixer for red blood cells
51. Neurological flashlight
52. Neurological hammer with needle and brush
53. Nomograms (DuBois to determine the body surface area; to determine the minute volume of respiration; to determine the proper values of indicators of human physical development)

54. Nose clip
55. Objects of different colors for perimetry
56. Oscilloscope
57. Osmometer
58. Oxyhemograph
59. Panchenkov device with Panchenkov capillaries
60. Personal Computer
61. Phonendoscope with tubes of different lengths
62. Pneumotachograph
63. Pneumotachometer (peakflowmeter)
64. Pointer
65. Polychromatic tables of Rabkin or Ishihara
66. Projector
67. Pulse oximeter
68. Ruler
69. Sali hemometer in the set
70. Sanitary clothing (rubber gloves, masks, goggles or face shield, waterproof apron and sleeves)
71. Set of weights 0.5-3 kg
72. Sets of chemical reagents (distilled water, NaCl, sodium bicarbonate, glucose, ammonia, hydrochloric acid, Lugol's or iodine solution, Ringer's solution, hydrogen peroxide, monosodium glutamate, quinine or benzalkonium chloride, citric acid, acetic acid, sodium citrate or EDTA, methylene blue, a set of buffers for calibrating the ionometer, saccharin; egg white or fibrin, gastric juice; starch; bile; vegetable oil)
73. Sets of electrocardiograms, phonocardiograms, polycardiograms, and electroencephalograms
74. Spirograph automatic
75. Standard cap for EEG recording
76. Standard correction (proofreading) tables
77. Sterile scarifiers (lancets) are disposable
78. Stopwatch
79. Tables for determining visual acuity (Golovin, Sivtsev, Orlova) in a lighting apparatus
80. Tables with digital and letter complexes
81. Tablets for determining blood groups
82. Tape measure 5m
83. Test strips for general urine analysis
84. Thermostat or water bath
85. TV set
86. Watch slides, flat slides, slides with a Goryaev grid, cover slips
87. Water spirometer
88. Water thermometer (0-50 oC)
89. Wrist heart rate tachometer.

**PROTOCOL OF THE CURRICULUM APPROVAL
BY OTHER DEPARTMENTS**

Title of the discipline requiring approval	Department	Offers for amendments to the curriculum in the academic discipline	Decision of the department that designed the curriculum (date, protocol #)
1. Psychology of Interpersonal Relationships	Psychiatry and Medical Psychology	There are no offers	Take into account 23.05.2024, protocol # 20
2. General Surgery	General Surgery	There are no offers	Take into account 23.05.2024, protocol # 20
3. General Hygiene	General Hygiene	There are no offers	Take into account 23.05.2024, protocol # 20
4. Radiation Medicine and Ecology	Radiation Medicine and Ecology	There are no offers	Take into account 23.05.2024, protocol # 20
5. Pathological Physiology	Pathological Physiology	There are no offers	Take into account 23.05.2024, protocol # 20
6. Pharmacology	Pharmacology	There are no offers	Take into account 23.05.2024, protocol # 20
7. Propaedeutics of Internal Diseases	Propaedeutics of Internal Diseases	There are no offers	Take into account 23.05.2024, protocol # 20
8. Obstetrics and Gynecology	Obstetrics and Gynecology	There are no offers	Take into account 23.05.2024, protocol # 20

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24.06. 2024

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