MINISTRY OF EDUCATION AND SCIENCE OF THE RUSSIAN FEDERATION

PENZA STATE UNIVERSITY

MEDICAL INSTITUTE

APPROVED:
Director of the Medical Institute
_____ A.N. Mitroshin
марта 20_16_ г.

STUDY PROGRAMME

C1.2.2 Physiology of functional systems

Course – 31.05.01 General Medicine

Graduate's Degree – Medical Doctor

Type of study – full-time

Penza, 2016

1. Objectives of the discipline

The purpose of discipline "Physiology of functional systems" is to train students systemic way of thinking based on the analysis of the nature and structure of the relationship between the organs and systems with integrated physiology position for future medical practice. This is especially important for students to understand the laws of the work of the whole organism and the development of clinical thinking.
The goals of the study discipline "Physiology of functional systems" are:
- Formation of skills of the analysis of the whole organism functions from the perspective of integrated physiology and analytical methodology;
- Formation of a systematic approach to understanding the physiological mechanisms underlying the implementation of the body's functions from the perspective of the concept of functional systems;
- The research of methods for studying the functions of the organism in an experiment, and also used for diagnosis in clinical practice.

2. Place the discipline in the structure of basic professional educational programs

Academic discipline "Physiology of functional systems" refers to the variable part of the block C1. "The physiology of functional systems" is one of the basic (clinical) disciplines, which is connected with the disciplines:
- In the cycle of humanitarian, social and economic disciplines: philosophy, bioethics, psychology and pedagogy;
- In a series of mathematical, natural sciences and biomedical sciences: chemistry, biology, biochemistry, anatomy, histology, cytology and embryology.
"The physiology of functional systems" is prior to the study of professional disciplines cycle.

3. Competences of the student, formed as a result of studying the discipline "Physiology of functional systems"

The process of studying the discipline is aimed at the formation of the elements of the following competencies in accordance with the federal state educational standards of higher education in this specialty:

Competency code	Title of competency	Structural elements of competency (as a result of studying the discipline the student should know and be able to own)
GEC-1	abstract thinking, logical analysis and synthesis skills	Knowledge: anatomical and physiological and psychological characteristics of a human; outstanding figures of medicine and the development of medical science.
		Skills: analyze problems and identify the person at different ages, associated with lack of knowledge, skills and health promotion skills.
		Working abilities: biomedical conceptual apparatus;
GPC-9	the capacity for evaluation of morphological and functional, physiological conditions and pathological processes in the human body for decision of professional tasks	Knowledge: morpho-functional characteristics of muscle, nerve, blood, cardiovascular, respiratory, digestive, excretory systems, central and peripheral nervous systems, sensory systems and the glands of internal secretion in adults.
		Skills:

Competency code	Title of competency	Structural elements of competency (as a result of studying the discipline the student should know and be able to own)
		evaluate the morphological and functional and physiological state of the human body, differentiated muscle tissue, parts of the central nervous system of the heart, blood vessels, blood cells, the respiratory tract, the departments of the nephron.
		Working abilities: biomedical conceptual apparatus.

4. The structure and content of the discipline "Physiology of functional systems"

4.1. The structure of the discipline

General work load of the subject totals 4 credit units, 144 hours.

№	Subject's (module's) sections and topics	Semester	Week of the semester	Types of training activities, including independent work of students and laboriousness (in hours)									Current progress monitoring types (by semester's weeks)							
				Class work				Out-of-class work												
				Total	Lecture	Practical lessons	Laboratory classes	Total	Class study preparation	Report paper	Course work (project)	Exam preparation	Interview	Tutorial	Tests assessment	Checking the test papers	Research paper assessment	Workbook assessment	Term paper (project)	Assessment of practical skills
1.	The theory of functional systems. General principles of the functioning of the whole organism. The basic properties of functional systems. The holographic principle of the functional systems.	3	1	5	2	3		3	3				1		1					
2.	Interaction of functional systems in the body.	3	2	5	2	3		3	3				2		2					
3.	Elementary physiological processes. System organization of pathways.	3	3	5	2	3		3	3				3		3					
4.	Neuromuscular physiology	3	4	5	2	3		3	3				4		4					
5.	Neurohumoral regulation of physiological functions.	3	5	5	2	3		3	3				5		5					

№	Subject's (module's) sections and topics	Semester	Week of the semester	Types of training activities, including independent work of students and laboriousness (in hours)																
				Class work				Out-of-class work												
				Total	Lecture	Practical lessons	Laboratory classes	Total	Class study preparation	Report paper	Course work (project)	Exam preparation	Interview	Tutorial	Tests assessment	Checking the test papers	Research paper assessment	Workbook assessment	Term paper (project)	
6.	The functional systems of homeostatic level. The functional system providing optimal metabolism of circulating blood volume.	3	6	5	2	3		2	2				6		6					
7.	The functional system supporting optimal metabolism in the body pH level. The acid-base status. The functional system supporting optimal metabolism for the amount of glucose	3	7	5	2	3		3	3				7		7					
8.	The functional system providing optimal for metabolism blood pressure	3	8	5	2	3		2	2				8		8					
9.	The functional system for maintaining optimal values of the respiratory parameters	3	9	5	2	3		3	3				9		9					
10.	The functional system, which determines the optimal level of nutrients for metabolism in the body	3	10	5	2	3		2	2				10		10					
11.	The functional system that supports optimal temperature of the body for the metabolism	3	11	5	2	3		2	2				11		11					
12.	The functional system, which determines the optimal level of the osmotic pressure for metabolism in the body.	3	12	5	2	3		2	2				12		12					
13.	The functional urinary system	3	13	5	2	3		2	2				13		13					

№	Subject's (module's) sections and topics	Semester	Week of the semester	Types of training activities, including independent work of students and laboriousness (in hours)									Current progress monitoring types (by semester's weeks)							
				Class work				Out-of-class work												
				Total	Lecture	Practical lessons	Laboratory classes	Total	Class study preparation	Report paper	Course work (project)	Exam preparation	Interview	Tutorial	Tests assessment	Checking the test papers	Research paper assessment	Workbook assessment	Term paper (project)	Assessment of practical skills
14.	Development of systems. System organization of congenital and acquired behavior	3	14	5	2	3		2	2				14		14					
15.	The functional unit of the integrative activity of the organism. Motivation as a component of systemic architectonics of behavioral acts	3	15	5	2	3		3	3				15		15					
16.	Analyzers	3	16	5	2	3		4	4				16		16					
17.	Memory as a component of systemic architectonics of behavioral acts. Emotions as a component of systemic architectonics of behavioral acts	3	17	5	2	3		2	2				17		17					
18.	System organization of human mental activity. System mechanisms of pain. Sleep as a system process.	3	18	5	2	3		3	3				18		18					
19.	System mechanisms work. System recovery mechanisms.	3	19	5	2	3		2	2				19		19					
	General workload, in hours			95	38	57		49	49				Interim attestation							
													Type			Semester				
													differentiated pass-fail exam			**3***				

4.2. Contents

1. General properties of functional systems

The origins of the theory of functional systems.

The concept of the body, its constituent elements. Levels of structural and functional organization of the human body. Normal physiology - the study of the mechanisms and processes of the vital activity. Relations of physiology and other sciences, including hygiene. Physiology as the scientific basis of medicine. Stages of development of physiology.

The basic properties of functional systems.

The interaction of the organism with the external environment (biological, industrial, social). A systematic approach to the study of the body's vital processes. Fundamentals of intercellular communication, information exchange, and the regulation of physiological functions of the cell. The interaction of the organism with the existence of the environment. The concept of chemical signaling.

2. FS interaction.

Self-organization of functional systems.

Functional System (P.K. Anochin), self-regulation principle. The dominant role of the result. Self-regulation. Isomorphism in the functional systems. The holographic principle of the organization of functional systems. The electoral mobilization of organs and tissues. Cooperation of elements of the functional systems contributing to the achievement of results. Information properties of functional systems. Conservatism and the plasticity of functional systems.

Interaction of functional systems in the body. The hierarchical dominance of functional systems. Multiparameter interaction of functional systems. Consistent interaction of functional systems. System quantization of vital functions. The systems development - systemogenesis. Prenatal systemogenesis. Postnatal systemogenesis. The functional unit of the integrative activity of the organism. The concept of the unity of organism and environment of its existence.

The concept of physiological functions and processes.

The main methods of intercellular communication involving chemical signals, their characteristics. The concept of molecular (cell) receptors and their ligands, primary and secondary intermediaries. Classification, structure and function of molecular receptors. Types of signaling molecules (ligands). Ligand-receptor interaction. The main pathways of intracellular signal transduction involving membrane and intracellular receptors. Modern understanding of second messenger system. The main physiological effects of ligand-receptor interaction at the cell level.

3. Neuromuscular physiology.

The concept of electrical signaling. Excitability.

Electrical signaling, and its use for the regulation of physiological functions.

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

Stimuli classification. The properties of stimuli that are important for the occurrence of excitation. Indicators (parameters) of excitability (the force threshold, the time limit, the minimum gradient of irritation). The concept of rheobase and chronaxia. The ratio between the strength of the stimulus and the time of its action on excitable tissue, having a value for the emergence of agitation. Curve "force - duration". The concept of lability (N.E.Vvedensky).

Laws describing the response of excitable tissues to the action of stimuli (the law of force, the duration, "All or Nothing", irritation of the gradient, etc..). The reaction of excitable tissues to the action of a constant electricity (polar law).

Ion channels. Generation of bioelectric potentials. Sensory receptors.

Modern ideas about the structure of the membranes of excitable cells features. The concept of passive, voltage-gated, ligand-dependent and other types of ion channels. The concept of ion pumps, ion exchange mechanism of transport. The ionic gradients and their role in causing the electric potential of cells.

Bioelectrogenesis. Biopotentials as carriers of information in living organisms.

Types of biopotentials. Sensory receptors. The concept of the receptors perceiving the stimulus of external and internal environment of the body. The role, classification, basic properties (high sensitivity to an adequate stimulus, background impulses, adaptation, etc.). Mechanisms of stimulus energy conversion in nerve activity in primarily- and secondary-sensory receptors. The concept of the principles of analog and discrete encoding in the receptors. Receptive field and reflexogenic zone. The concept of membrane associated sensory receptors (photoreceptors, olfactory receptors) and intracellular mechanisms of origin of the receptor potential.

The resting potential, its genesis, mechanism of maintaining of the rest potential (selective permeability of the cell membrane, the work of K- Na pump, etc.).

Modern understanding of the mechanisms and phases of the action potential. Comparative characteristics of the local response and action potential. Changes in the excitability of excitement. Refractory, its causes and significance.

The genesis and conduction of nerve impulses. Synaptic transmission

The appearance of nerve impulses in the sensory receptors and axon hillocks. Nerve fiber. The physiological role of the structural elements of the nerve fiber. Mechanism and laws of nerve impulses along the nerve fiber. Axonal transport of substances, its value. Growth Factors. Characterization of the nerve fibers of type A, B, C.

Synapse. Structure and classification of synapses and their physiological role. Modern understanding of the mechanisms of signal transmission at synapses. Mediators, their classification, synthesis, secretion, synaptic cleft in transition, the interaction with the receptors of the postsynaptic membrane. Postsynaptic potentials. General properties of synapses (the neuromuscular synapse). The participation of synapses in regulating of intracellular processes. The concept of ionotropic and metabotropic receptors. The notion of the possibilities to influence the postsynaptic cell function through its influence on the processes of synaptic signaling.

Skeletal muscle. The physical and physiological properties of skeletal muscles. Types and modes of contraction. A single muscle contraction and its phases. Summation of contractions, tetanus. The dependence of the amplitude of muscle contraction on the frequency of stimulation. Optimum and pessimum (N.E.Vvedensky). Muscle tone. Strength and muscle work. Law medium loads. The types of muscle fibers. Motor units and their characteristics in different muscles. Changes in muscle, coming after denervation. Physiological substantiation of application of methods of delaying development of muscle atrophy, and promote the restoration of their functions (electrical stimulation, massage, etc.). The mechanism of contraction and relaxation of single muscle fibers and muscle (sliding filament theory and screwing). The concept of the nature of skeletal muscle tone. Electromyography.

Metabolism in the muscle, as in organ at rest conditions and at different levels of physical activity (blood flow, oxygen, nutrients and energy consumption). The notion of the possibilities to influence the contraction of the muscles by affecting the signaling processes in the neuromuscular junction (the effect of Botox, acetylcholinesterase inhibitors, n-cholinergic receptors blockers).

Smooth muscle. Physiological properties and characteristics of smooth muscle compared to skeletal muscle. Transmission signals of the nerve fiber on smooth muscle. Types of mediators. Smooth muscle fibers receptors (alpha and beta-adrenergic receptors, m-cholinergic receptors, et al.). Mechanisms of contraction and relaxation of smooth muscle.

Features of regulation of smooth muscle contraction (force, duration, tone). The role of calcium ions in smooth muscle function implementation. The concept of the nature of the tone of smooth muscles. Effects on smooth muscle tone through its influence on the transmission process and the perception of signals of smooth muscle receptors.

Changes in the peripheral nervous system, synaptic transmission in the muscle tissue in the aging process.

4. The concept of the signaling mechanisms of regulation of physiological functions.

The concept of the system principle of organization and regulation of functions. Nervous and humoral mechanisms of regulation of body functions. Regulation levels: cellular, tissue, organ, organism. Types of regulations (by perturbation and rejection).

The functions of the central nervous system and its role in ensuring the integrity of life of the organism and its relationship with the environment. The concept of the central and peripheral nervous system. Methods of study of the nervous system.

Neuron. Functional classification of neurons. Physiological properties of nerve cells and the functions of the structural elements of the neuron (soma, axon, dendrites). Morphological and biophysical characteristics of neurons that provide their specific functions (perception, integration, communication). Features of the emergence and spread of excitation in the neuron.

Combinations of neurons in the neural circuit. Types and functions of these associations. Basic principles of propagation of excitation in nerve circuits (divergence, convergence, reverb, etc..). Determinancy and variability of neuronal circuits. The concept of pathways and their functions. Other structures and cells of the nervous system. The role of the glia.

Features of the structure and functions of the central nervous system synapses in comparison with peripheral synapses. Neurotransmitters. The nerve centers. The physiological concept of the nerve center. The functions of the nervous centers, their properties (spatial and temporal summation, transformation of excitation rhythm, tone, flexibility, fatigue of nerve centers). Afferent and efferent neural pathways, their varieties and functions.

The reflex principle of functioning of the nervous system (R. Descartes, G. Prohazka, I. M. Sechenov, I. P. Pavlov, P. K. Anohin). Reflex - adaptive response of the body to the action of stimuli. Types of reflexes. The concept of the reflex arc. Feedback and its value. Multi-level organization of the reflex. Substrate, mechanism and forms of neuron excitation in the nerve center.

Inhibition of the nervous system (I.M. Sechenov, F. Golts). Modern understanding of the mechanisms of central inhibition (G. Ekkls, Renshaw). Types of inhibitory processes: primary (postsynaptic, presynaptic), secondary (pessimal, braking after excitation).

The interaction of excitation and inhibition - the basis of coordination of the central nervous system. The basic principles of coordination: the principle of the dual (reciprocal) inhibition, total final way principle (Ch.Sherrington), the dominant principle (A. A. Ukhtomskii), reverse afferentation principle (P. K. Anohin). The interaction between the various levels of the CNS functions in the regulation process. The notion of the integrative activity of the central nervous system.

Features of brain metabolism and maintenance of the system of cerebral circulation. Life expectancy of brain neurons in hypoxia, anoxia, hypothermia, hyperthermia. Possibility of recovery of brain functions. Time of cardiopulmonary resuscitation. The concept of the structure and function of the blood-brain barrier (BBB). Features of the BBB in different parts of the brain and in various states of the organism. Role of cerebrospinal fluid in brain activity. The indicators characterizing the composition, properties of liquor and liquor dynamics in the norm.

Age-related changes in the central nervous system.

Private physiology of the central nervous system.

Spinal cord. Structural and functional organization. Reflex activity of the spinal cord. Sensory functions of the spinal cord. Perception and processing of signals from the skin receptors and proprio- interoceptors. Motor function. Spinal mechanisms regulating muscle tone, posture and movement. Conductor of spinal cord function. Afferent and efferent conductive paths of the spinal cord. Autonomic function. Spinal mechanisms of regulation of autonomic functions (regulation of vascular tone, the internal organs, activity of the sweat glands, and others.). Integrative function. Distribution of muscle tone, the organization of complex movements. Spinal mechanisms of integration of somatic and autonomic functions. Clinically significant of spinal reflexes in humans (somatic and autonomic).

Brainstem. Medulla. Structural and functional organization. Sensory functions of the medulla oblongata. Perception and processing of signals from the skin receptors and proprio- interoceptors, taste and auditory receptors and receptors of the vestibular apparatus. Motor functions. Regulation of muscle tone, posture and movement. Conductor function. The afferent and efferent pathways. Autonomic function. Bulbar mechanisms regulating vascular tone. Vasomotor center. Reflex cardiovascular regulation. Respiratory Center. Regulation of functions of the digestive system and other internal organs. Integrative function. Distribution of muscle tone, posture maintenance, organization of complex movements. Integration of autonomic functions. Integration of somatic and autonomic functions. Protective reflexes.

The midbrain and the bridge. Structural and functional organization. Sensory functions. Perception and processing of signals from the skin receptors, proprioceptors. Processing of visual and auditory information. Conductive sensory pathways. Motor function. Regulation of muscle tone, posture and movement. Oculomotor function. Autonomic function. The conductive path of the autonomic nervous system. Pupillary and other reflexes. Integrative function.

Organization of indicative, visual and auditory reflexes, "startle response", apprehension reaction. Organization of complex movements, the integration of the autonomic and somatic functions (chewing, swallowing, etc.), Regulation of breathing.

Cerebellum. Structural and functional organization. Participation in the implementation of touch functions. Perception and processing of information from the skin receptors, proprioceptors, vestibular receptors, visual and auditory systems and from the cerebral cortex. Motor function. Participation in the distribution of muscle tone, posture organization, participation in the implementation of targeted slow and fast ballistic movements, participation in motor part program correction. Autonomic function. Participation of the cerebellum in the regulation of the cardiovascular, respiratory, digestive and other systems. Integrative function. Integration of sensory and motor functions.

Reticular formation of the brain stem. Structural and functional organization. Descending and ascending reticular formation influence on the central nervous system activity. The participation of the reticular formation in maintaining and redistribution of muscle tone, in the regulation of autonomic functions. The participation of the reticular formation in the integrative activity of the central nervous system.

Thalamus. Structural and functional organization. Basic sensory and motor pathways. Functional characterization of thalamic nuclei. Participation of thalamus in the formation of pain and the implementation of higher integrative functions of the brain.

Hypothalamus. Structural and functional organization. Participation in the implementation of sensory functions. Communications of hypothalamus with the cerebral cortex and other parts of the brain. Neurosecretory cells. Properly sensory neurons of the hypothalamus (thermo-, osmosensitive, and others). Polysensory neurons. Endocrine function (hypothalamic hormones and releasing factors). Autonomic function. Higher centers of the autonomic nervous system. Inegrativnye function. The integration of neuroendocrine functions, integration of somatic and autonomic functions, participation in the implementation of higher integrative functions of the brain.

The limbic system. Structural and functional organization. The role in the formation of motivation, emotion, memory organization. The participation of the limbic structures in the integrative activity of the central nervous system.

The basal nuclei. Structural and functional organization. The integrating function of the basal ganglia in the organization and implementation of complex movements. The role of dopamine and acetylcholine in neurotransmitter systems.

Cortex. Structural and functional organization. The modules (columns) as examples of structural and functional units. The role of the cerebral cortex in the formation of the system of the organism. Modern views on the localization of functions in the cortex. The plasticity of the cortex.

Influence of physical and mental work on the functional state of the central nervous system.

Regulation of muscle tone, maintenance of posture and movement organization.

Structural and functional basis of multi-level system of muscle tone regulation, maintenance of posture and movements organization. Proper mechanisms of the spinal cord, providing the regulation of muscle tone. The spinal cord is a common final pathway for supraspinal CNS departments in the mechanisms regulating muscle tone, posture and maintain the organization of movements. Changes in the structure and function of muscles during hypodynamia, inactivity, denervation. Changes in muscle tone and movement in disfunction of the spinal cord, brain stem, cerebellum, basal ganglia, cerebral cortex. Theoretical basis of the correction of tone violations, muscles trophism and movements. The importance of electrical diagnostic and electrical stimulation in the prevention of muscle atrophy and restoration of their functions in violation of innervation, hypodynamia and other conditions.

Age characteristics of the functions of central nervous system.

Autonomous (vegetative) nervous system.

The role of the autonomic (vegetative) nervous system (ANS) in the maintenance of the body's vital functions. ANS functions. Comparative characteristics of the structure and the physiological properties of the ANC and the somatic nervous system (afferent, central, efferent divisions). Comparison of the structure and physiological properties of the sympathetic and parasympathetic divisions of the ANS. The concept of metasympathetic nervous system. Autonomic ganglia, their functions (transmission, reflex, integrative). Preganglionic and ganglionic neurons and their axons: morphological, functional and neurochemical differences. Neurotransmitters and their receptors, ANS effector cells. The concept of the principles of correction of autonomic functions by affecting the neurotransmitter-receptor mechanisms.

General characteristics of the influence of the sympathetic and parasympathetic divisions of the ANS on the effector organs, sensory function. Synergies and relative antagonism of their effects. Autonomic reflexes. The centers of the autonomic nervous system, their tone. The interaction of somatic and ANS in the regulation of body functions. Adaptive-trophic function of the ANS. Participation in the integration of ANS functions in the formation of integral behavioral acts. ANS providing somatic functions. Age-related changes in the autonomic nervous system.

Neurohumoral regulation of physiological functions.

The endocrine system, the physiological role and regulation of the hormones formation.

The importance of the endocrine systems in vital activity. Modern understanding of the functions of the endocrine system (endocrine glands, diffuse elements). General characteristics of the endocrine glands, characteristics and classification of hormones. The mechanisms of action of hormones, idea of hormone receptors and second messenger system. Regulation of hormone secretion by various glands and endocrine cells. The relationship of the endocrine glands and nervous system. Role of endocrine system in the regulation of homeostasis. Techniques for studying the functions of the endocrine glands.

Mechanisms of hormonal regulation of physiological functions.

Pituitary gland. Functions of pituitary gland. Morphological and functional connections of pituitary gland and hypothalamus. The hormones of the pituitary gland and hypothalamus, their role in the regulation of endocrine and not endocrine organs. The interaction of neural and humoral regulatory mechanisms on the hypothalamic level. The most frequent disorders of the endocrine function of the pituitary gland and hypothalamus.

Epiphysis, its endocrine function.

Thyroid gland. Iodine-containing thyroid hormones, mechanisms of their action and effect. Influence of thyroid hormones on the process of maturation of the central nervous system. Effects of hypothyroidism for the central nervous system of the fetus and newborn. The role of thyroid hormones in the adaptation process. Regulation of hormone secretion. Typical symptoms of excess or insufficient hormone production. Calcitonin.

Parathyroid glands. Parathyroid hormone.

Regulation of calcium and phosphorous in the human budy. Effect of calcitonin, parathyroid hormone and vitamin D on the exchange of calcium and phosphorus. The daily requirement for calcium and their sources.

The adrenal glands. Hormones of the adrenal cortex and adrenal medulla. The mechanisms of action of hormones and the effects caused by them. Regulation of hormone secretion. Typical symptoms of excess or inadequate secretion of hormones. Regulation of the endocrine functions of the adrenal glands.

Gonads. Sex hormones. The mechanisms of action of hormones and the effects caused by them. Mechanisms of regulation of hormone secretion. Typical symptoms of excess or insufficient hormone production. Age features of the endocrine function of sex glands. The endocrine function of the placenta. The concept of the reproductive system of the body.

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

Thymus. The concept of APUD-system of intestinal. The endocrine function of the heart. The endocrine function of the liver. The endocrine function of the kidneys. Hormonal mechanisms for maintaining fluid and electrolyte balance in the body (antidiuretic hormone, renin-angiotensin-aldosterone system, atrial natriuretic factor, prostaglandins). Hormonal mechanisms of regulation of body weight (leptin, ghrelin, insulin, cholecystokinin). The participation of the endocrine glands in the adaptive activity of the organism. General adaptation syndrome, ctress. The concept of stress-realizing and stress-limiting systems of the body.

Age-related changes in endocrine functions.

Functional systems

1. Functional systems of homeostatic level.

Homeostasis. Blood functions and their mechanisms. Mechanisms of regulation of homeostasis. Body fluids (blood, lymph, intercellular fluid, intracellular fluid, cerebrospinal fluid, etc.), their distribution in the body. The concept of the internal environment of the body.

Blood. The concept of the blood system (G.F.Lang). The composition, the main function of the blood. Major physiological blood constants characterizing homeostasis. Electrolyte composition of the blood plasma. The osmotic pressure of the blood and its regulation role in electrolyte and water exchange between blood and tissues. The concept of a state of hyper- and dehydration of tissues. Blood plasma proteins, their classification and importance. Plasma oncotic pressure and its role. The rheological properties of blood. Acid-base status of the blood. Physico-chemical and physiological mechanisms that support the constancy of blood pH. The concept of acidosis and alkalosis, mechanisms of their occurrence.

Lymph, its quantity, composition, physical and chemical properties and functions.

Liquor. Physico-chemical properties. CSF functions. The importance of the study of cerebrospinal fluid for the diagnosis. Other body fluids (interstitial, intracellular et al.), Their composition, physico-chemical properties and physiological role.

Hematopoiesis. Hemostatic system.

Hematopoiesis: stem cell theory. Age features of hematopoiesis (the embryo, fetal, adult). The role of the microenvironment of the stem cells in the hematopoiesis. Properties and functions of the hematopoietic pluripotent stem cells and other progenitor cells of committed mature blood cells. The notion of the possibilities of differentiation of embryonic stem cell and other cell types. Nervous and humoral mechanisms of regulation of hematopoiesis. The concept of the signaling molecules that are important for the regulation of hematopoiesis [main group of cytokines (growth factors of hematopoietic cells, interleukins, interferons, non-hematopoietic cell growth factors), hormones, neurotransmitters, etc.], Their origin. The role of cytokines and other signaling molecules in the regulation of self-renewal, differentiation, proliferation and apoptosis in these cells.

Hematopoiesis: stem cell theory. Age features of hematopoiesis (the embryo, fetal, adult). Role of stem cell microenvironment in hematopoiesis. Properties and functions of the hematopoietic pluripotent stem cells and other committed progenitor cells of mature blood cells. Properties and functions of the hematopoietic pluripotent stem cells and other progenitor cells of committed mature blood cells. The notion of the possibilities of differentiation of embryonic stem cell and other cell types. Nervous and humoral mechanisms of regulation of hematopoiesis. The concept of the signaling molecules that are important for the regulation of hematopoiesis [main group of cytokines (growth factors of hematopoietic cells, interleukins, interferons, non-hematopoietic cell growth factors), hormones, neurotransmitters, etc.], their origin. The role of cytokines and other signaling molecules in the regulation of self-sustaining, differentiation, proliferation and apoptosis in these cells.

The significance and the body needs essential nutrients, vitamins and minerals to maintain normal hematopoiesis. The general concept of violations of hematopoiesis with a deficit of supply of these substances in the body.

The concept of erythron. Erythropoiesis and destruction of red blood cells, their age features. Erythropoietin and its role in regulating of erythropoiesis. The products of destruction of red blood cells. Features of the structure and properties of red blood cells, ensuring their functions. The number of red blood cells, counting techniques. Hemoglobin and its functions. Features of the structure and properties, ensuring the implementation of its functions. Types of hemoglobin, quantity, methods for the determination. Color index and

its calculation. The concept of anemia. Hemolysis. Types of hemolysis. Erythrocyte sedimentation rate (ESR) and the factors influencing it.

White blood cells, their types, quantity, counting methods. Features of the structure and properties, ensuring their functions. The concept of leukocytosis and leukopenia. WBC count: agranulocytes and granulocytes, their types, number, functions, lifetime.

The concept of the T- and B-lymphocytes. The concept of the mechanisms of nonspecific and specific protection of the body.

Thrombopoiesis. Platelets (thrombocytes), their number, structure, function, lifetime. Thrombopoiesis regulation. The role of thrombopoietin.

The hemostatic system. Primary (vascular and platelet) and secondary (coagulation) hemostasis and its importance. Schmidt's enzymatic theory of hemostasis. Modern ideas about the main factors involved in blood coagulation (tissue, plasma, platelet, erythrocyte, leukocyte). The phases of blood clotting. Fibrinolysis. The role of the vascular wall in the regulation of blood clotting and fibrinolysis. Indicators of coagulation.

Key indicators of the blood test. Physiological assessment of the results. The concept of the age norms of basic indicators of blood. Diagnostic value of total blood analysis.

Influence of physical activity, atmospheric pressure, temperature, gas composition at the quantity and composition of the blood.

Blood groups. AB0 system. Rhesus (Rh)

Blood groups. AB0 system, HLA, Rh, and others. The basic principles of selection of donated blood. Risk factors for the recipient. Blood-substituting solutions, the requirements to them, their classification by type of functions they perform in the body.

Age characteristics of the blood system.

Hemodynamics. Functional indicators of blood circulation.

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

The basic laws of hemodynamics. Morphological and functional classification of the blood vessels. The concept of system, organ, and local blood flow. Factors contributing the movement of blood through the vessels. The volume and the linear velocity of blood flow in different parts of the vascular bloodstream, the factors determining them. The peripheral resistance of blood flow and its value. Blood pressure, its types: blood (systolic, diastolic, pulse, average), venous. The role of blood pressure; the factors that determine its value. Blood pressure in various parts of the vascular blood stream. Blood pressure at various functional conditions of the organism. The notion of "normal value" of blood preassure, age-related changes in blood pressure. Techniques for measuring blood pressure. Arterial pulse, its origins and characteristics. Pulse wave velocity, methods of research and registration. Blood flow in the venous vessels, venous return. The blood pressure in the veins. Central venous pressure. Venous pulse, research methodology and registration.

Microcirculation. Structural and functional characteristic of the main components of the microcirculatory straem. Capillary blood flow and its features. Pre- and post-capillary resistance, blood pressure in the capillaries of different organs. Transcapillary exchange of fluids and a substances between blood and tissues and its mechanisms. Factors influencing the processes of microcirculation and transcapillary exchange (hemodynamic parameters, properties of blood, the state of the vascular wall, lymph, interstitial fluid properties). The concept of delivery mechanisms in cells from interstitial spaces of oxygen, nutrients and other substances and removing carbon dioxide and other cell metabolites.

Blood circulation in the organs. Features of organ blood flow. Blood circulation in the brain, myocardium, lung and other organs, its regulation. The concept of the methods of studying the organ circulation.

Physiological properties and characteristics of the myocardium. Cardiac cycle. Polycardiography.

Physiological properties and characteristics of the heart muscle. The blood supply to the myocardium. The blood flow in the coronary vessels in systole and diastole. The consumption of oxygen and nutrients to the heart under conditions of relative rest and during exercise. The concept of the determinants of myocardial oxygen consumption.

The structure, physiological properties and functions of the cardiac conduction system. The modern concept of substrate, nature and gradient of cardiac automaticity. Interaction of the cardiac conduction system with typical cardiomyocytes. Excitation of the contractile cardiomyocytes and its mechanisms. The spread of excitation in the myocardium. Electromechanical conjugation. Contraction of cardiomyocytes, the role of calcium ions. Structure and physiological properties of the contractile myocardium. The laws of contraction of the heart. Myocardial contractility and its indicators.

Functions of atriums, ventricles and heart valves. The direction of blood flow. Connections of large and small cycles of circulation.

The structure of the cardiac cycle, the sequence of phases and periods. Valves position, pressure change and blood volume in the cavities of the heart in different phases of the cardiac cycle. The concept of preload and afterload. Comparative characteristics of the pumping function of the right and left ventricles. The systolic and minute volume of blood in conditions of relative rest and during exercise. The methods of their determination.

ejection fraction, cardiac index. Heart work. Cardiac reserve and coronary blood flow, their implementation during exercise.

External manifestation of the heart work. Electrical manifestations of cardiac activity. Electrocardiography (ECG). Formation of different ECG components. The general plan of analysis and standards criteria for ECG, its diagnostic value. ECG extrasystoles, myocardial ischemia. Sound manifestations of cardiac activity. Heart sounds and their origin. Auscultation and phonocardiography (PCG), their diagnostic value. Mechanical manifestations of cardiac activity. Apical impulse, arterial and venous pulse. Sphygmography (SG) and its diagnostic value. Ultrasonic cardiography. Invasive methods of investigation of cardiac activity. Polycardiography. A comparison of the periods and phases of the cardiac cycle, electrical (ECG), sound (PCG) and mechanical manifestations of cardiac activity over time.

Age-related changes in cardiac activity.

The regulation of the circulatory system as the maintenance of metabolic processes of the body. Adjustable parameters of the circulatory system: heart activity, vascular tone, blood volume, its structure and properties.

Regulation of cardiac activity (intracardiac and extracardiac mechanisms). Adjustable indicators of cardiac pump function: frequency rate, stroke volume, cardiac output blood flow. The effector mechanisms of regulatory effects on the heart. The role of intracellular calcium channels and mechanisms. Cardiac device to the body's needs.

Vascular tone, its nature. Regulation of vascular tone as the main mechanism for the maintenance of blood pressure in the systemic circulation and local blood flow. Reflex regulation of vascular tone. Vasomotor center: its afferent and efferent communications of influence. Humoral regulation of vascular tone. Vasoconstrictor and vasodilator endogenous substances. Mechanisms of fast and slow response.

Local mechanisms of regulation of circulation. The role of local metabolic factors in the regulation of arteriolar tone, local impact endothelial cell factors (angiotensin 2, endothelin, nitric oxide), myogenic regulation of arteriolar tone.

Functional system providing regulation of systemic blood pressure. Physiological background disturbances in blood pressure and the theoretical basis of the correction of these violations. Age features of a hemodynamics.

The lymphatic system, its structure and functions. Lymph formation and the mechanisms of its regulation. Factors ensuring lymph and the mechanisms of its regulation.

Recommendations for a healthy lifestyle to maintain normal function of the cardiovascular system and increase in its reserves. Hemodynamics during exercise and hypokinesia. Effect of reduction and the absence of gravitational forces on hemodynamics. Effect of physical and mental activity, emotional stress, environmental factors and manufacturing (temperature, humidity, barometric pressure, and others.) On the heart and circulatory system generally. The mechanism of these effects. Functional tests to assess the reserves and the risk of diseases of the cardiovascular system. The indicators of fitness of the cardiovascular system.

2. Functional system for maintaining optimal values of the respiratory parameters.

External respiration.

The role and place of the respiratory system in the body as a system serving the metabolic processes. Cellular respiration. The main stages of breathing (external respiration, gas transport system of blood, gas exchange).

External respiration. Physiology of the respiratory tract. Regulation of their clearance. The value of the ciliated epithelium. Respiratory cycle. Ventilation, its irregularity in different departments. The elastic properties of the thorax. Surfactant. The pressure in the pleural cavity, its role during breathing. The mechanism of inspiration and expiration. The work of the respiratory muscles. The relationship between pulmonary blood flow, ventilation and gravity.

Indicators of external respiration (vital capacity, respiratory minute volume, streaming characteristics of external respiration curve "flow - volume") and changes in obstructive and restrictive disorders. Spirometry, spirography, pneumotachometry.

Gas exchange in the lung. Composition of atmospheric and alveolar air. The partial pressure of oxygen and carbon dioxide in the alveolar air and blood. The relative constancy of the composition of the alveolar air. lung diffusion capacity. Factors influencing the processes of diffusion of oxygen and carbon dioxide between the alveolar air and blood.

Transport of blood gases. Hemoglobin compounds with gases. Factors influencing the affinity of hemoglobin for oxygen and carbon dioxide. The curve of binding of oxygen by hemoglobin and oxyhemoglobin dissociation. Oxygen capacity of blood. Transport of carbon dioxide.

Gas exchange between blood and tissues. The coefficient of oxygen utilization at rest and during exercise.

Regulation of breathing as a way to meet the needs of cell respiration and maintain blood gas constants (PO_2, pSO_2, pH). Adjustable external respiration: frequency, depth of breathing. Respiratory center, its departments. Mechanisms for respiratory periodicals. Receptors of airways, lungs and respiratory muscles. The

reflex reaction when they are irritated. Hering-Breuer reflex. Receptors of pH, CO2 and O2 in the body and their role.

The relationship between gas exchange and acid-base balance. A functional system supporting relatively constant of blood gas tension. Changes in external respiration during pH and blood gas change. The relationship between alveolar ventilation and blood flow in the pulmonary circulation, mechanisms providing consistency in a changing gas composition and blood pH. External respiration during muscular work, low and high air pressure. Physiological basis of " caisson disease " and " mountain sickness ". Impact of particulate air pollution on breathing. Effect of hyperventilation on the breath. Breathing at excessively intense physical activity: "dead point", "second breath ". Respiration and phonation. The first breath of the newborn. Hypoxia and its symptoms. Theoretical foundations of different types of artificial respiration. Age-related changes in breathing.

Functional reserves of the cardiovascular and respiratory systems of the body in the delivery of oxygen.

The interaction of the respiratory and cardiovascular systems in the implementation of the gas exchange. Their functional reserves in the delivery of oxygen. Indicators of reserves of both systems: ECG, maximum oxygen consumption (MOC), oxygen debt, the threshold of anaerobic metabolism and other. Age-related changes of reserves of the cardiovascular and respiratory systems.

3. Functional digestive system

Characteristics of the functional digestive system, the role and place of the digestive proces. Food motivation. Physiological mechanisms of hunger and satiety. Appetite. Pavlov's concept of food center. Types of digestion depending on the characteristics of the hydrolysis and its localization. Experimental and clinical research methods of the gastrointestinal tract. The importance of the work of Pavlov in the development of ideas about the functions and mechanisms of regulation of the secretory function of the digestive glands. Digestive and non- digestive function of the gastrointestinal tract.

Digestion in the mouth. Mechanical and chemical processing of food. Salivation, chewing, swallowing. The mechanisms of their regulation. The number, composition and properties of saliva. Role of saliva in digestion.

Digestion in the stomach. The composition and properties of the gastric juice. Role of hydrochloric acid and gastric mucus. Phases and mechanisms of regulation of the secretion of gastric glands (fasting and postprandial). The motor and evacuation functions of the stomach fasting and postprandial, their regulation.

Digestion in the duodenum. The role of the pancreas in digestion. The composition and properties of pancreatic juice. Fasting and postprandial mechanisms of regulation of pancreatic juice secretion. The role of the liver in digestion. Bile production and biliary excretion. The composition and properties of bile, its participation in the process of digestion. Mechanisms of regulation of bile formation and biliary excretion, fasting and postprandial.

Digestion in the jejunum and ileum. The composition and properties of the intestinal juice. Mechanisms of regulation of intestinal secretion. Abdominal and membrane hydrolysis of nutrients. Motor function of the small intestine and its regulation.

Digestion in the large intestine. The importance of colon microflora. The motor activity of the colon. Functional system providing the act of defecation.

Absorption of fat hydrolysis products, carbohydrates and proteins in various parts of the digestive tract and its mechanisms. Conjugation of hydrolysis and absorption (digestive-transport conveyor). Regulation of suction. Age features of digestion. Nervous, humoral and local mechanisms of regulation of digestive functions and their relationship in different parts of the gastrointestinal tract. The value of blood flow to the gastrointestinal tract for its vital functions.

Effect of work, hypokinesia, emotional stress on secretory, motor and absorptive function of the digestive tract. Digestion in various environmental conditions (heat, cold, high altitude, etc).

The concept of integrated indicators of metabolism and energy. The exchange of substances between the organism and the environment as a basic condition of life. Characteristics of the processes of anabolism and catabolism. The relationship between these processes in different conditions of life. Plastic role of metabolism. Essential nutrients. General understanding of the metabolism of fats, carbohydrates and proteins. Nitrogen balance. Positive and negative nitrogen balance. Energy role of metabolism. Energy sources.

The energy balance of the body. Methods for determining the energy consumption of the body (direct and indirect calorimetry). Caloric value of different nutrients. The caloric equivalent of oxygen. Respiratory rate. Basal metabolic rate, the amount and the factors determining it. Power consumption of the organism in a basal metabolism. The value of the study of basal metabolism. Power consumption of the body at different types of work (according to the severity of physical activity). Metabolism during limitation of physical activity. Thermogenic effect of food.

The principles of healthy eating. The balance of income and energy consumption. Using of data of the energy consumption of the body and the body's need for plastic materials for the preparation of food rations. The concept of normal body weight. The excess (obesity) and lack of body weight. Excessive consumption of fats and carbohydrates as risk factors for the development of diseases. Deposition processes and the use of the deposited nutrient (glycogen depot in the liver and muscles, fat depots). Daily rate of fat, protein, carbohydrates, essential vitamins, trace elements intake. Mechanisms regulating metabolism in human bodys. Integration of metabolism.

Features of metabolism in children. Features of metabolism in middle and old age. The importance of the nature of eating to preserve the health and reduce the impact of adverse environmental factors and working environment.

4. Functional system that maintains optimum temperature for the metabolism of the body.

The role and place of thermoregulation as a system to ensure optimal conditions for the occurrence of metabolic processes. The value of a constant internal environment of the body temperature for normal life processes. The concept of homeothermy, poikilothermy and geterotermy. Human body temperature and its daily fluctuations. The temperature of different parts of the skin and internal organs. Thermometry.

Physical and chemical thermoregulation. Sources of heat production in the body. Regulation of heat production processes.

Heat dissipation of the body. Physical processes that provide heat. Physiological mechanisms of regulation of heat transfer processes.

A functional system that provides a constant of internal temperature of the body. Nervous and humoral mechanisms of thermoregulation. Role of the central and peripheral receptors in the thermoregulation. Endo- and exopyrogens. Hyperthermia and fever. The protective role of fever. The concept of endo- and exopyrogens. Hypothermia.

Thermoregulation during muscular work in industrial and agricultural activities. Influence of environment temperature on the cardiovascular and respiratory systems. Effect of different environmental factors (temperature, humidity, air movement) and the indoor climate on the formation of sweat and perspiration. Increasing the body's resistance to high and low temperatures, the concept of hardening of the body. Age features of thermoregulation.

5. Functional system of uropoiesis and urination

The role and place of excretion as a system serving the metabolic processes. Excretory organs: kidney, skin, lungs, digestive tract. Their involvement in homeostasis.

Kidneys. Secretory and excretory function of the kidney. Nephron as a structural and functional unit of the kidney. Blood circulation in the kidney, its regulation.

The main processes of urine formation (glomerular filtration, tubular reabsorption and secretion). Mechanisms of glomerular filtration rate, the composition of primary urine. Reabsorption in the tubules and collecting ducts. Properties and mechanisms of reabsorption of substances. Swing-counterflow system. Secretory processes in the tubules. Synthesis processes in the kidney. The final urine and its composition. The importance of quantitative and qualitative analysis of urine for the assessment of body functions. Functional evaluation of the kidneys.

Regulation of the kidneys work.

Neurohumoral regulation of urine formation (filtration processes, reabsorption, secretion). Adjustable parameters (renal hemodynamics; volumetric filtration rate; reabsorption of water, glucose, Na, K, Ca, P, H, HCO3-, urea, etc.). The role of the kidneys in the maintenance of acid-base balance, osmotic pressure, ionic composition of blood, blood volume, blood flow in the systemic regulation of hematopoiesis, water and electrolyte balance. Adaptive changes in kidney function under different environmental conditions (stress, heat, cold, intense physical work, fluid and salt load and deprivation). Function and regulation of the urinary system (frequency, volume of urine, day and night diuresis). Regulation of urination. Clinico-physiological methods of investigation of kidney function. The concept of the consequences of the removal of a kidney. The concept of an artificial kidney dialysis and blood. Physiological basis of the possibility of regulation of the transplanted kidney. Age-related changes of urine formation and urine.

Functional system, which determines the optimal level of metabolism of the osmotic pressure in the body. Architectonics of functional system. The mechanisms of self-regulation of the osmotic pressure. Thirst motivation and salt motivation. Functional separation system. Functional evaluation of urine. Functional system providing urinate. A functional system of sweating. Elimination through the lungs and intestines.

System architectonics of behavioral acts.

1. The reflex principle of organization of behavior.

Rules of formation of conditioned reflexes. Classification of conditioned reflexes. The mechanism of formation of conditioned reflexes. Systemic principle of the organization of behavior. The result is a leading factor in the organization of behavior. Components of the systemic organization of behavior. Quantization of behavior. Quantums of behavior - system activity unit. Mixed quantization. Congenital forms of behavior (unconditioned reflexes and instincts), their importance for the adaptive activity of the organism. System organization of congenital and acquired behavior. "Systemic quantums" of congenital behavior. "Systemic quantums" of acquired behavior. Instincts. Programming behavior. Behavior in a changing environment. Acquired behavior. Genetic mechanisms of acquired behavior. Imprinting. Individual training. Programming of acquired behavior based on conditioned responses. Systemogenesis of behavioral acts. The general scheme of self-regulation of behavior. Adaptive role of behavior. The principal differences between the behavior and reflex theory.

2. Motivation as a component of systemic architectonics of behavioral acts.

Functional systems - units of the integrative activity of the organism. The concept of higher nervous activity (I. P. Pavlov). The conditioned reflex as a form of adaptation of animals and humans to the changing environmental conditions. Rules and physiological mechanisms of formation of conditioned reflexes. Classification of conditioned reflexes.

Inhibition in higher nervous activity. Inhibition types. The modern idea of the inhibition mechanisms.

Types of higher nervous activity in animals and humans (I. P. Pavlov), their classification, characteristics, methods of determination. The importance of the psychological characteristics of a person for career guidance and professional selection to create optimal psychological climate in the team. The teaching of I.P. Pavlov about the first and second signal systems.

Twoness in the activity of the cerebral cortex, the functional asymmetry of the cerebral hemispheres of the human and its role in the implementation of mental functions (speech, thought, etc). The functions of the associative cortex. The functions of the frontal lobes of the cortex.

Higher mental functions of the brain. The concept of the physiological basis of human mental functions (attention, perception, memory, motivation, emotion, thought, consciousness, speech). The importance of the functional state of the central nervous system for the implementation of mental functions.

Purposeful behavior, its systemic mechanisms (for example, food-procuring behavior). Architecture of holistic behavioral act from the point of view of the theory of functional systems (P.K. Anohin). Motivation and dominant, their neurophysiological mechanisms and the role of goal-directed behavior.

System organization of motivations. Theories of motivation. Mechanisms of motivation. Afferent synthesis. The dominant motivation. Situational afferentation. The interaction of motivation and environment. The role of the associative environment. Effect of stopping the formation of behavior. The dynamism of relationship between motivation and environment. Properties of motivational centers. The motivation and memory. Motivation and reinforcement. Motivation in the formation of personality. Motivation and emotion.

3. General physiology of sensory systems.

The role of the analyzers in the system of organization of behavior. Situational, launcher, reverse afferentation. Guide and efficient reverse afferent impulses.

The concept of the senses, analyzers, the sensory systems. The teachings of I. P. Pavlov about analyzers. The general principles of the structure of the sensory systems, role in maintaining of the functional state of the organism. Classification of the sensory systems.

The mechanisms of perception of the stimulus of external and internal environment of the body's receptors. Encoding, decoding, transmission, processing information in the pathways and the central parts of sensory systems. The role of sensory systems in the brain development and cognition of the world. Structural and functional organization of the analyzers.

Physiology of sensory systems.

The sense of vision. The structure anf functions of sense of vision. Features of the structure and properties of the eye providing the function of vision. The structure and functional significance of retina. Photochemical processes in the retina during the action of light. Features of pigmented, horizontal, bipolar and ganglion cells of the retina. Transmission and processing of information in the pathways and the central parts of the visual system. Theories of color vision. The main forms of violations of color perception. Field of vision. Visual acuity. Refraction and accommodation. Basics of correction of r refraction disorders. Adaptation, adaptation levels. Eye movements. Central and peripheral mechanisms of coordination of visual and oculomotor functions. Age features of view.

The sense of hearing. Features of the structure and properties of sound-conductive apparatus. The mechanisms of perception and analysis of sounds. Transmission and processing of information in the pathways and the central part of the hearing system. Adaptation. Protective reflexes. The binaural hearing. Audiometry, its importance for the evaluation of hearing and diagnosis of occupational diseases. Vibration sensitivity, the impact of industrial noise and vibration on the vestibular sensory system. Age features of hearing. Basics of correction of hearing disorders.

The vestibular system. Structures and properties of the receptor department, providing the perception and evaluation of body position in space, static and moving. Functional system providing optimal body position in space. The dynamics of the work of the functional system to maintain optimal body position in space. Transmission and processing of information in the pathways and central parts of the vestibular system. Reaction of organism to stimulation of the vestibular apparatus. The possibilities of correction of vestibular apparatus.

The olfactory system. Reception smells. Pathways and central parts of the olfactory system. Perception and classification of odors. The reactions of the organism to the irritation of the olfactory system. Protective reflexes.

The sense of taste. Taste reception. Pathways and central parts of the flavor system. The perception of taste. Classification of taste sensations. The reactions of the organism to taste stimuli.

The significance of the taste and olfactory sensory systems to organoleptic methods used in hygiene practices.

Somatic and visceral sensory system. Skin sensitivity. Mechanoreception. Types of receptors. Transmission and processing of information in the pathways and the central departments. Thermoreception.

The role of the skin, internal organs, blood vessels, and central nervous system thermoreception. Transmission and processing of information in the pathways and the central departments. The reactions of the organism to the action of heat and cold.

Nociception. Reception of pain. Structure and properties of the conductive pathways and the central departments. Central mechanisms of pain. Antinociceptive system. Neurochemistry of antinociception. The principles of anesthesia. Projected and reflected pain.

Proprioceptive sensitivity. The receptor mechanisms. The characteristics of pathways and central departments. The role in the perception and evaluation of body position in space, in the formation of muscle tone, posture and movement.

Interoceptive sensitivity. The receptor mechanisms. Types of interoceptive sensitivity. The reactions of the organism to the irritation of interoceptors. Interoception role in homeostasis.

The mechanisms self-regulation of analyzers.

4. Memory as a component of systemic architectonic of behavioral acts.

Memory, its types and mechanisms. Perception, capturing and storing. Data storage. The sequence of memorizing process. Processes of remembrance. The role of the various parts of the brain in remembering, storage and playback of information. Morphological theory. Cascade changes in synapse during memory formation. Reserves and ways to memory improvement. Holographic hypothesis of memory.

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

Perception, capturing and storing. Data storage. Playback of memory traces. Forgetting.

5. Emotions as a component of systemic architectonic of behavioral acts.

Emotions and their neurophysiological mechanisms. The role of emotional states. Behavioral, autonomic and endocrine manifestations of emotion. Emotional stress as a health risk factor. The impact of emotional states on productivity. The mechanisms of emotion. Theories of emotion. Emotions and training. Medical aspects of emotions. Emotional stress. The adaptive significance of emotions. The training of emotions.

6. System organization of human mental activity.

Functional systems of mental activity. The concept of the physiological basis and neurophysiological mechanisms of consciousness. Medical criteria for the assessment of human consciousness.

Mental activity. Architectonic of mental activity. Emotional basis of mental activity. Verbal basis of mental activity. Thinking and speech, their neurophysiological mechanisms. Morphological and functional bases of recognition of visual object. "Figurative" memory. The development of abstract thinking in humans. The functional asymmetry of the cerebral cortex associated with the development of speech in humans. Speech functions in right-handers and left-handers. The dynamics of mental activity. Systemogenesis of mental activity. Self-control of mental activity. Creative activity. Programming of mental activity. The motivation of mental activity.

7. Systemic mechanisms of pain.

Classification of pain. The causes of pain. Receptors and pathways. Pain as an integrative systemic reaction. The neurochemical mechanisms of pain. The behavioral and autonomic manifestations of pain. The endogenous antinociceptive system. Psychogenic regulation of pain. The pain and the theory of functional systems.

8. Sleeping as a system process.

Sleeping and waking. Modern views on the role and mechanisms of sleepinf. Objective evidence of sleeping. Sleep disorders. Electroencephalographic indicators of sleep. Somatic, autonomic and endocrine functions during sleeping. The phases of sleeping and dreams. The phases of sleeping and mental activity. Theories of sleep. The therapeutic effect of sleep. Hypnosis.

9. System mechanisms of labor activity.

Physiological basis of labor activity. Meaning of conditioned reflexes for the formation of labor skills. Dynamic stereotype as a physiological basis of industrial activity (motor skills, automated movements).

Occupational physiology. Types of work, depending on the energy consumption and the nature of the load (physical, mental). Energy consumption during work and its restoration. Tiredness, fatigue and recovery from the physical and neuro-psychological work. Changes of physiological functions during dynamic and static exercise (endocrine function, metabolism in muscles,activity of cardiovascular system, respiratory system, oxygen consumption, indicators of blood, temperature, and etc). Changes in physiological functions during mental work. Physiological mechanisms of formation of labor skills. The concept of operability. The limits of operability, the basic factors determining them (the amount of energy in muscles and etc). The operability tests (maximum oxygen consumption). Fatigue. The role of motivation. Programming of labor activity.

General operability as a combination of mental and physical operability. The dynamics of operability during the working day and the working week. The physiological explanation of the rational mode of work and rest. Prediction of physical and mental possibilityы of human to work. Integrated idea of the fatigue of the whole organism. The theory of fatigue of I.M. Sechenov. The commonality and difference in nature of the physical and mental fatigue. Fatigue at the local and overall loading. Chronic fatigue. Prevention of physical and mental fatigue. System mechanisms of labor activity.

Characteristics of results fo activity of the functional system. The dynamic of the work of the functional system.

10. System mechanisms of rehabilitation.

Human adaptation to environmental conditions. The concept of adaptation, acclimatization, acclimation and the body's resistance. General principles and mechanisms of adaptation. Passive and active ways of the adaptation to external factors. Energy consumption as an indicator of the adaptation process. The concept of stress as the general adaptation syndrome. Characteristics of adaptation processes. Urgent and long-term adaptation and its mechanisms. The role of the nervous and endocrine systems. The role of behavioral reactions. Structural trace and "autonomic memory." The standart of adaptive reaction, disadaptation, price of adaptation. Genotypic and phenotypic adaptation. Complicated adapatation and cross-adaptation. The reversibility of the processes of adaptation.

Protective reflexes. Protective behavior of animals and humans. Functional system of maintaining of integrity of the body's tissue.

Factors that ensure the integrity of the body. Barriers of external and internal environment of the body (skin, mucous membranes, cell membranes and the blood-brain barriers). Their physico-chemical and physiological properties. The protective role of mucus.

Immunity, its types. Immunocompetent cells and their cooperation in the immune response. Neuro-humoral regulation of the immune response. Immunity as the regulatory system. The immune system of various organs.

The genetic apparatus. Regulation of human physiological variability.

The concept of human biological rhythms.

Physiological basis of a healthy lifestyle. Valeology - the science of the laws of manifestation, mechanisms and methods of maintaining and improving of human health. The physical, mental and social health. The age and individual standards of the health. Health diagnostic. The physiological basis of health. The significance of physical activity, a balanced diet, work and rest for the preservation of health.

Non-drug rehabilitation.

5. Educational technologies

The educational process in the framework of the teaching such subjects as "physiology of functional systems" consists of lectures, classroom teaching and extra-curricular (independent) work of students.
Teaching discipline is based on the use of the following types of educational technologies:
1. Lectures with the use of multimedia technologies;
2. Seminars in the form of group discussions and analysis of specific situations;
3. The decision of situational problems;
4. Conducting tests on sections of discipline;
5. Computer testing.

5.1. Active learning methods

The decision of situational tasks (case-tasks)

3rd semester

A functional system supporting optimal for metabolism pH level. The acid-base status. A functional system supporting optimal level of glucose for metabolism. A functional system maintaining optimal blood pressure for metabolism. A functional system maintaining optimal respiratory parameters.

Functional system, which determines the optimal level of nutrients for metabolism. Functional system that supports optimal temperature for metabolism. Functional system, which determines the optimal level of osmotic pressure for metabolism. Functional system of excretion. Functional systems as integrative units of the organism. Motivation as a component of systemic architectonic of behavioral acts.

5.2. Educational technologies for people with disabilities and disabled people

For the realization of the individual approach to training students carrying out educational process on their own trajectory within the individual working plan, studying of this discipline is based on the following opportunities: ensuring out-of-class work with students including electronic educational environment with the use of the proper program equipment, Internet resources, individual consultations etc.

6. Educationaland methodological support of students' out-of-class work.
Assessment means for current progress monitoring, interim attestation of subject mastering results

6.1. Plan for independent work of students

Week №	Topic	Out-of-class work type	Task	Recommended literature	Amount of hours
III семестр					
1	The theory of functional systems. General principles of the functioning of the whole organism. The basic properties of functional systems. The holographic principle of the functional systems.	Preparation for the classes	To study the theoretical material on the topic of the lesson. To answer the questions for self-monitoring in guidelines	Normal physiology: textbook / ed. B. I. Tkachenko. - 3rd ed., M.: GEOTAR-Media, 2014. - 688 p. Normal physiology: textbook / LZ Tel [et al.]; Ed. LZ Telya, NA Aghajanyan. - M.: Litterra, 2015. - 768 p.	3
2	Interaction of functional systems in the body.	Preparation for the classes	To study the theoretical material on the topic of the lesson. To answer the questions for self-monitoring in guidelines	Normal physiology: textbook / ed. B. I. Tkachenko. - 3rd ed., M.: GEOTAR-Media, 2014. - 688 p. Normal physiology: textbook / LZ Tel [et al.]; Ed. LZ Telya, NA Aghajanyan. - M.: Litterra, 2015. - 768 p.	3
3	Elementary physiological processes. System organization of pathways.	Preparation for the classes	To study the theoretical material on the topic of the lesson. To answer the questions for self-monitoring in guidelines	Normal physiology: textbook / ed. B. I. Tkachenko. - 3rd ed., M.: GEOTAR-Media, 2014. - 688 p. Normal physiology: textbook / LZ Tel [et al.]; Ed. LZ Telya, NA Aghajanyan. - M.: Litterra, 2015. - 768 p.	3
4	Neuromuscular physiology	Preparation for the classes	To study the theoretical material on the topic of the lesson. To answer the questions for self-monitoring in guidelines	Normal physiology: textbook / ed. B. I. Tkachenko. - 3rd ed., M.: GEOTAR-Media, 2014. - 688 p. Normal physiology: textbook / LZ Tel [et al.]; Ed. LZ Telya, NA Aghajanyan. - M.: Litterra, 2015. - 768 p.	3
5	Neurohumoral regulation of physiological functions.	Preparation for the classes	To study the theoretical material on the topic of the lesson. To answer the questions for self-monitoring in guidelines	Normal physiology: textbook / ed. B. I. Tkachenko. - 3rd ed., M.: GEOTAR-Media, 2014. - 688 p. Normal physiology: textbook / LZ Tel [et al.]; Ed. LZ Telya, NA Aghajanyan. - M.: Litterra, 2015. - 768 p.	3
6	The functional systems of homeostatic level. The functional	Preparation for the classes	To study the theoretical material on the topic of the lesson.	Normal physiology: textbook / ed. B. I. Tkachenko. - 3rd ed., M.: GEOTAR-	2

Week №	Topic	Out-of-class work type	Task	Recommended literature	Amount of hours
	system providing optimal metabolism of circulating blood volume.		To answer the questions for self-monitoring in guidelines	Media, 2014. - 688 p. Normal physiology: textbook / LZ Tel [et al.]; Ed. LZ Telya, NA Aghajanyan. - M.: Litterra, 2015. - 768 p.	
7	The functional system supporting optimal metabolism in the body pH level. The acid-base status. The functional system supporting optimal metabolism for the amount of glucose	Preparation for the classes	To study the theoretical material on the topic of the lesson. To answer the questions for self-monitoring in guidelines	Normal physiology: textbook / ed. B. I. Tkachenko. - 3rd ed., M.: GEOTAR-Media, 2014. - 688 p. Normal physiology: textbook / LZ Tel [et al.]; Ed. LZ Telya, NA Aghajanyan. - M.: Litterra, 2015. - 768 p.	3
8	The functional system providing optimal for metabolism blood pressure	Preparation for the classes	To study the theoretical material on the topic of the lesson. To answer the questions for self-monitoring in guidelines	Normal physiology: textbook / ed. B. I. Tkachenko. - 3rd ed., M.: GEOTAR-Media, 2014. - 688 p. Normal physiology: textbook / LZ Tel [et al.]; Ed. LZ Telya, NA Aghajanyan. - M.: Litterra, 2015. - 768 p.	2
9	The functional system for maintaining optimal values of the respiratory parameters	Preparation for the classes	To study the theoretical material on the topic of the lesson. To answer the questions for self-monitoring in guidelines	Normal physiology: textbook / ed. B. I. Tkachenko. - 3rd ed., M.: GEOTAR-Media, 2014. - 688 p. Normal physiology: textbook / LZ Tel [et al.]; Ed. LZ Telya, NA Aghajanyan. - M.: Litterra, 2015. - 768 p.	3
10	The functional system, which determines the optimal level of nutrients for metabolism in the body	Preparation for the classes	To study the theoretical material on the topic of the lesson. To answer the questions for self-monitoring in guidelines	Normal physiology: textbook / ed. B. I. Tkachenko. - 3rd ed., M.: GEOTAR-Media, 2014. - 688 p. Normal physiology: textbook / LZ Tel [et al.]; Ed. LZ Telya, NA Aghajanyan. - M.: Litterra, 2015. - 768 p.	2
11	The functional system that supports optimal temperature of the body for the metabolism	Preparation for the classes	To study the theoretical material on the topic of the lesson. To answer the questions for self-monitoring in guidelines	Normal physiology: textbook / ed. B. I. Tkachenko. - 3rd ed., M.: GEOTAR-Media, 2014. - 688 p. Normal physiology: textbook / LZ Tel [et al.]; Ed. LZ Telya, NA Aghajanyan. - M.: Litterra, 2015. - 768 p.	2
12	The functional system, which determines the optimal level of the osmotic pressure for metabolism in the body.	Preparation for the classes	To study the theoretical material on the topic of the lesson. To answer the questions for self-monitoring in guidelines	Normal physiology: textbook / ed. B. I. Tkachenko. - 3rd ed., M.: GEOTAR-Media, 2014. - 688 p. Normal physiology: textbook / LZ Tel [et al.]; Ed. LZ Telya, NA Aghajanyan. - M.:	2

Week №	Topic	Out-of-class work type	Task	Recommended literature	Amount of hours
				Litterra, 2015. - 768 p.	
13	The functional urinary system	Preparation for the classes	To study the theoretical material on the topic of the lesson. To answer the questions for self-monitoring in guidelines	Normal physiology: textbook / ed. B. I. Tkachenko. - 3rd ed., M.: GEOTAR-Media, 2014. - 688 p. Normal physiology: textbook / LZ Tel [et al.]; Ed. LZ Telya, NA Aghajanyan. - M.: Litterra, 2015. - 768 p.	2
14	Development of systems. System organization of congenital and acquired behavior	Preparation for the classes	To study the theoretical material on the topic of the lesson. To answer the questions for self-monitoring in guidelines	Normal physiology: textbook / ed. B. I. Tkachenko. - 3rd ed., M.: GEOTAR-Media, 2014. - 688 p. Normal physiology: textbook / LZ Tel [et al.]; Ed. LZ Telya, NA Aghajanyan. - M.: Litterra, 2015. - 768 p.	2
15	The functional unit of the integrative activity of the organism. Motivation as a component of systemic architectonics of behavioral acts	Preparation for the classes	To study the theoretical material on the topic of the lesson. To answer the questions for self-monitoring in guidelines	Normal physiology: textbook / ed. B. I. Tkachenko. - 3rd ed., M.: GEOTAR-Media, 2014. - 688 p. Normal physiology: textbook / LZ Tel [et al.]; Ed. LZ Telya, NA Aghajanyan. - M.: Litterra, 2015. - 768 p.	3
16	Analyzers	Preparation for the classes	To study the theoretical material on the topic of the lesson. To answer the questions for self-monitoring in guidelines	Normal physiology: textbook / ed. B. I. Tkachenko. - 3rd ed., M.: GEOTAR-Media, 2014. - 688 p. Normal physiology: textbook / LZ Tel [et al.]; Ed. LZ Telya, NA Aghajanyan. - M.: Litterra, 2015. - 768 p.	4
17	Memory as a component of systemic architectonics of behavioral acts. Emotions as a component of systemic architectonics of behavioral acts	Preparation for the classes	To study the theoretical material on the topic of the lesson. To answer the questions for self-monitoring in guidelines	Normal physiology: textbook / ed. B. I. Tkachenko. - 3rd ed., M.: GEOTAR-Media, 2014. - 688 p. Normal physiology: textbook / LZ Tel [et al.]; Ed. LZ Telya, NA Aghajanyan. - M.: Litterra, 2015. - 768 p.	2
18	System organization of human mental activity. System mechanisms of pain. Sleep as a system process.	Preparation for the classes	To study the theoretical material on the topic of the lesson. To answer the questions for self-monitoring in guidelines	Normal physiology: textbook / ed. B. I. Tkachenko. - 3rd ed., M.: GEOTAR-Media, 2014. - 688 p. Normal physiology: textbook / LZ Tel [et al.]; Ed. LZ Telya, NA Aghajanyan. - M.: Litterra, 2015. - 768 p.	3
19	System mechanisms work. System recovery mechanisms.	Preparation for the classes	To study the theoretical material on the topic of the lesson.	Normal physiology: textbook / ed. B. I. Tkachenko. - 3rd ed., M.: GEOTAR-	2

Week №	Topic	Out-of-class work type	Task	Recommended literature	Amount of hours
			To answer the questions for self-monitoring in guidelines	Media, 2014. - 688 p. Normal physiology: textbook / LZ Tel [et al.]; Ed. LZ Telya, NA Aghajanyan. - M.: Litterra, 2015. - 768 p.	

6.2. Instructional guidelines on students' out-of-class work organization

Out-of-class work of students is conducted in accordance with the methodological recommendations of the Department of Human Physiology:

1. Anfinogenova OI, Mikulyak NI, Morozova MI Physiology of functional systems. Methodical recommendations for practical classes for students of specialties "Medical business" and "Pediatrics". - Penza, 2017. - 105 p.

6.3. Materials to carry out current monitoring and interim attestation of students' knowledge

Control of development of competences

№	Type of assessment	Topics (parts) assessed	Competences and elements assessed
1.	Tests assessment	Topic 1, 2, 3, 4, 5, 6, 7, 8, 9, 10,11,12,13,14,15,16,17,18,19	GEC-1, GPC-9
2.	Interview	Topic 1, 2, 3, 4, 5, 6, 7, 8, 9, 10,11,12,13,14,15,16,17,18,19	GEC-1, GPC-9

Examples of tests

1) The muscle tissue type that consists of single, very long, cylindrical, multinucleate cells with very obvious striations is:
A) skeletal muscle only
B) cardiac and smooth muscle
C) cardiac and skeletal muscle
D) cardiac muscle only
E) smooth muscle only

2) Which one of the following does NOT compress the abdomen:
A) rectus abdominis
B) internal oblique
C) latissimus dorsi
D) external oblique
E) transversus abdominis

3) Neurotransmitters are released upon stimulation from a nerve impulse by the:
A) thick filaments
B) motor unit
C) axon terminals of the motor neuron
D) sarcolemma of the muscle cell
E) myofibrils

4) What type of membrane wraps a fascicle:
A) perimysium
B) aponeuroses
C) tendons
D) epimysium
E) endomysium

5) Which one of the following muscles is involved in abduction of the arm at the shoulder joint:
A) biceps brachii
B) triceps brachii
C) deltoid
D) latissimus dorsi
E) pectoralis major

6) While doing ″jumping jacks″ during an exercise class, your arms and legs move laterally away from the midline of your body. This motion is called:
A) extension
B) adduction
C) circumduction

D) flexion
E) abduction

7) Which of the following muscles closes the jaw:
A) the frontalis
B) the masseter and the temporalis
C) the sternocleidomastoid
D) the masseter
E) the buccinator

8) An elaborate and specialized network of membranes in skeletal muscle cells that function in calcium storage is the:
A) sarcolemma
B) mitochondria
C) sarcoplasmic reticulum
D) myofibrillar network
E) intermediate filament network

9) A sarcomere is:
A) the area between two intercalated discs
B) the nonfunctional unit of skeletal muscle
C) the wavy lines on the cell, as seen in a microscope
D) the contractile unit between two Z discs
E) a compartment in a myofilament

10) A muscle located on the ventral (anterior) side of the body is the:
A) occipitalis
B) gluteus medius
C) gastrocnemius
D) latissimus dorsi
E) pectoralis major

11) Which of the following muscles is not involved in dorsiflexion and/or plantar flexion of the foot:
A) gastrocnemius
B) extensor digitorum longus
C) soleus
D) iliopsoas
E) tibialis anterior

12) During skeletal muscle contraction, myosin cross bridges attach to active sites of:
A) the H zone
B) Z discs
C) actin filaments
D) myosin filaments
E) thick filaments

13) The plasma membrane of a muscle cell is called the:
A) myofilament
B) sarcomere
C) sarcolemma
D) sarcoplasm
E) sarcoplasmic reticulum

14) The gap between the axon terminal of a motor neuron and the sarcolemma of a skeletal muscle cell is called the:
A) cross bridge
B) motor unit
C) neuromuscular junction
D) sarcomere
E) synaptic cleft

15) Which of these pathways to regenerate ATP during muscle activity is the fastest:
A) direct phosphorylation of ADP by creatine phosphate
B) aerobic respiration

C) both aerobic respiration and anaerobic glycolysis
D) oxidative phosphorylation
E) anaerobic glycolysis and lactic acid formation

16) Which of the following muscles inserts on the calcaneus:
A) the soleus
B) the iliopsoas
C) the tibialis anterior
D) the sartorius
E) the semitendinosus

17) A nursing infant develops a powerful sucking muscle that adults also use for whistling or blowing a trumpet called the:
A) zygomaticus
B) temporalis
C) masseter
D) buccinator
E) platysma

18) Anaerobic glycolysis occurs without:
A) glucose
B) oxygen
C) lactic acid
D) ATP
E) carbon dioxide

19) The type of muscle tissue pictured in Figure 6.3 is:
A) striated
B) found only in the heart
C) skeletal muscle
D) voluntary
E) smooth muscle

20) Paralysis of which of the following would make an individual unable to flex the thigh:
A) biceps femoris
B) vastus intermedius
C) vastus lateralis
D) vastus medialis
E) iliopsoas and rectus femoris

Criteria for assessing of the test

"Excellent" ("5") - 91% and more correct answers to questions.
"Good" ("4") - 81-90% of correct answers to questions.
"Satisfactory" ("3") - 71-80% of correct answers to questions.
"Unsatisfactory" ("2") - 70% and less correct answers to questions.

Sample questions for interview

Physiology of excitable tissues

1. Physiology as a subject, its importance for medicine and objectives. Relationship of physiology with other medical sciences. The role of physiology in human activity. Physiology and technology.
2. Methods of physiological studies and the history of their development (observation, registration of physiological processes, study of bioelectric phenomena, electrical stimulation and recording of non-electrical quantities, acute and chronic experiments).
3. History of the development of physiology. Physiological representations in the Ancient World, in the middle and 16th - 17th centuries.
4. Development of physiology in the 18-19th centuries.
5. Development of physiology in the 20 century. Nobel Prize laureates.
6. Physiology of the whole organism. Physiology and Cybernetics. Studying of higher nervous activity. Relationships between structure and function. Subcellular processes. Cell, membrane, tissues, organs, physiological and functional systems.

General properties of the central nervous system

1. Mechanisms of regulation of physiological processes. Humoral and nervous mechanisms, their features. Regulation of functions from the position of cybernetics. Negative and positive feedbacks, their importance in

regulation.

2. Neural theory. The structure of neurons and their functional classification. Conducting of the action potential and local potentials. The role of neuroglia.
3. Reflex, reflex arc and ring. Mono- and polysynaptic reflexes.
4. Classification of receptors. Mechanisms of generation of action potential in the afferent nerve. The Weber-Fechner law. General properties of receptors.
5. Nerve fiber and its structure functions. The degeneration of the fiber after

Regulation of physiological functions

1. Humoral regulation of physiological functions. Classification of humoral agents and endocrine glands. Biochemical nature of hormones. The mechanism of their perception and action.
2. The main aspects of humoral influences. Regulation of hormone production. The contours of self-regulation, the principle of "plus-minus interaction." Methods of examination of endocrine glands.
3. Pituitary gland, its structure. The anterior lobe of pituitary gland and its hormones.
4. Intermediate and posterior lobes of the pituitary gland, their hormones.
5. Thyroid and parathyroid glands. Their hormones and regulation of activity.

Circulation

1. Functions of the cardiovascular system. Structure of circulatory system.
2. Movement of blood in the heart. Significance of cardiac valve.
3. The heart cycle and its phases.
4. Mechanical and sound manifestations of cardiac activity.
5. Morphological characteristics of the heart muscle.
6. 6. Functional characteristics of the myocardium

Digestion

1. Digestion. Functions of the digestive system and classification of digestive processes. Principles of the regulation of digestion. The food center, the motivation for hunger and satiety. Innervation of the gastrointestinal tract.
2. The role of the nervous and humoral mechanisms of the regulation of digestion. Own hormones of the gastrointestinal tract and their characteristics. Phases of secretion of the digestive glands. Start-up effects on the gastrointestinal tract. Methods of studying the function of the digestive tract.
3. Digestion in the mouth. Salivary glands and methods for their study. Regulation of salivation. Swallowing.
4. Digestion in the stomach and methods of its study in animals and humans. The structure and innervation of the glands of the stomach. Composition of gastric juice. Curves of secretion for different foods. Regulation of gastric secretion, the phase of secretion and their mechanisms. Own hormones of the stomach.
5. Digestion in the duodenum. Methods of research.

Excretion

1. Excretion system and renal function. Methods of studying of the kidneys.
2. Structure and blood supply of the nephron. Yuxtaglomerular complex.
3. The theory of urination. The mechanism of glomerular filtration. Composition of primary urine.
4. Proximal reabsorption and its mechanisms.
5. Functions of the proximal tubule and the loop of Henle. Intensity of proximal reabsorption. Dilution and concentration of urine.
6. Distal (regulating) reabsorption. Its displacement in hydremia and water deficiency. Mechanisms of sodium reabsorption.
7. The involvement of the kidneys in the regulation of homeostasis: water exchange, osmotic pressure, pH, Isoionium, blood pressure, erythropoiesis. Excretory, secretory and metabolic functions of the kidneys

Blood System

1. The concept of the blood system. The ratio of plasma and formed elements. Composition of blood.
2. Morphological characteristica of erythrocytes. Regulation of erythropoiesis.
3. The structure of hemoglobin. Quantification of the amount of hemoglobin in the blood. Color indicator.
4. Characteristics of leukocytes. Leukogram and its meaning.
5. Quantification of leukocytes in the blood.

Human life activity under various types of activity

1. Higher and lower nervous activity (I.M. Sechenov, I.P. Pavlov). Conditioned and unconditioned reflexes. Their similarities and differences. Classification of unconditioned and conditioned reflexes, their components. Signals of conditioned reflexes.
2. Principles of conditioned reflex activity of the cortex. The mechanisms and conditions for the formation of conditioned reflexes.
3. The mechanism of formation of conditioned reflexes (I.P. Pavlov, Gasto, Yoshii). Scheme of the conditioned reflex

arc.

4. The biological nature of conditioned reflexes. Theory of convergent closure of temporary bonds by P.K. Anokhin. Conditional reflexes of the second and third orders.
5. Modern ideas about the mechanisms of memory. Types of memory. Physical and biochemical theory of memory.

Respiration

1. Respiration system, its importance for the organism. The main stages of the breathing. Functional system for maintaining the consistency of the gas composition of the blood.
2. Respiratory cycle. Physiology of the respiratory tract. Regulation of their clearance. The significance of ciliated epithelium.
3. External breathing. The mechanism of a calm and deep inhale and exhale. Pressure in the pleural cavity, its change during breathing. The Donders scheme.
4. Dynamic and static resistance to breathing. Elastic properties of the lungs and chest wall. Surfactant and its meaning.
5. Ventilation of the lungs, its unevenness in different parts of the organism. Alveolar and pulmonary ventilation. Spirometry and spirography.

Criteria for assessing the interview

"Excellent" - the answer is complete, correct and logical; Proficiency in medical terminology; The answers to the additional questions are clear and short.

"Good" - the answer is not logical enough with single errors in details; Single errors in medical terminology; The answers to additional questions are correct, but not clear enough.

"Satisfactory" - the answer is not correct enough, incomplete, with errors in details; Errors in medical terminology; The answers to additional questions are not clear enough, with errors in details.

"Unsatisfactory" - the answer is incorrect, incomplete, with gross mistakes; Ignorance of medical terminology; Answers to additional questions are incorrect.

Exemplary questions for pass-fail exam

1) Basic properties of functional systems. The concept of the body, its constituent elements. Levels of the structural and functional organization of the human body
2) Self-organization, self-regulation, isomorphism, holographic principle of FS construction. Functional system (PK Anokhin).
3) Interaction of elements in functional systems, contributing to the achievement of the result. Conservatism and plasticity of functional systems.
4) Information properties of FS.
5) Basic properties of functional systems. Basics of intercellular communication, information exchange and regulation of the physiological functions of the cell.
6) Interaction of functional systems in the body. Multiparametric interaction of functional systems. Consecutive interaction of functional systems. System quantization of vital activity.
7) Elementary physiological processes. The main methods of intercellular communication with the participation of chemical signals, their characteristics.
8) Systemic organization of conducting paths. Classification, structure and functions of molecular receptors. Types of signal molecules (ligands). The main ways of intracellular signal transmission involving membrane and intracellular receptors.
9) Interaction of functional systems in the body. Functional systems are units of integrative activity of an organism.
10) Cells and tissues. The concept of irritability and excitability. Classification of stimuli. The laws of the reaction of excitable tissues to the action of stimuli.
11) Excitation and inhibition. The interaction of the processes of excitation and inhibition is the basis of the coordination activity of the central nervous system.
12) Reception. The emergence and conduct of nerve impulses.
13) Synaptic transmission. The structure and classification of synapses, their physiological role.
14) The origins of the theory of functional systems. The concept of the body, its constituent elements. Levels of structurally functional organization of the human body.
15) General physiology of the central nervous system. The concept of the central and peripheral nervous system.
16) General physiology of the central nervous system. Functional classification of neurons. Features of the occurrence and propagation of excitation in the neuron. Combining neurons into neural circuits. Features of the structure and functions of CNS synapses. Reflex principle of the functioning of the nervous system.
17) Private CNS. Sensory functions of the spinal cord. Clinically important spinal reflexes in humans.

18) Private CNS. The trunk of the brain. Sensory functions of the medulla oblongata. Middle brain and bridge. Regulation of muscle tone, posture and movements. Regulation of the functions of the digestive system and other internal organs. Integrative functions. Conductive sensory pathways. Motor functions.
19) Private CNS. Cerebellum. Reticular formation of the brain stem. Structurally functional organization and functions.
20) Private CNS. The thalamus. Hypothalamus. Limbic system. Structurally functional organization and functions.
21) Private CNS. Basal nuclei. Bark of the cerebral hemispheres. Structurally functional organization and functions.
22) Physiology of the autonomic nervous system. The role of autonomous (vegetative)
23) Physiology of the autonomic nervous system. General characteristics of the influence of the sympathetic and parasympathetic departments of the ANS.
24) Hormonal regulation of physiological functions. The importance of the endocrine system for the life of the organism.
25) Mechanisms of hormones, representations of hormone receptors and the system of secondary mediators. Regulation of the secretion of hormones by various glands and endocrine cells. Connections of the glands of internal secretion and the nervous system. The involvement of the endocrine system in the regulation of homeostasis.
26) Interaction of nervous and humoral mechanisms of regulation of functions.
27) Functional system for ensuring the integrity of body tissues.
28) PS supporting the optimal cellular metabolism of blood for metabolism. The concept of the blood system (GF Lang).
29) FS, which provides the optimal volume of circulating blood for metabolism. The basic laws of hemodynamics.
30) PS, which maintains the optimal pH level in the body for metabolism. Physico-chemical and physiological mechanisms that ensure a constant pH of the blood.
31) Acid-base condition. Interrelation between gas exchange and acid-base balance.
32) Functional system that maintains the optimal amount of glucose in the blood for metabolism. The value and needs of the body in essential nutrients, vitamins and trace elements to maintain normal hematopoiesis.
33) Blood pressure, its types: arterial (systolic, diastolic, pulse, mean), venous. Functional system that provides the optimal level of blood pressure for metabolism.
34) Functional system for maintaining optimal values of respiratory parameters. Interaction of respiratory and cardiovascular systems in gas exchange. Functional reserves of the cardiovascular and respiratory systems of the body in the delivery of oxygen.
35) General characteristics of the functional food system, the role and place in it of digestion processes. The presentation of IP Pavlov about the food center. Types of digestion.
36) Energy balance of the body. Functional system that maintains body temperature that is optimal for body metabolism.
37) Functional system that determines the optimal level of osmotic pressure in the body for metabolism.
38) Functional selection system. Role and place of allocation as a system serving metabolic processes.
39) Systemogenesis.
40) Reflective principle of organization of behavior. Systemic organization of congenital and acquired behavior.
41) Muscular contraction. Physical and physiological properties of skeletal muscles. Physiological properties and features of smooth muscles in comparison with skeletal muscles.
42) Functional systems are units of integrative activity of an organism. The concept of higher nervous activity (IP Pavlov).
43) Motivation as a component of system architectonics of behavioral acts.
44) The concept of sense organs, analyzers, sensory systems. Structurally functional organization of analyzers.
45) Private physiology of sensory systems. Mechanisms of self-regulation of analyzers.
46) Memory as a component of system architectonics of behavioral acts.
47) Emotions as a component of system architectonics of behavioral acts.
48) Systemic organization of a person's mental activity. The concept of the physiological basis of consciousness and their neurophysiological mechanisms. Thinking and speaking.
the nervous system (ANS) in providing vital activity to the whole organism.
49) Systemic mechanisms of pain.
50) Sleep as a system process.
51) Physiological basis of labor activity. Energy costs during operation. General performance as a combination of mental and physical performance. The theory of fatigue IM Sechenov.
52) The concept of adaptation, acclimatization, acclimation, resistance of the organism.

Criteria pass-fail exam assessment

Assessment pass-fail exam for the discipline consists of the current and the examination ratings. Pass-fail exam rating is determined as follows:

Stage Points	**Баллы**

Test	10
Interviews	30

Criteria for the assessment test

"Excellent" (10 points) – 91% or more correct answers to test items.

"Good" (9 points) – 81-90% of correct answers to test items.

"Satisfactory" (8 points) – 71-80% of correct answers to test items.

Unsatisfactory (0 points) – 70% or less correct answers to the test tasks.

The criteria for the evaluation of answers to theoretical questions

30 points - the student thoroughly understands the material covered, gives clear answers, comprehensive; kable to assess facts independently; demonstrate the ability to justify conclusions.

27 points - the student thoroughly understands the material covered, clear answers and comprehensive, able to assess facts independently argues, is characterized by the ability to justify conclusions and explain them in a logical sequence, but allows some inaccuracies and errors of a General nature.

24 points - student understands the material covered, but can't theoretically justify some conclusions.

21 points - the student's partially responses with significant gaps in the material covered

18 points - the student's response is correct only in part, the explanation of the material is subject to bad errors.

16 point - the student has a general idea about the topic, but is not able to rationalize his thoughts or has only partial understanding of the subject.

0 points - no answer.

• the rating of "excellent" − the total amount of rating points is 87–100;

• "good" – the total amount of rating points is 73–86;

• evaluation of "satisfactory" − the total amount of rating points is 60–72;

• evaluation of "unsatisfactory" exhibited student, if the total amount of rating points is less than 60.

"Excellent" – the story complete, competent, logical; fluency in medical terminology; answers to additional questions, a clear brief.

"Good" – the lack of a coherent story with a single error in the particulars; individual errors in medical terminology; answers to additional questions correct, is not clear.

"Satisfactory" – the story is competent enough, incomplete, with errors in detail; errors in medical terminology; answers to the additional questions is not clear, with errors in the particulars.

"Unsatisfactory" – the story of an illiterate, incomplete, to blunder; ignorance of medical terminology; answers to supplementary questions wrong.

Examples of situational task

Task 1

When the cerebral cortex is irritated, the dog makes movements with the front paws. Which area of the brain, in your opinion, is irritated?

Task 2

Two students decided to prove in the experiment that the tone of skeletal muscles is maintained reflexively. Two spinal frogs were hung on a hook. Their lower legs were slightly compressed, which indicates the presence of a tone. Then the first student cut the front roots of the spinal cord, and the second - the posterior. Both frogs hang their paws, like whips. Which of the students set the experience correctly?

Task 3

The sick right-hander, does not remember the names of the objects, but gives a correct description of their purpose. Which region of the brain is affected in this person?

Criteria for assessing of situational task

"Excellent" - the answer to the question of the problem is correct. The explanation of the course of its decision is detailed, consistent, competent, with theoretical justifications, with correct and free possession of medical terminology; answers to additional questions are correct, clear.

"Good" - the answer to the question of the problem is correct. The explanation of the course of its decision is detailed, but not logical enough, with single errors in the details, some difficulties in the theoretical justification, the answers to additional questions are correct, but not clear enough.

"Satisfactory"- the answer to the question of the problem is correct. The explanation of the course of its solution is not complete, inconsistent, with errors, weak theoretical justification, the answers to additional questions are not clear enough, with errors in details.

"Unsatisfactory" - the answer to the question of the task is given incorrectly. The explanation of the course of its solution is incomplete, inconsistent, with gross errors, without theoretical justification; answers to additional questions are incorrect or absent.

7. Educational, methodological and informational means provided for subject

a) Basic literature:

1. Normal physiology: textbook / LZ Tel [and others]; Ed. LZ Telya, NA Agadzha-nyana. - M.: Litterra, 2015. - 768 p. http://www.studmedlib.ru/book/ISBN9785423501679.html
2. Normal physiology: textbook / ed. K.W. Sudakova. - M.: GEOTAR-Media, 2015. - 880 p. http://www.studmedlib.ru/book/ISBN9785970435281.html

b) Additional literature:

1. Human physiology: Atlas of dynamic schemes: a textbook / K.V. Sudakov, V.V. Andrianov, Yu.E. Vagin, I.I. Kiselev. - 2 nd ed., Rev. and additional. - M.: GEOTAR-Media, 2015. 416 p. http://www.studmedlib.ru/book/ISBN9785970432341.html
2. Atlas of Physiology: Textbook: 2 t. / A.G. Kamkin, I.S. Kiseleva. - 2013, 408 p. http://www.studmedlib.ru/book/ISBN9785970424193.html

c) Software and Internet resources:

1. Department site - http://dep_fizch.pnzgu.ru/
2. The Journal "Human Physiology" - https://elibrary.ru/title_about.asp
3. Stanford University - https://www.stanford.edu
4. MIT - Massachusetts Institute of Technology - http://web.mit.edu/

Licensed Software:

- "Microsoft Windows"; 00037FFEBACF8FD7 registration number, contract number SD-130712001 from 12.07.2013;

- "Kaspersky antivirus" 2016-2017, registration number KL4863RAUFQ, contract number CP-567116 from 29.08.2016;

Open software:

Open Office; Mozilla Firefox; Google Chrome; Adobe Acrobat Reader.

8. Material and technical means provided for subject

№	Name of special classroom and classroom for independent work	Equipment of special classroom and classroom for independent work
1.	Classroom 10 – 310, housing 10, 19,3 м^2	- Multimedia learning tools (multimedia projector, screen, computer). - Educational board - A set of electronic presentations / slides of lectures. - A set of tests on the discipline and discipline in general. - Demonstration tables. - Training aids. - Laboratory equipment, equipment, tools, utensils. - Training table - 12 pcs. - chairs - 24 pcs.
2.	Classroom 10 – 311, housing 10, 19,3 м^2	- Multimedia learning tools (multi-media projector, screen, computer). - Educational board - A set of electronic presentations / slides of lectures. - A set of tests on the discipline and discipline in general. - Demonstration tables. - Training aids. - Laboratory equipment, equipment, tools, utensils. - Training table - 9 pcs. - chairs - 18 pieces.

The study program for the discipline "Physiology of functional systems" is drawn in accordance with the federal state educational standard of higher education and academic plan for the course 31.05.01 General Medicine.

The program developers:

Head of Department "Human Physiology", Professor _____ N.I. Mikulyak
Assoc. Professor of Department "Human Physiology" _____ M.I. Morozova
Assistant lecturer of Department "Human Physiology" _____ A.I. Mikulyak

The program was discussed and agreed at the department meeting

Records № 12 on « 4 » 03 2016

Head of Department "Human Physiology" _____ N.I. Mikulyak

The program is agreed with the Dean of the Faculty of General Medicine of PSU

Dean of the Faculty of General Medicine _____ LYA. Moiseeva

The program was approved by methodological commission of the Medical Institute

Records № 7 on " 5 " 03 2016

Chair of the methodological commission _____ O.V. Kalmin

Verification, correction: Department of Foreign Languages,
Assoc. Professor _____ E.V. Shepeleva

РП по РС. анест.

Data on re-approval of the program for consecutive academic years and record of alterations

Academic year	Departments' decision (records №, date, head of the department signature)	Introduced alterations	Page numbers		
			changed	new	annulled
2016/2017	Протокол № 1 от 5.09.2016	Раб. программа утверждена без изменений			
2016/2017	Прот. № 13 17.05.2017	На основании приказа Минобра и науки № 320 от 10.04.2017 квалифик. „Врач общей практики" заменяется на „Врач-лечебник"	1		
2017/2018	Протокол № 1 от 4.09.2017	Добавлено в п. 5 описание приемлемых образоват. технологий к обучающимся с ограниченными возможностями здоровья и инвалидов	18		
2017/2018	Протокол № 1 4.09.2017	Раб. программа утверждена с изменениями			
2018/19	Протокол № 13 5.06.2018г.	Раб. программа переутверждена без изменений			
2019/2020	Протокол № 11 17.06.19	Раб. программа переутверждена без изменений			

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