

# SYLLABUS

## 1. General information on the course

<b>Full course name</b>	Physiology
<b>Full official name of a higher education institution</b>	Sumy State University
<b>Full name of a structural unit</b>	Academic and Research Medical Institute. Кафедра фізіології і патофізіології з курсом медичної біології
<b>Author(s)</b>	Obukhova Olha Anatoliivna, Harbuzova Viktoriia Yuriivna, Demenko Maryna Mykolaivna
<b>Cycle/higher education level</b>	The Second Level Of Higher Education, National Qualifications Framework Of Ukraine – The 7th Level, QF-LLL – The 7th Level, FQ-EHEA – The Second Cycle
<b>Semester</b>	18 weeks across 3 semester, 20 weeks across 4 semester
<b>Workload</b>	9 ECTS, 270 hours. For full-time course 198 hours are working hours with the lecturer (18 hours of lectures, 180 hours of seminars), 72 hours of the individual study.
<b>Language(s)</b>	English

## 2. Place in the study programme

<b>Relation to curriculum</b>	Compulsory course available for study programme "Medicine"
<b>Prerequisites</b>	Necessary knowledge of medical biology, anatomy, biophysics, biochemistry, bioorganic chemistry, anatomy, histology, cytology and embryology
<b>Additional requirements</b>	There are no specific requirements
<b>Restrictions</b>	There are no specific restrictions

## 3. Aims of the course

The aim of the discipline is to achieve students' fundamental thinking and knowledge system about the functioning of the human body as a whole and the ability to use them in clinical practice.

## 4. Contents

<b>Module 1. Introduction to physiology. Physiology of excitable structures</b>
---

### Topic 1 Subject and tasks of physiology

Instruction on safety rules. General information about the discipline. Discipline regulations. Physiology as a scientific basis of medicine about body functions, ways of maintaining health and working capacity. The value of physiology in training a doctor. Basic concepts of physiology. Levels of the structure of the human body. The unity of the organism and the external environment. Physiological characteristics of functions, their parameters. Age and sex characteristics of functions. Functions of cells, tissues, organs, organism as a whole. The main functional characteristics of living organisms are metabolism of substances and energy, homeostasis, adaptation, self-regulation, reproduction, growth, development, irritability.

### Topic 2 The main stages of development of physiology. Methods of physiological research

A brief description of the development of physiology. The role of the works of Harvey and R. Descartes. Formation and development of physiology in the 19th century (K. Bernard, E. Dubois-Raymon, I. Cannon, B. Ludwig, C. Sherrington). Contribution of the works of I.M. Sechenova, I.P. Pavlova, M.E. Vvedenskyi, O.O. Ukhtomskyi, L.A. Orbeli, P.K. Anokhin in the development of world physiology. Ukrainian Physiological School - V.Ya. Danylevskyi, V.Yu. Chagovets, D.S. Vorontsov, P.M. Serkov, P.G. Kostyuk, V.I. Skok, M.F. Shuba, G.S. Folbort, V.V. Frolkis, V.M. Nikitin. Overview of the main methods of physiological research. Characteristics of experimental and clinical methods. Experimental models. Laboratory animals.

### Topic 3 Functional properties of cell membranes.

Modern understanding of the structure and functions of cell membranes. The main differences in the chemical composition of the extracellular fluid and the intracellular environment. Mechanisms of transport of substances through the cell membrane. Passive transport of substances, its types and mechanisms. Factors affecting the intensity of diffusion. Active transport of substances, its types and mechanisms. The study of this topic involves theoretical work in the classroom, the use of virtual simulation (watching a film on the specified topic) with further discussion.

### Topic 4 The potential for rest of nerve and muscle fibers

Modern idea of the structure and function of cell membranes. The main differences in the chemical composition of extracellular fluid and intracellular environment. Mechanisms of transport of substances across the cell membrane. The concept of membrane potential and rest potential. The role of V.Yu. Chagovets in the development of the hypothesis about the ionic mechanism of origin of the resting potential. Methods of registration of resting potential, physical characteristics, mechanism of origin. Physiological role of resting potential.

### Topic 5 The potential of nerve and muscle fibers

Action potential, its physical and physiological characteristics. Structure and main properties of ionic channel proteins involved in the development of AP. Ionic mechanisms of occurrence of the main phases of AP. Excitability, its changes during the development of AP.

### Topic 6 Preparation of a neuromuscular preparation

Irritability, irritation, excitability, excitement. The concept of excitable structures. Laws of irritation. Direct and indirect irritation. Preparation of spinal frog preparation, rheoscopic paw, neuromuscular preparation. Checking the physiological integrity of the drug with an electrical stimulator. Demonstration of direct and indirect irritation.

Topic 7 Mechanisms of electrical stimulation of excitable structures.

Methods of electrical stimulation of nerve and muscle fibers. Parameters of electric current that determine its ability to cause excitation. Passive and active electrical potentials caused by electrical stimulation. Comparative characteristics of local response and action potential. Cell parameters that determine the degree of its excitability. Changes in the excitability of nerve and muscle fibers caused by electric current.

Topic 8 Study of bioelectrical phenomena in living tissues

The concept of bioelectric potentials. Types of potentials arising in a living organism. Damage potential. The mechanism of bioelectric potentials. Reproduction of bioelectric phenomena in the experiments of Galvani, Aldini, Matteucci.

Topic 9 Conduction of excitation along nerve and muscle fibers

The mechanism of conduction of a nerve impulse along unmyelinated nerve fibers. Peculiarities of conduction of excitation along myelinated nerve fibers. and myelin fibers. Laws of conduction of excitation along nerve and muscle fibers. Factors determining the speed of action potential conduction along nerve fibers. Characteristics of nerve fibers according to Erlanger-Gasser. Structure and classification of synapses. Features of the functioning of electrical and chemical synapses. The mechanism of transmission of excitation through the neuromuscular synapse.

Topic 10 Solving situational problems from the section "Electrophysiology".

Calculation of the value of the equilibrium potential according to the Nernst equation. Calculation of the value of the membrane potential of the nerve fiber according to the Goldman-Hodgkin-Katz equation. Determination of deviation of the potential from the normal value of the resting potential of the nerve fiber. Calculation of the reliability factor and estimation of its value. Determination of the absolute strength of the muscles, the level of work capacity and the indicator of the decrease in work capacity according to the data of dynamometry. Determination of the type of muscle contraction depending on the frequency of its stimulation. Calculation of the frequency of stimulation of the muscle to obtain different types of contraction.

Topic 11 Skeletal and smooth muscle contractions

Structural organization of the muscle contractile apparatus. Sarcomere, its components. The essence of Huxley-Hanson's theory ("sliding of myofilaments"). Structure of actin and myosin filaments. Modern understanding of the mechanism of muscle fiber contraction. Stages of the reduction process. Chemistry and energy of muscle contraction. The concept of motor unit. Classification of motor units. The main features of the contractile apparatus and the functioning of smooth muscles.

Topic 12 Study the main characteristics of muscle contraction

Physiological characteristics of muscle contraction. The concept of isotonic and isometric modes of muscle contraction. Power. Types of muscle strength and factors affecting it. The length of the short. The concept of tetanus and its types. Speed. Dependence of the rate of reduction on the load. Work. Static and dynamic types of muscle work. Muscle fatigue. Factors affecting fatigue. Electromyography as a method of studying the physiological characteristics of muscle contraction. Using dynamometry to determine muscle strength.

Topic 13 Calculation work from the content module 1 "Introduction to physiology. Physiology of excitable structures".

Topic 14 Final lesson from module 1 "Introduction to physiology. Physiology of excitable structures".

Physiology as a science, the connection of physiology with other disciplines. Basic concepts of physiology: function, functional unit, physiological system, functional state of the organism. The main functional properties of the organism as a whole. The concept of stimuli, stimuli, biological reaction, excitation, excitability, excitable structures. Features of the structure of the cell membrane, the functions of its main components. Differences in the chemical composition of extracellular fluid and intracellular environment. Passive transport of substances, its types and mechanisms. Active transport of substances, its types and mechanisms. The concept of membrane potential and rest potential. Methods of registration of resting potential, its physical characteristics. Ionic mechanisms of resting potential origin. The resting potential of nerve and skeletal muscle fibers. The main and additional factors that affect its value. Potential of action: structure, physical and physiological characteristics. Structure and main properties of ionic channel proteins involved in the development of AP. Ionic mechanisms of development of the main phases of AP. Excitability, its changes during the development of AP. The value of the parameters of direct electric current for the occurrence of excitation. Passive and active electrical potentials due to electrical stimulation. Changes in the excitability of nerve and muscle fibers

## **Module 2. Nervous regulation of body functions**

Topic 15 General patterns of nervous regulation of functions

Physiological characteristics of muscle contraction. The concept of isotonic and isometric modes of muscle contraction. Power. Types of muscle strength and factors affecting it. The length of the short. The concept of tetanus and its types. Speed. Dependence of the rate of reduction on the load. Work. Static and dynamic types of muscle work. Muscle fatigue. Factors affecting fatigue. Electromyography as a method of studying the physiological characteristics of muscle contraction. Using dynamometry to determine muscle strength.

Topic 16 Reflex arc analysis.

Concept of reflexes, their classification. Reflex arc, functions of its individual elements. Reproduction of Turk's reflex in frogs. Determination of reflex time. Analysis of the reflex arc. Study of the phenomena of sequential and simultaneous summation.

Topic 17 Excitation and inhibition in the CNS

Characteristics of excitatory and inhibitory postsynaptic potentials. Mechanisms of central excitation. Central inhibition, its types and significance. The role of inhibitory neural circuits in the emergence of central inhibition.

Topic 18 Study of inhibition of spinal reflexes

Mechanisms of pre- and postsynaptic inhibition. The value of reverse, lateral and reciprocal inhibition in the work of nerve centers. Study of central inhibition of spinal reflexes (experiment by I.M. Sechenov).

Topic 19 The role of the spinal cord in the regulation of body functions

General structural and functional characteristics of the spinal cord. Analysis of sensory information by the spinal cord. Mechanisms of muscular and articular reception (proprioception). Muscle spindles (tension receptors), their structure, functions, excitation mechanism. Gamma loop functions. Golgi tendon receptors, their functions, reflexes from tendon receptors. Conductive function of the spinal cord, its role in the regulation of motor functions. Brown-Sekara syndrome. Spinal shock. Autonomic function of the spinal cord. Reflex function of the spinal cord. Characteristics of tonic reflexes (myotatic and cervical tonic), their reflex arc. Characteristics of phase reflexes (tendon, skin, rhythmic, flexion, extensor cross), their reflex arcs

Topic 20 Study of clinically important spinal reflexes in humans

Characteristics and classification of spinal reflexes. Reproduction of clinically important spinal reflexes in humans: tendon (knee, elbow flexor (biceps reflex), elbow extensor (triceps reflex), Achilles), skin (plantar, upper abdominal (upper, middle, lower)), periosteal (p 'clear-radial'), the study of their reflex arcs. Determination of the area of spinal cord damage depending on the violation of reflexes. Determination of violations of reflex activity depending on the level of damage to the spinal cord.

Topic 21 The role of the hindbrain in the regulation of body functions

Neuronal organization of the hindbrain. Sensory function of the hindbrain. Conductive function of the hindbrain. Descending motor pathways, their role in regulating the activity of alpha and gamma motoneurons of the spinal cord. Vegetative function of the hindbrain. The role of the hindbrain in secured antigravity postures. Characteristics of vestibular static and cervical tonic reflexes.

Topic 22 The role of the midbrain and basal nuclei in the regulation of body functions

Neuronal organization of the midbrain. Sensory function of the midbrain. Vegetative function of the midbrain. Reflex function of the middle brain. Decerebral rigidity. Characteristics of static, statokinetic and orientational reflexes. The role of the reticular formation in the implementation of motor functions. The influence of the medial and lateral reticulospinal tracts on motoneurons of the spinal cord. Functional organization and connections of basal nuclei. Functions of the basal nuclei. Neurotransmitters in the system of basal nuclei, their physiological role. Cycles of the shell and caudate body. Clinical manifestations in damaged basal nuclei, their physiological mechanisms.

Topic 23 The role of the cerebellum, thalamus, and hypothalamus in the regulation of body functions.

Structural and functional organization of the cerebellum, its afferent and efferent connections, their physiological role. Functions of the cerebellum. Consequences of removal or damage to the cerebellum occurring in humans, their physiological mechanisms. Functional characteristics of thalamus nuclei. Functions of the hypothalamus. Limbic system. Its connections and functions

Topic 24 Study of functional asymmetry of the cortex of the large hemispheres

Peculiarities of the geniculate structure of the cortex of the large hemispheres. Zones of the cortex of the large hemispheres. Functions of the cortex of the large hemispheres. Interhemispheric asymmetry. The phenomenon of ambidexterity. Study of functional asymmetry of the cortex of the large hemispheres by conducting morphological and functional tests. Identification of the leading hemisphere of the brain.

### Topic 25 Nervous regulation of autonomic functions

Structural and functional features of the autonomic nervous system. Sympathetic, parasympathetic and metasympathetic division. Features of the reflex arc of the autonomic reflex. Vegetative ganglia, their functions. Preganglionic and postganglionic fibers. The mechanism of excitation transmission in the autonomic ganglia. Mediators and blockers of the autonomic nervous system. Influence of sympathetic, parasympathetic and metasympathetic divisions on organs. Classification of autonomic reflexes. Reflex arc of the autonomic reflex. Research and use of autonomic reflexes in practical medicine. Central regulation of visceral functions. Integrative centers of regulation of visceral functions.

### Topic 26 Research of autonomic tone and autonomic reactivity in humans

The concept of vegetative tone (vago-tonia, sympatho-tonia, eito-tonia) and vegetative reactivity in humans. Determination of the vegetative tone in a person using the Curdew index calculation and dermographism. Evaluation of autonomic reactivity by reproduction of Danini-Ashner and Chermak reflexes. The study of ensuring the work of internal organs according to the calculations of the Hildebrandt coefficient and the Letunov test.

### Topic 27 Calculation work and solution of situational problems from the content module 2 "Nervous regulation of body functions"

Calculation of the frequency of presynaptic pulses. Calculation of reflex time according to the complexity of the reflex arc. Calculation of the Kerduh index and its estimation. Calculation of the Hildebrandt coefficient and its estimation.

### Topic 28 Final lesson from module 2 "Nervous regulation of body functions".

The main features of nervous regulation of functions. The structure and function of the neuron. Functions of neuroglia. Reflex. Classification of reflexes. Reflex arc. Features of excitation by reflex arc. Functions of individual components of the reflex arc. Classification of receptors. General mechanisms of receptor function. The concept of the nerve center. Properties of nerve centers. Principles of interaction between nerve centers. Classification of mediators, their general characteristics. Characteristics of excitatory and inhibitory postsynaptic potentials. CNS synapses, their structure, mechanisms of information transfer. Features of excitation transmission in central synapses. Central braking, its types and significance. Characteristics and mechanisms of pre- and postsynaptic inhibition. Functions of the spinal cord. Mechanisms of muscle and joint reception (proprioception). Characteristics of tonic reflexes (myotatic and cervical tonic), their reflex arcs. Characteristics of phase reflexes (tendon, skin, rhythmic, flexion, extensor cross), their reflex arcs. Neural organization and functions of the hindbrain. Neural organization and functions of the midbrain. The role of reticular formation in the implementation of motor functions. Influence of medial and lateral reticulospinal pathways on spinal cord motoneurons. Functional organization and functions of basal ganglia. Cerebellar functions.

## **Module 3. Humoral regulation of body functions**

### Topic 29 General regularities of humoral regulation of vegetative functions

Relationship of nervous and humoral regulation. Contour of humoral regulation, the role of feedback in regulation. Factors of humoral regulation, their characteristics and classification. The role of factors of local regulation. Structural and functional organization of the endocrine system. Endocrine glands, endocrine cells, their hormones and significance.

Topic 30 Hypothalamic-pituitary system.

Hypothalamus as the central endocrine organ. Functional connection of the hypothalamus with the pituitary gland. Neurosecretes of the hypothalamus. The role of liberins and statins. Consequences of dysfunction of the hypothalamic-pituitary system.

Topic 31 The role of hormones in the regulation of physical and mental development

Hormones of the adenohypophysis: chemical nature, regulation of secretion, mechanism of action. Functional, metabolic and structural effects. The role of somatotropic hormone in ensuring growth and development processes. The value of somatomedins. Consequences of hypo- and hypersecretion of somatotropin. Thyroid hormones: chemical nature, synthesis and secretion, regulation of secretion, mechanism of action. Functional and metabolic effects. Consequences of hypo- and hypersecretion. The role of other hormones affecting growth processes (insulin, sex hormones, cortisol).

Topic 32 The role of hormones in the regulation of sexual development

Gonads. Sexual differentiation, development and functions of the reproductive system. Male sex hormones: chemical nature, regulation of secretion, mechanism of action, functional, metabolic and structural effects. Female sex hormones: chemical nature, regulation of secretion, mechanism of action, functional, metabolic and structural effects. Menstrual cycle. Pregnancy. Hormones of the placenta. Thymus hormones. Thymic-lymphatic status. Hormones of the pineal gland

Topic 33 The role of hormones in the regulation of homeostasis

Determination of the consequences of disruption of the mechanisms of regulation of endocrine glands. Determination of the role of hormones in the regulation of physical, mental, and sexual development. Determination of the role of hormones in the regulation of homeostasis indicators. Determination of the role of hormones in regulating the body's adaptation to stress.

Topic 34 The role of hormones in regulating the body's adaptation to stress factors

The concept of stress and stressors. Types of adaptation to stress factors. General adaptation syndrome (G. Cellier). The role of the sympatho-adrenal system in adaptation. The role of hormones of the adrenal cortex (glucocorticoids, mineralocorticoids), pituitary gland, thyroid hormones (thyroxine, triiodothyronine), vagoinsular system in ensuring non-specific adaptation of the body to stress factors.

Topic 35 Solving situational problems from the content module 3 "Humoral regulation of body functions".

Determination of the consequences of disruption of the mechanisms of regulation of endocrine glands. Determination of the role of hormones in the regulation of physical, mental, and sexual development. Determination of the role of hormones in the regulation of homeostasis indicators. Determination of the role of hormones in regulating the body's adaptation to stress.

Topic 36 Final lesson from module 3 "Humoral regulation of body functions".

The main features of humoral regulation of functions. Factors of humoral regulation, their characteristics and classification. The concept of hormones. Properties of hormones. Classification of hormones. The concept of endocrine function, its components: regulation of endocrine glands, mechanisms of secretion and forms of hormone transport, mechanisms of cyto-reception. The concept of the hypothalamic-pituitary system. The role of liberins and statins. Neurohypophysis hormones: chemical nature, regulation of secretion, mechanism of action, functional effects. Adenohypophysis hormones: chemical nature, secretion regulation, mechanism of action, functional, metabolic and structural effects. Pancreatic hormones: insulin, glucagon, somatostatin, their effect on metabolism and blood glucose concentration. Hormones that regulate calcium and phosphate homeostasis: parathyroid hormone, calcitonin, 1.25 (OH) 2D3. Influence of other hormones on calcium metabolism (glucocorticoids, somatotropic, thyroid hormones, estrogens, insulin). Thyroid hormones: chemical nature, synthesis and secretion, secretion regulation, mechanism of action. Functional and metabolic effects. Consequences of hypo- and hypersecretion. Adrenal cortex hormones: chemical nature, regulation of secretion, mechanism of action, functional and metabolic effects. Hormones of the adrenal medulla: chemical nature, regulation of secretion, mechanism of action,

#### **Module 4. Physiology of analyzers and HNA**

Topic 37 Sensor systems. Study of the somato-sensory analyzer

The concept of sensor systems (analyzers). General principles of structure and basic functions of analyzers. Properties and functional organization of analyzers. Concept of absolute and differential threshold of sensation. Weber-Fechner law. Classification of receptors, their functions. Functions of the conductor and central departments of the analyzers. Structural and functional organization of the somato-sensory system (skin and proprioceptive sensitivities). Physiological basis of pain. Nociception, physiological characteristics and classification of nociceptors. Nociceptive or pain system, its structural and functional organization, leading pathways and levels of information processing. Antinociceptive system, its structural and functional organization, opiate and non-opiate mechanisms, physiological role. Physiological basis of analgesia. Structural and functional organization of the taste sensory system. Types of tastes, mechanisms of their perception, physiological role. Structural and functional organization of the olfactory sensory system. Classification of smells, theories of their perception.

Topic 38 Visual analyzer

Structural and functional organization of the visual analyzer. Optical system of the eye. Mechanism of refraction and accommodation. Refraction anomalies of the eye. Pupillary reflex, its physiological significance. Photochemical and electrical phenomena in the retina. Light and contrast sensitivity of the organs of vision. The concept of vision adaptation. Modern ideas about the mechanisms of color perception. The main forms of color perception disorders.

Topic 39 Auditory and vestibular analyzer

General characteristics of the auditory analyzer. Functions of the outer and middle ear. Structural and functional organization of the inner ear. Mechanisms of sound perception. Analysis of the frequency and power of sounds. Characteristics of sound sensations. Structural and functional organization of the vestibular analyzer. Vestibular reactions.

Topic 40 Study of the properties of visual, auditory and vestibular analyzers

The concept of visual acuity. Methods of determining visual acuity in humans, evaluation of the obtained indicators. Definition of field of vision. Study of the pupillary reflex. Determination of hearing acuity. The concept of air and bone conduction of sounds. Determination of conductivity. Research of the vestibular analyzer.

Topic 41 Physiological bases of behavior

Physiological bases of behavior Comparative characteristics of conditioned and unconditioned reflexes. General characteristics of innate (unconditioned-reflex) forms of behavior. Instincts, their meaning. Acquired (conditionally reflexive) forms of behavior, their meaning. Patterns of formation and storage of conditioned reflexes. Inhibition of conditioned reflexes, types of inhibition, their physiological significance. Memory. Types and mechanisms of memory. Sleep. Its phases. Mechanisms of sleep development. The importance of sleep for the body. Needs and motivations, their physiological mechanisms, role in the formation of behavior. Functional behavior system. The structure of a holistic behavioral act of behavior (according to P.K. Anokhin). Mechanism of formation and biological significance of emotions. Theories of emotions.

Topic 42 Higher nervous activity of a person

Types of higher nervous activity, their classification, physiological bases, research methods. Thinking. The role of brain structures in the thinking process. Consciousness. Physiological foundations of consciousness. The concept of signaling systems. Comparative characteristics of I and II signaling systems. Formation of the II signaling system in ontogenesis. Language functions. Language centers. Types of higher nervous activity of people depending on the level of functioning of signaling systems. The main provisions of the teaching of I.P. Pavlov on the types of higher nervous activity of humans and animals.

Topic 43 Study of cognitive processes and types of higher human nervous activity

Study of cognitive processes and types of higher human nervous activity Types and mechanisms of memory. Assessment of the capacity of various types of short-term memory (visual, auditory, logical). The concept of attention, its types and disorders. Methods of studying attention. Conducting and evaluating the proofreading test. Typological properties of the human nervous system (strength, speed, balance). Evaluation of the mobility of nervous processes. The concept of temperament, its types. Methods of studying human temperament. Determining the type of temperament using the Eysenck questionnaire.

Topic 44 Individual work of students from module 4 "Physiology of analyzers and VND

Topic 45 Final lesson from module 4 "Physiology of analyzers and HNA".

The concept of sensor systems (analyzers). General principles of structure and basic functions of analyzers. Properties and functional organization of analyzers. The concept of absolute and differential threshold of sensation. Weber-Fechner law. Classification of receptors, their functions. Functions of the conducting and central departments of the analyzers. Structural and functional organization of the somato-sensory system (skin and proprioceptive sensitivities). Physiological basis of pain. Nociception, physiological characteristics and classification of nociceptors. Nociceptive or pain system, its structural and functional organization, leading pathways and levels of information processing. Physiological significance of pain. Antinociceptive system, its structural and functional organization, opiate and non-opiate mechanisms, physiological role. Physiological bases of anesthesia. Structural and functional organization of the taste sensory system. Types of tastes, mechanisms of their perception, physiological role. Structural and functional organization of the olfactory sensory system. Types of higher nervous activity, their classification, physiological bases, research methods. Thinking. Consciousness. The concept of signaling systems. Physiological bases of behavior. Congenital and acquired forms of behavior, their significance for the adaptive activity of the organism. Regularities of formation and storage of conditione

### **Module 5. Physiology of the blood system**

Topic 46 Physico-chemical properties of blood

General characteristics of liquid media. Physiological blood system. Its structure. General characteristics and composition of peripheral blood. The main functions of the physiological blood system. Functional significance of water and blood plasma electrolytes. Blood plasma proteins. Their composition and main functions. Basic physical and chemical properties of blood: osmotic pressure, density, viscosity, blood reaction.

Topic 47 Determination of ESR

Erythrocyte sedimentation rate (ESR). Factors influencing this indicator. ESR research methods in the clinic. Determination of ESR by the method of Panchenkov, evaluation of the indicator.

Topic 48 Properties and functions of erythrocytes

General characteristics of erythrocytes. Their function. Hematocrit. Factors on which its value depends. Osmotic resistance of erythrocytes. Its significance. Hemolysis of erythrocytes. Types and mechanisms of hemolysis. Hemoglobin as the main component of erythrocytes. The structure of hemoglobin. Calculation of color index and oxygen capacity of blood. The main forms and compounds of hemoglobin. Color index, its definition. Mechanisms of formation and physiological destruction of erythrocytes. Regulation of erythrocyte content in peripheral blood.

Topic 49 Counting the number of erythrocytes. Determination of hemoglobin level

Methods for counting the number of erythrocytes in the blood in the clinic. Counting the number of erythrocytes using Goryaev's camera, evaluation of the indicator. Methods for assessing the content of hemoglobin in the blood in the clinic. Determination of hemoglobin content using Sally hemometer, evaluation of the indicator.

Topic 50 Protective properties of blood

Leukocytes, their distribution in the body. Quantitative and qualitative composition of peripheral blood leukocytes. The main functions of certain types of leukocytes. Mechanisms of phagocytosis. Characteristics of nonspecific and specific immunity. Regulation of leukopoiesis and leukocyte activity.

#### Topic 51 Determination of blood groups

The concept of blood groups. Agglutinogens and agglutinins. Characteristics of blood groups of the ABO system. Modern ideas about blood groups of the ABO system. Characteristics of blood groups of the CDE system. Determination of blood groups in the ABO system and rhesus factor using standard sera and coliclons. Blood transfusion (blood transfusion), its stages.

#### Topic 52 Hemostasis system

The concept of hemostasis and its two main mechanisms. The structure of the hemostasis system. The role of the vascular wall and platelets in hemostasis. Mechanisms of vascular-platelet hemostasis: arteriole spasm, adhesion, platelet aggregation, release reaction, thrombus consolidation. Mechanisms of coagulation hemostasis. Blood clotting system. Phases of blood clotting, their essence. Characteristics of the anticoagulant blood system. Characteristics of the fibrinolysis system. Regulation of blood clotting. Physiological bases of methods of research of a condition of a hemostasis. Age-related changes in the hemostasis system. Mechanisms for maintaining the liquid state of the blood.

#### Topic 53 Evaluation of clinical blood test. Calculation work from the content module 5 "Physiology of blood".

Evaluate the clinical analysis of the blood of a healthy three-year-old child, a healthy adult adult, a healthy adult woman, a pregnant woman. Calculate the direction of fluid movement in the capillary by the magnitude of hydrostatic and oncotic pressures in the capillary and intercellular fluid. Calculate the oxygen capacity of the blood. Calculate the color index.

#### Topic 54 Solving situational problems from the content module 5 "Physiology of blood".

#### Topic 55 Final lesson from module 5 "Physiology of the blood system".

Functions and composition of blood. Physico-chemical properties of blood. Plasma proteins: quantity, classification, functions. Oncotic blood plasma pressure. The role of proteins in the redistribution of water in the body. The role of water and electrolytes in blood plasma. Osmotic pressure of blood plasma, the mechanisms of its support. The concept of hypo-, iso-, and hypertonic solutions. Properties of blood substitutes. blood pH. Mechanisms of its support. Characteristics of buffer systems of blood. Indicators of acid-base balance. Characteristics of blood groups of the ABO system. Modern ideas about blood groups. Characteristics of blood groups of the rhesus system. Rhesus conflict. Stages of blood transfusion. Properties of blood substitutes. General characteristics and properties of erythrocytes. Functions of erythrocytes. Causes and mechanisms of destruction of erythrocytes in the body. The concept of hemolysis of erythrocytes, types of hemolysis. Erythropoiesis. Regulation of erythrocyte content in peripheral blood. The main physiological and pathological compounds of hemoglobin. Color indicator. Distribution of leukocytes in the body. Types and causes of leukocytosis. General characteristics and properties of leukocytes. Leukocyte formula, the concept of its shift. Functions of granulocytes. Functions of agranulocytes. Regulation of leukopoiesis and leukocyte activity. The structure of the hemostasis system.

### **Module 6. Physiology of the cardiovascular system**

Topic 56 General characteristics of the circulatory system

General characteristics of the circulatory system, its structure. Functional departments of the circulatory system. Basic and additional functions of the circulatory system. Functional properties of heart muscle. Comparative characteristics of atypical and typical muscle fibers. The leading system of the heart, its meaning. Mechanisms of spontaneous pulse generation in the conductor system. The law of "gradient automatism". Conduction of impulses through the conduction system to the working myocardium. Functional properties of contractile muscle fibers of the heart. Action potential of contractile myocytes. Ionic mechanisms of the emergence of its main phases. Periods of absolute and relative refractoriness in the myocardium. Their physiological significance. Mechanisms of electromechanical coupling in cells of the contracting myocardium. Features of the actual contraction and relaxation processes in myocytes.

Topic 57 Study of the functioning of the conduction system of the heart of a frog. Ligatures of Stanius

The structure of the frog's heart. Localization of various elements of the conduction system of the heart of a frog. PD generation frequency in different nodes.

Topic 58 Mechanical work of the heart. Phase analysis of the cardiac cycle

Structural and functional elements of the heart as a pump. Functions of atria and ventricles. Valve apparatus of the heart, its functions. Modes of contractions of the heart and types of loads on it. The concept of the cycle of cardiac activity. Phase structure of the cardiac cycle. Characteristics of ventricular systole: periods of tension and expulsion. Characteristics of ventricular diastole: periods of relaxation and filling. Systolic and minute volumes of blood, cardiac index.

Topic 59 Examination of the apical impulse and heart tones

The concept of heart tones and methods of their study. Phonocardiography. Characteristics of the first heart sound. Characteristics of the second heart sound. Heart attack, its properties.

Topic 60 Regulation of the heart

Regulation of the heart Myogenic mechanisms of heart regulation. Frank-Starling law. Immediate mechanisms of heart adaptation to volume and resistance loads. The nature and mechanisms of the influence of the parasympathetic nervous system on the work of the heart. The nature and mechanisms of influence of the sympathetic nervous system on the work of the heart. The role of the metasympathetic nervous system in the regulation of heart activity. Intracardiac reflexes. The influence of factors of humoral regulation on the work of the heart.

Topic 61 Electrical work of the heart. Study methods

Conduction of electrical potentials from isolated muscle fibers, individual sections of the myocardium and the heart as a whole. Electrocardiogram elements (teeth, segments, intervals) and their characteristics. Electrocardiogram (ECG) registration methods.

Topic 62 Fundamentals of vector ECG analysis

Vector analysis of the origin of ECG waves. Electric axis of the heart. Causes of deviation of the electrical axis of the heart under normal conditions.

Topic 63 Calculation work "ECG registration and analysis".

ECG examination of the main segments, intervals, teeth, duration of the cardiac cycle, heart rate, systolic index. ECG evaluation of heart rate, sources of excitation, myocardial conduction. Methods for determining the electrical axis of the heart.

Topic 64 Basics of hemodynamics.

Laws of hemodynamics. Hemodynamic indicators: volume of blood in vessels, speed of blood movement, blood pressure, hemodynamic resistance, blood viscosity, nature of blood movement, hemodynamic factors of the vascular wall. Functional classification of blood vessels according to Folkov.

Topic 65 Patterns of blood circulation in arterial and venous vessels

Peculiarities of blood movement in arterial vessels: pulse fluctuations of blood movement speed, volume and pressure. Blood pressure: systolic, diastolic, pulse, average. Methods of measuring blood pressure. Factors determining this indicator. Concept of arterial pulse. Its main characteristics. Sphygmogram. Pulse wave propagation speed. Patterns of blood movement in venous vessels. The concept of venous pressure, venous pulse, venous return. Factors that ensure venous return of blood. Phlebogram.

Topic 66 Measurement of blood pressure in humans.

Blood pressure: systolic, diastolic, pulse, average. Methods of measuring blood pressure. Measurement of blood pressure in humans by the Riv-Roch's and Korotkov's methods

Topic 67 Regulation of local and systemic blood circulation

Peculiarities of mechanisms of microcirculatory vessel regulation. Myogenic, metabolic and histomechanical mechanisms of local blood circulation regulation. Concept of physiological arterial hyperemia. Nervous regulation of local blood circulation. Humoral mechanisms of local blood circulation regulation. Vascular tone and its regulation, nervous and humoral mechanisms. Regulation of systemic blood circulation. Cardiovascular center, its structure, afferent and efferent connections. The concept of a single hemodynamic center (Frolkis V.V.). The main reflexogenic zones, baroreceptors and chemoreceptors of the carotid sinus and aortic arch, their role. Reflexes from the receptors of the atria and large veins. Pressor and depressor reflexes. Interrelated mechanisms of nervous and humoral regulation of heart activity, vascular tone, and circulating blood volume during various adaptive reactions. Physiological prerequisites for blood pressure disorders. Nervous and humoral mechanisms of blood pressure regulation

Topic 68 Investigation of functional tests of the cardiovascular system.

Carrying out and estimation of orthostatic test of Martinat of Shalkov's test (with physical activity).

Topic 69 Solving situational problems from the content module 6 "Physiology of the cardiovascular system".

Topic 70 Final lesson from module 6 "Physiology of the cardiovascular system".

Basic and additional functions of the circulatory system. Functional properties of atypical cardiomyocytes. Leading system of the heart, its significance. Mechanisms of spontaneous pulse generation in a conductor system. The law of "gradient of automatism". Functional properties of contractile muscle fibers of the heart. The action potential of contractile myocardial cells. Ionic mechanisms of its main phases. The concept of the cycle of cardiac activity. Pulse fluctuations in blood flow, volume and pressure in arterial vessels. Patterns of blood flow in venous vessels. The concept of venous pressure, venous pulse, venous return. Myogenic, metabolic and histomechanical mechanisms of regulation of local blood circulation. Frank-Starling's law. Immediate mechanisms of adaptation of the heart to loads of volume and resistance. The nature and mechanisms of the parasympathetic nervous system on the heart. The nature and mechanisms of influence of the sympathetic nervous system on the heart. Nervous mechanisms of regulation of systemic hemodynamics. Characteristics of afferent central and efferent links of regulation. The role of reflexes in the regulation of systemic circulation.

### **Module 7. Physiology of the respiratory system**

Topic 71 General characteristics of the respiratory system. Research of indicators of external respiration.

Stages of respiration. General structure and main functions of the external respiratory system. Functional characteristics of the structural elements of the external respiratory system: chest, respiratory muscles, pleural cavity, airways, lungs. The concept of transpulmonary, pleural and alveolar pressure. Elastic traction of the lungs. Surfactants, their significance. Biomechanics of respiration. Mechanisms of inhalation and exhalation. Static indicators of lung ventilation. The concept of lung volume and lung capacity. Dynamic indicators of lung ventilation. Minute volume and lung capacity. Dynamic indicators of lung ventilation. Minute breathing volume, its definition. Spirometry. Spirography.

Topic 72 Calculation work "Registration and analysis of spirogram".

Determine by spirogram tidal volume, inspiratory reserve volume, expiratory reserve volume, lung vital capacity, respiratory rate, minute tidal volume, minute alveolar ventilation, minute O<sub>2</sub> intake. Find in the Harris-Benedict tables the appropriate value of these indicators by the value of the basic exchange. Calculate the percentage deviation of the obtained indicators from the appropriate ones.

Topic 73 Gas exchange in the lungs. Blood gas transport. Regulation of respiration.

The composition of inhaled, exhaled, alveolar air. The relative constancy of the composition of alveolar air. Tension of gases dissolved in the blood. Partial pressure of gases (PCO<sub>2</sub>, PO<sub>2</sub>) in alveolar air. Mechanisms of gas exchange between inhaled air and alveolar gas mixture, between alveoli and blood in pulmonary capillaries. Properties of the pulmonary membrane. Diffusion capacity of the lungs. Relationship between pulmonary circulation and pulmonary ventilation. Anatomical and physiological "dead space". Forms of oxygen transport by blood. Transport of physically dissolved oxygen in blood plasma. Influence of mechanical factors on the activity of the respiratory center. Types of mechanoreceptors in the lungs. Goering-Breyer reflex. Influence of chemical factors on the activity of the respiratory center. Central and peripheral mechanisms of these influences. Evaluation by means of functional respiratory tests of elasticity of pulmonary fabric, width of small bronchial tubes and a tone of bronchial muscles

Topic 74 Investigation of functional tests of the respiratory system

Measure the vital capacity of the lungs with a dry spirometer. Evaluate the elasticity of lung tissue based on the results of Christie's test. Evaluate the width of the small bronchi and the tone of the bronchial muscles according to the results of the Votchak test. Investigate the Stange-Gench test with respiratory arrest.

**Module 8. Physiology of the digestive system**

Topic 75 General characteristics of the digestive system

Structure and functions of the digestive system. Digestive tract and digestive glands. The main functions of the digestive system: secretion, motility, absorption. Digestion: its types (cavity, membrane, intracellular), main stages. Features of secretory cells, mechanisms of secretion, the role of calcium ions and cellular mediators in the secretory process. Basic principles and mechanisms of digestion regulation. Gastrointestinal hormones. Phases of secretion of the main digestive glands. Periodic activity of the digestive system. Digestive tract motility. Features of the structure and functions of the smooth muscles of the digestive tract. Physiological bases of methods of research of functions of the digestive tract. Physiological bases of hunger and satiety. Nutritional motivation, ideas about the food center. Contour of regulation of maintenance of constancy of the content of nutrients in the internal environment.

Topic 76 Digestion in the mouth and stomach

The value of the oral cavity as the initial part of the digestive system. Composition, properties and significance of saliva. Mechanisms and regulation of salivation. Mechanical processing of food. Mechanisms of chewing and swallowing. Taste analyzer, its structure and value. The importance of the stomach in digestive processes. Gastric juice, its composition, properties and values

Topic 77 Digestion in the intestines. The role of the liver and pancreas in digestion processes

The importance of small intestines in digestion processes. Pancreatic juice, its composition, properties and importance of the main components. The influence of various food substances on the secretion of pancreatic juice. Nervous and humoral mechanisms of regulation of pancreatic secretion. Bile, its composition, properties and significance of the main components. Mechanisms of bile secretion and regulation of this process. Protective (barrier and antitoxic), metabolic and hemodynamic functions of the liver. Intestinal secretion, composition and properties of intestinal juice, its role in digestion. Research methods. Regulation of intestinal secretion. Cavity and membrane hydrolysis of nutrients in the small intestine. Motor activity of the small intestine, its role in digestion. Types of motility, its regulation. The role of the metasymphathetic system in the regulation of the secretory and motor functions of the intestines. Digestion in the large intestine. The role of gut microflora. Colon motility, its regulation. Act of defecation. Absorption mechanisms in different departments of the digestive system. Absorption of water, mineral salts, hydrolysis products of proteins, fats and carbohydrates

Topic 78 Individual work of students from module 8 "Physiology of the digestive system".

Absorption in the gastrointestinal tract (discussion of presentations).

**Module 9. Physiology of metabolism and energy. Thermoregulation**

#### Topic 79 Thermoregulation

The concept of core and shell as temperature zones of the body. Periodic fluctuations in body temperature, changes in body temperature under physiological conditions. Mechanisms of heat generation. The concept of contractile and non-contractile thermogenesis. Mechanisms of heat transfer. Environmental factors affecting heat transfer. Properties and physiological reactions of the body that determine the intensity of heat transfer. The center of thermoregulation, its structure and basic principles of functioning. Afferent and efferent link of thermoregulation. Significance of small intestines in digestive processes

#### Topic 80 Exchange of substances and energy

Physiological significance of proteins, fats and carbohydrates. Concept of nitrogen balance. Energy conversion in the body. Methods of determining energy exchange: direct and indirect calorimetry. The caloric equivalent of oxygen and the respiratory rate, their significance in metabolic studies. The concept of basic exchange. Factors affecting its value. Specific dynamic effect of food. Energy expenditure of the body during physical and mental activity. Physiological foundations of rational nutrition. Calorie ratios of nutrients.

#### Topic 81 Estimated work "Compilation of food ration".

Determine the basic exchange in humans according to the tables of Harris-Benedict. Determine the daily energy consumption in humans by incomplete gas analysis. Determine the daily energy expenditure of a person in different activities. Make a diet.

### **Module 10. Physiology of the excretory system**

#### Topic 82 General characteristics of the excretory system.

The structure and functions of the excretory system. The excretory system, its structure, functions. Excretory organs (kidneys, skin, lungs, alimentary canal), their participation in maintaining body homeostasis. Kidneys as the main organs of the excretory system. Nephron as a structural and functional unit of the kidney. Blood circulation in the kidney, its features. Physiological basis of methods of research of kidney function. Assessment of clinical urinalysis

#### Topic 83 The main processes of urine formation

The main processes of urine formation: filtration, reabsorption, secretion. Filtering mechanisms, composition of primary urine. Filter speed adjustment. Reabsorption in tubules, its mechanisms. The rotary-countercurrent-multiple system, its role. Secretory processes in proximal and distal tubules and collecting tubules. Diuresis. Composition of primary and secondary urine.

#### Topic 84 Calculation work "Determination of filtration and reabsorption in the kidneys."

Investigate the glomerular filtration rate by inulin clearance, evaluate the value obtained. Investigate the amount of water reabsorption, evaluate the value obtained. Evaluate the clinical analysis of urine. Investigate the value of maximum glucose reabsorption, evaluate the value obtained. Investigate the amount of reabsorption and secretion of various substances, evaluate the results.

#### Topic 85 Regulation of kidney function

Mechanisms of regulation of kidney function. Secretory function of the kidneys. Renin-angiotensin-aldosterone system, mechanisms of activation, physiological significance. The role of kidneys in the regulation of water-salt exchange. The role of kidneys in the regulation of acid-base balance.

Topic 86 Solving situational problems from the content modules 7 - 10 "Physiology of the respiratory system", "Physiology of the digestive system", "Physiology of metabolism". Thermoregulation ", " Physiology of selection ".

Topic 87 Final lesson from modules 7 - 10 "Physiology of the respiratory system", "Physiology of the digestive system", "Physiology of metabolism and energy". Thermoregulation ", " Physiology of the excretory system ".

Stages of respiration. General structure and main functions of the external respiratory system. Functional characteristics of the structural elements of the external respiratory system: chest, respiratory muscles, pleural cavity, airways, lungs. Biomechanics of respiration. Mechanisms of inhalation and exhalation. Static and dynamic indicators of lung ventilation. Composition and partial pressure of alveolar mixture gases. The concept of the respiratory center. Methods of research of its localization. Physiological significance of proteins, fats and carbohydrates. The concept of nitrogen balance. Energy conversion in the body. Methods for determining energy metabolism: direct and indirect calorimetry. Thermoregulation center, its structure and basic principles of operation. Afferent and efferent link of thermoregulation The concept of types of digestion. General characteristics of the mechanisms of regulation of digestive processes. Gastrointestinal hormones. Basic methods of studying the functions of the digestive tract. The value of the oral cavity as the initial part of the digestive system. General characteristics of the selection system. Kidney function. Nephron as a functional unit of the kidneys. Features of blood supply to the kidneys. Processes that ensure the formation of urine. Characteristics of filtration processes in the kidneys. Evaluation of filtration in the clinic.

Topic 88 Practical skills from the course "Physiology".

Determining the absolute strength of the muscles of the hand. Determining the efficiency of the muscles of the hand. Determination of the rate of decrease in the efficiency of the muscles of the hand. Determining the type of muscle contraction. You-value the reflex time. Determining the type of response of the neuron during its stimulation. Reproduction of clinically important reflexes. Determination of the leading part of the body and the dominant hemisphere. You-value of the patient's autonomic tone. Determination of the type of autonomic reactivity. Determining the type of intersystem relations at rest and during exercise. Determination of sensitivity of different parts of the body. Characteristics of the general analysis of blood. Study of erythrocyte sedimentation rate (ESR), assessment of the magnitude and determination of factors that affect it. Study of the content of hemoglobin in the blood by the method of Sali and evaluation of the obtained value. Examination of the number of erythrocytes in the blood and evaluation of the obtained value. Calculation of color index. Calculation of blood oxygen capacity. Investigation of blood groups in the ABO and Rh systems using standard sera and coliclons. Determination of blood pressure, calculation of pulse and mean blood pressure and assessment of their values. Determining the type of response of the cardiovascular system to exercise.

<p>Topic 89 Practical skills from the course "Physiology"</p> <p>Be able to determine the value of arterial pressure, calculate pulse and average arterial pressure and estimate their value. Be able to determine the type of reaction of the cardiovascular system to physical exertion. To be able to investigate the properties of an apical thrust. Be able to investigate the properties of heart sounds by auscultation. Be able to calculate the minute volume of the heart. Be able to calculate systolic (stroke), end-diastolic (KDO) and end-systolic volumes (KSO). Be able to calculate the duration of the cardiac cycle and the frequency of heart contractions from the ECG and evaluate the obtained values. To be able to determine the duration of the electrical systole of the heart from the ECG and calculate the systolic index and evaluate the obtained values. Be able to determine the direction of the electrical axis of the heart of the ECG and evaluate the obtained result. Be able to determine the characteristics of the teeth of the ventricular complex and segments in standard ECG leads and evaluate the obtained values. Be able to determine the duration of the main ECG intervals and evaluate the obtained values. To be able to evaluate the regularity of heart contractions according to the ECG. To be able to evaluate the conduction of the myocardium according to the ECG. Be able to determine the source of excitation in the heart by ECG. Be able to determine the direction of movement of liquid in the capil</p>
<p>Topic 90 Preparation for the license exam "KROK-1".</p>
<p>Topic 91 Practical indicative exam</p> <p>Conducting the exam in accordance with the regulations</p>

## 5. Intended learning outcomes of the course

After successful study of the course, the student will be able to:

LO1	To explain the mechanisms of functioning of human organs and systems under different conditions.
LO2	To analyze the role of nervous and humoral regulation in ensuring homeostasis.
LO3	To recognize the age characteristics of the human body and assess the health status of people of different ages.
LO4	To apply laboratory and instrumental research methods to assess the condition of organs and systems of the human body.
LO5	To make calculations of the indicators reflecting functioning of an organism, on the basis of laboratory and instrumental inspection.
LO6	To anticipate physiological changes in the activities of organs and systems under the influence of various environmental factors.
LO7	To identify the leading mechanisms to ensure the integrative activity of the organism.

## 6. Role of the course in the achievement of programme learning outcomes

Programme learning outcomes achieved by the course.

For 222 Medicine:

PO2	Understanding and knowledge of basic and clinical biomedical sciences, at a level sufficient for solving professional tasks in the field of health care.
PO4	Identify and identify leading clinical symptoms and syndromes (according to list 1); according to standard methods, using preliminary data of the patient's history, data of the patient's examination, knowledge about the person, his organs and systems, establish a preliminary clinical diagnosis of the disease (according to list 2).
PO5	Collect complaints, history of life and diseases, evaluate psychomotor and physical development of the patient, state of organs and systems of the body, based on the results of laboratory and instrumental studies, evaluate information regarding the diagnosis (according to list 4), taking into account the age of the patient.
PO11	Determine the approach, plan and tactics of managing physiological pregnancy, physiological childbirth and the postpartum period by making a reasoned decision according to existing algorithms and standard schemes.
PO12	To assess the general condition of a newborn child by making a reasoned decision according to existing algorithms and standard schemes, observing the relevant ethical and legal norms.
PO17	Perform medical manipulations (according to list 5) in the conditions of a medical institution, at home or at work based on a previous clinical diagnosis and/or indicators of the patient's condition by making a reasoned decision, observing the relevant ethical and legal norms.
PO21	Search for the necessary information in the professional literature and databases of other sources, analyze, evaluate and apply this information.

## 7. Soft Skills

SS1	Ability to learn and master modern knowledge.
SS2	Ability to apply knowledge in practical situations.
SS3	Knowledge and understanding of the subject area and understanding of professional activity.
SS4	Ability to use information and communication technologies.
SS5	Ability to search, process and analyze information from various sources.
SS6	The ability to preserve and multiply moral, cultural, scientific values and achievements of society based on understanding the history and patterns of development of the subject area, its place in the general system of knowledge about nature and society and in the development of society, technology and technologies, to use various types and forms of motor activity for active recreation and leading a healthy lifestyle.

## 8. Teaching and learning activities

### Topic 1. Subject and tasks of physiology

lect.1 "Introduction to physiology. Physiology of excitatory structures" (full-time course)

Physiology as a science. General information about the discipline. Physiology as a scientific basis of medicine about body functions. The value of physiology in training a doctor. The main stages of the development of physiology. Basic concepts of electrophysiology. The concept of membrane potential and resting potential. The physiological role of resting potential. The role of V.Yu. Chagovets in the development of the hypothesis about the ionic mechanism of the origin of the resting potential. Methods of recording resting potential, physical characteristics, mechanism of origin. Teaching is conducted in the form of multimedia lectures (in case of quarantine - in online mode).

pr.tr.1 "Subject and tasks of physiology." (full-time course)

Instruction on safety rules. General information about the discipline. Regulations on discipline. Physiology as a scientific basis of medicine about the functions of the body. The importance of physiology in the training of physicians. The study of this topic involves theoretical work in the classroom, the use of virtual simulation (watching a movie on this topic) with further discussion.

### **Topic 2. The main stages of development of physiology. Methods of physiological research**

pr.tr.2 "The main stages of development of physiology. Methods of physiological research (discussion of presentations)." (full-time course)

A brief description of the development of physiology. Review of the main methods of physiological research. The study of this topic involves theoretical work in the classroom, a speech with presentations followed by discussion.

### **Topic 3. Functional properties of cell membranes.**

pr.tr.3 "Functional properties of cell membranes" (full-time course)

Modern understanding of the structure and functions of cell membranes. The main differences in the chemical composition of the extracellular fluid and the intracellular environment. Mechanisms of transport of substances through the cell membrane. Passive transport of substances, its types and mechanisms. Factors affecting the intensity of diffusion. Active transport of substances, its types and mechanisms. The study of this topic involves theoretical work in the classroom, the use of virtual simulation (watching a film on the specified topic) with further discussion.

### **Topic 4. The potential for rest of nerve and muscle fibers**

pr.tr.4 "The potential of nerve and muscle fibers." (full-time course)

The concept of membrane potential and rest potential. Methods of registration of resting potential, physical characteristics, mechanism of origin. Physiological role of resting potential. The study of this topic involves theoretical work in the classroom, the use of virtual simulation (watching a movie on this topic) with further discussion.

### **Topic 5. The potential of nerve and muscle fibers**

pr.tr.5 "The potential of nerve and muscle fibers" (full-time course)

Action potential, its physical and physiological characteristics. Structure and main properties of ionic channel proteins involved in the development of PD. Ionic mechanisms of occurrence of the main phases of PD. Excitability, its changes during the development of PD. The study of this topic involves theoretical work in the classroom, the use of virtual simulation (watching a movie on this topic) with further discussion.

#### **Topic 6. Preparation of a neuromuscular preparation**

pr.tr.6 "Preparation of a neuromuscular preparation." (full-time course)

The study of this topic involves laboratory studies in the classroom, namely the manufacture of a spinal frog, rheoscopic foot, neuromuscular drug, demonstration of direct and indirect irritation, checking the physiological integrity of the drug with an electrical stimulator.

#### **Topic 7. Mechanisms of electrical stimulation of excitable structures.**

pr.tr.7 "Mechanisms of electrical stimulation of excitable structures. Mechanisms of excitation through nerve and muscle fibers." (full-time course)

Methods of electrical stimulation of nerve and muscle fibers. Parameters of electric current that determine its ability to cause excitation. The mechanism of nerve impulse conduction through myelin-free and myelin fibers. Structure and classification of synapses. Features of functioning of electric and chemical synapses. The study of this topic involves theoretical work in the classroom, the use of virtual simulation (watching a movie on this topic) with further discussion.

#### **Topic 8. Study of bioelectrical phenomena in living tissues**

pr.tr.8 "Study of bioelectrical phenomena in living tissues." (full-time course)

The concept of bioelectric potentials. Types of potentials that arise in a living organism. Damage potential. The mechanism of bioelectric potentials. Reproduction of bioelectric phenomena in the experiments of Galvani, Aldini, Matteucci. The study of this topic involves laboratory research in the classroom (experiments Galvani, Aldini, Matteucci) with subsequent discussion of the results.

#### **Topic 9. Conduction of excitation along nerve and muscle fibers**

pr.tr.9 "Conduction of excitation along nerve and muscle fibers" (full-time course)

The mechanism of conduction of a nerve impulse along unmyelinated nerve fibers. Peculiarities of conduction of excitation along myelinated nerve fibers. and myelin fibers. Laws of conduction of excitation along nerve and muscle fibers. Factors determining the speed of action potential conduction along nerve fibers. Characteristics of nerve fibers according to Erlanger-Gasser. Structure and classification of synapses. Features of the functioning of electrical and chemical synapses. The mechanism of transmission of excitation through the neuromuscular synapse. The study of this topic involves theoretical work in the classroom, the use of virtual simulation (watching a film on the specified topic) with further discussion.

#### **Topic 10. Solving situational problems from the section "Electrophysiology".**

pr.tr.10 "Solving situational problems from the section "Electrophysiology"." (full-time course)

The study of this topic involves solving situational problems from the section "Electrophysiology" with further discussion of the results.

**Topic 11. Skeletal and smooth muscle contractions**

pr.tr.11 "Skeletal and smooth muscle contractions." (full-time course)

Structural organization of the muscle contractile apparatus. Modern understanding of the mechanism of muscle fiber contraction. Stages of the reduction process. The main features of the contractile apparatus and the functioning of smooth muscles. The study of this topic involves theoretical work in the classroom, the use of virtual simulation (watching a movie on this topic) with further discussion.

**Topic 12. Study the main characteristics of muscle contraction**

pr.tr.12 "Study the main characteristics of muscle contraction." (full-time course)

Physiological characteristics of muscle contraction: load, strength, duration, speed, work, fatigue. Electromyography. Dynamometry. The study of this topic involves laboratory studies in the classroom (determination of the absolute strength of the muscles of the hand, the level of efficiency and fatigue of the muscles of the hand by dynamometry), followed by discussion of the results.

**Topic 13. Calculation work from the content module 1 "Introduction to physiology. Physiology of excitable structures".**

pr.tr.13 "Calculation work from the content module 1 "Introduction to physiology. Physiology of excitable structures"." (full-time course)

The study of this topic involves theoretical work in the classroom: performing computational tasks (equilibrium potential according to the Nernst equation, the value of the membrane potential of the nerve fiber according to the Goldman-Hodgkin-Katz equation, reliability factor, determination of absolute muscle strength, efficiency and efficiency, the type of muscle contraction depending on the frequency of its stimulation, the frequency of muscle stimulation to obtain different types of contraction), followed by discussion of the results.

**Topic 14. Final lesson from module 1 "Introduction to physiology. Physiology of excitable structures".**

pr.tr.14 "Final lesson from the content module 1 "Introduction to physiology. Physiology of excitable structures"." (full-time course)

Computer testing and oral examination from module 1 "Introduction to physiology. Physiology of excitable structures"

**Topic 15. General patterns of nervous regulation of functions**

lect.2 "General patterns of nervous regulation of body functions." (full-time course)

The main features of nervous regulation of functions. Properties of nerve centers. Coordination of reflex activity. CNS synapses, their structure, mechanisms of information transfer. Classification of mediators, their general characteristics. Characteristics of excitatory and inhibitory postsynaptic potentials. Central braking, its types, mechanisms, significance. The role of inhibitory neural circuits in the occurrence of central inhibition. Teaching is carried out in the form of multimedia lectures (in the presence of quarantine - on-line).

pr.tr.15 "General patterns of nervous regulation of functions." (full-time course)

The main features of nervous regulation of functions. Properties of nerve centers. Coordination of reflex activity. The study of this topic involves theoretical work in the classroom, the use of virtual simulation (watching a movie on this topic) with further discussion.

### **Topic 16. Reflex arc analysis.**

pr.tr.16 "Reflex arc analysis. Study of excitation and inhibition in the CNS." (full-time course)

The concept of reflexes, their classification. Reflex arc, functions of its separate elements. The study of this topic involves laboratory studies in the classroom (reproduction of the Turk's reflex in frogs, determining the reflex time, analysis of the reflex arc, the study of sequential and simultaneous summation, the study of central inhibition of spinal reflexes (IM Sechenov's experiment) with further discussion of the results .

### **Topic 17. Excitation and inhibition in the CNS**

pr.tr.17 "Study of clinically important spinal reflexes in humans." (full-time course)

Characteristics and classification of spinal reflexes. Determination of the area of

### **Topic 18. Study of inhibition of spinal reflexes**

pr.tr.18 "Determination of functional asymmetry of the cortex of the large hemispheres." (full-time course)

Interhemispheric asymmetry. Psychophysiological differences of people depending on brain organization, features of their emotional sphere. The phenomenon of ambidexterity. The study of this topic involves laboratory research in the classroom: the study of functional asymmetry of the cortex of the large hemispheres by conducting morphological and functional tests, identifying the leading hemisphere of the brain.

### **Topic 19. The role of the spinal cord in the regulation of body functions**

lect.3 "The role of the spinal cord in the regulation of motor and autonomic functions of the body." (full-time course)

General structural and functional characteristics of the spinal cord. Analysis of sensory information by the spinal cord. Mechanisms of muscular and articular reception (proprioception). Muscle spindles (tension receptors), their structure, functions, excitation mechanism. Gamma loop functions. Golgi tendon receptors, their functions, reflexes from tendon receptors. Conductive function of the spinal cord, its role in the regulation of motor functions. Reflex function of the spinal cord. Characteristics of tonic reflexes (myotatic and cervical tonic), their reflex arc. Characteristics of phase reflexes, their reflex arcs. Teaching is conducted in the form of multimedia lectures (in the presence of quarantine - on-line).

pr.tr.19 "The role of the spinal cord in the regulation of body functions." (full-time course)

General structural and functional characteristics of the spinal cord. Analysis of sensory information by the spinal cord. Conductive function of the spinal cord, its role in the regulation of motor functions. Brown-Sekara syndrome. Spinal shock. Autonomic function of the spinal cord. Reflex function of the spinal cord. The study of this topic involves theoretical work in the classroom, the use of virtual simulation (watching a movie on this topic) with further discussion.

### **Topic 20. Study of clinically important spinal reflexes in humans**

pr.tr.20 "Study of autonomic tone and autonomic reactivity in humans." (full-time course)

The concept of autonomic tone (vagotonia, sympathocotonia, eytonia) and autonomic reactivity in humans. The study of this topic involves laboratory studies in the classroom with the following discussion and evaluation of the obtained indicators: determination of autonomic tone in humans by calculating the Curdue index and dermographism; assessment of autonomic reactivity by reproducing the reflexes of Danini-Ashner and Chermak; study of ensuring the work of internal organs by calculating the Hildebrant coefficient and conducting the Letunov test.

### **Topic 21. The role of the hindbrain in the regulation of body functions**

pr.tr.21 "Determination of functional asymmetry of the cortex of large hemispheres." (full-time course)

Interhemispheric asymmetry. Psychophysiological differences of people depending on the brain organization, features of their emotional sphere. The phenomenon of ambidexterity. The study of this topic involves laboratory research in the classroom: the study of functional asymmetry of the cortex of the large hemispheres by conducting morphological and functional tests, identifying the leading hemisphere of the brain.

### **Topic 22. The role of the midbrain and basal nuclei in the regulation of body functions**

pr.tr.22 "The role of the midbrain and basal nuclei in the regulation of body functions" (full-time course)

Neuronal organization of the midbrain. Sensory function of the midbrain. Vegetative function of the midbrain. Reflex function of the middle brain. Decerebral rigidity. Characteristics of static, statokinetic and orientational reflexes. The role of the reticular formation in the implementation of motor functions. The influence of the medial and lateral reticulospinal tracts on motoneurons of the spinal cord. Functional organization and connections of basal nuclei. Functions of the basal nuclei. Neurotransmitters in the system of basal nuclei, their physiological role. Cycles of the shell and caudate body. Clinical manifestations in damaged basal nuclei, their physiological mechanisms.

### **Topic 23. The role of the cerebellum, thalamus, and hypothalamus in the regulation of body functions.**

pr.tr.23 "The role of the cerebellum, thalamus and hypothalamus in the regulation of body functions" (full-time course)

Structural and functional organization of the cerebellum, its afferent and efferent connections, their physiological role. Functions of the cerebellum. Consequences of removal or damage to the cerebellum occurring in humans, their physiological mechanisms. Functional characteristics of thalamus nuclei. Functions of the hypothalamus. Limbic system. Its connections and functions

### **Topic 24. Study of functional asymmetry of the cortex of the large hemispheres**

pr.tr.24 "Study of functional asymmetry of the cortex of the large hemispheres" (full-time course)

Peculiarities of the geniculate structure of the cortex of the large hemispheres. Zones of the cortex of the large hemispheres. Functions of the cortex of the large hemispheres. Interhemispheric asymmetry. The phenomenon of ambidexterity. Study of functional asymmetry of the cortex of the large hemispheres by conducting morphological and functional tests. Identification of the leading hemisphere of the brain.

**Topic 25. Nervous regulation of autonomic functions**

pr.tr.25 "Nervous regulation of autonomic functions." (full-time course)

Structural and functional features of the autonomic nervous system. Features of the reflex arc of the autonomic reflex. Classification of autonomic reflexes. Vegetative ganglia, their functions. The mechanism of excitation transmission in the autonomic ganglia. Mediators and blockers of the autonomic nervous system. Influence of sympathetic, parasympathetic and metasympathetic divisions on organs. Research and use of autonomic reflexes in practical medicine. Central regulation of visceral functions. Integrative centers of regulation of visceral functions. The study of this topic involves theoretical work in the classroom, the use of virtual simulation (watching a movie on this topic) with further discussion.

**Topic 26. Research of autonomic tone and autonomic reactivity in humans**

pr.tr.26 "Research of autonomic tone and autonomic reactivity in humans." (full-time course)

The concept of vegetative tone (vago-tonia, sympatho-tonia, eito-tonia) and vegetative reactivity in humans. The study of this topic involves laboratory research in the classroom with the following discussion and assessment of the obtained indicators: determination of the vegetative tone in a person using the calculation of the Curdew index and conducting dermographism; assessment of autonomic reactivity by reproduction of Danini-Ashner and Chermak reflexes; study of ensuring the work of internal organs according to calculations of the Hildebrandt coefficient and carrying out the Letunov test.

**Topic 27. Calculation work and solution of situational problems from the content module 2 "Nervous regulation of body functions"**

pr.tr.27 "Calculation work and solution of situational problems from the content module 2 "Nervous regulation of body functions"." (full-time course)

The study of this topic involves theoretical work in the classroom: performing computational tasks (calculating the frequency of presynaptic pulses, calculating the reflex time by the complexity of the reflex arc, calculating the Curduy index and its estimation, calculating the Hildebrant coefficient and its estimation) and solving situational problems the following discussion of the obtained results.

**Topic 28. Final lesson from module 2 "Nervous regulation of body functions".**

pr.tr.28 "Final lesson from the content module 2 "Nervous regulation of body functions"." (full-time course)

Computer testing and oral examination from module 2 "Nervous regulation of body functions".

**Topic 29. General regularities of humoral regulation of vegetative functions**

lect.4 "General patterns of humoral regulation of body functions." (full-time course)

Relationship of nervous and humoral regulation. The contour of humoral regulation, the role of feedback in regulation. Factors of humoral regulation, their characteristics and classification. The role of factors of local regulation. Structural and functional organization of the endocrine system. Endocrine glands, endocrine cells, their hormones and significance. Determination of endocrine function and its components. Mechanisms of regulation of endocrine glands. Types of secretion and forms of hormone transport. Characteristics of cyto-reception mechanisms. The main stages of intracellular and cytoplasmic cyto-reception. The value of secondary intermediaries. Hormone metabolism. Teaching is conducted in the form of multimedia lectures (in the presence of quarantine - on-line).

pr.tr.29 "General regularities of humoral regulation of vegetative functions." (full-time course)

The main features of humoral regulation of functions. Factors of humoral regulation, their characteristics and classification. The role of factors of local regulation. Structural and functional organization of the endocrine system. The study of this topic involves theoretical work in the classroom, the use of virtual simulation (watching a movie on this topic) with further discussion.

### **Topic 30. Hypothalamic-pituitary system.**

pr.tr.30 "Hypothalamic-pituitary system." (full-time course)

The hypothalamus as the central endocrine organ. Functional connection of the hypothalamus with the pituitary gland. Neurosecretes of the hypothalamus. The role of liberins and statins. Consequences of dysfunction of the hypothalamic-pituitary system. The study of this topic involves theoretical work in the classroom, the use of virtual simulation (watching a movie on this topic) with further discussion.

### **Topic 31. The role of hormones in the regulation of physical and mental development**

pr.tr.31 "The role of hormones in the regulation of physical and mental development" (full-time course)

Hormones of the adeno-hypophysis: chemical nature, regulation of secretion, mechanism of action. Functional, metabolic and structural effects. The role of somatotropic hormone in ensuring growth and development processes. The value of somatomedins. Consequences of hypo- and hypersecretion of somatotropin. Thyroid hormones: chemical nature, synthesis and secretion, regulation of secretion, mechanism of action. Functional and metabolic effects. Consequences of hypo- and hypersecretion. The role of other hormones affecting growth processes (insulin, sex hormones, cortisol). The study of this topic involves theoretical work in the classroom, the use of virtual simulation (watching a film on the specified topic) with further discussion.

### **Topic 32. The role of hormones in the regulation of sexual development**

pr.tr.32 "The role of hormones in the regulation of sexual development" (full-time course)

Gonads. Sexual differentiation, development and functions of the reproductive system. Male sex hormones: chemical nature, regulation of secretion, mechanism of action, functional, metabolic and structural effects. Female sex hormones: chemical nature, regulation of secretion, mechanism of action, functional, metabolic and structural effects. Menstrual cycle. Pregnancy. Hormones of the placenta. Thymus hormones. Thymic-lymphatic status. Hormones of the pineal gland. The study of this topic involves theoretical work in the classroom, the use of virtual simulation (watching a film on the specified topic) with further discussion.

### **Topic 33. The role of hormones in the regulation of homeostasis**

pr.tr.33 "The role of hormones in the regulation of homeostasis." (full-time course)

Pancreatic hormones (insulin, glucagon, somatostatin) and their effects on metabolism and blood glucose concentration. Contour of hormonal regulation of maintenance of constancy of concentration of glucose in blood. Calcium balance in the body and hormones that regulate calcium and phosphate homeostasis: parathyroid hormone, calcitonin,  $1,25(\text{OH})_2\text{D}_3$ . The effect of other hormones on calcium metabolism (glucocorticoids, somatotropin, IGF-1, thyroid hormones, estrogens, insulin). The role of vasopressin, oxytocin. Hormones of the adrenal medulla (catecholamines), their role in the body, regulation of secretion. Hormones of the adrenal cortex, contours of regulation of their secretion, circadian rhythms of glucocorticoid secretion, their effects and mechanisms of action on target cells. The study of this topic involves theoretical work in the classroom, the use of virtual simulation (watching a movie on this topic) with further discussion.

### **Topic 34. The role of hormones in regulating the body's adaptation to stress factors**

pr.tr.34 "The role of hormones in regulating the body's adaptation to stress factors" (full-time course)

The concept of stress and stressors. Types of adaptation to stress factors. General adaptation syndrome (G. Cellier). The role of the sympathetic-adrenal system in adaptation. The role of hormones of the adrenal cortex (glucocorticoids, mineralocorticoids), pituitary gland, thyroid hormones (thyroxine, triiodothyronine), weight-insular system in ensuring non-specific adaptation of the body to stress factors. The study of this topic involves theoretical work in the classroom, a speech with presentations followed by discussion.

### **Topic 35. Solving situational problems from the content module 3 "Humoral regulation of body functions".**

pr.tr.35 "Solving situational problems from the content module 3 "Humoral regulation of body functions"." (full-time course)

The study of this topic involves theoretical work in the classroom, solving situational problems in the section "Humoral regulation of body functions" with subsequent discussion of the results.

### **Topic 36. Final lesson from module 3 "Humoral regulation of body functions".**

pr.tr.36 "Final lesson from the content module 3 "Humoral regulation of body functions"." (full-time course)

Computer testing and oral examination from the module "Humoral regulation of body functions".

**Topic 37. Sensor systems. Study of the somato-sensory analyzer**

pr.tr.37 "Sensor systems. Study of the somato-sensory analyzer" (full-time course)

The concept of sensor systems (analyzers). General principles of structure and basic functions of analyzers. Properties and functional organization of analyzers. The concept of absolute and differential threshold of sensation. Weber-Fechner law. Classification of receptors, their functions. Functions of the conducting and central departments of the analyzers. Structural and functional organization of the somato-sensory system (skin and proprioceptive sensitivities). Physiological basis of pain. Nociception, physiological characteristics and classification of nociceptors. Nociceptive or pain system, its structural and functional organization, leading paths and levels of information processing. Physiological significance of pain. Antinociceptive system, its structural and functional organization, opiate and non-opiate mechanisms, physiological role. Physiological bases of anesthesia. Structural and functional organization of the taste sensory system. Types of tastes, mechanisms of their perception, physiological role. Structural and functional organization of the olfactory sensory system. Classification of odors, theories of their perception. Structural and functional organization of the visual analyzer. Optical eye system. The mechanism of refraction and accommodation. Anomalies of refraction of the eye. Pupil reflex, its physiological meaning. Photochemical and electrical phenomena in the retina. Light and contrast sensitivity

**Topic 38. Visual analyzer**

pr.tr.38 "Visual analyzer" (full-time course)

Structural and functional organization of the visual analyzer. Optical system of the eye. Mechanism of refraction and accommodation. Refraction anomalies of the eye. Pupillary reflex, its physiological significance. Photochemical and electrical phenomena in the retina. Light and contrast sensitivity of the organs of vision. The concept of vision adaptation. Modern ideas about the mechanisms of color perception. The main forms of color perception disorders. The study of this topic involves theoretical work in the classroom, the use of virtual simulation (watching a film on the specified topic) with further discussion

**Topic 39. Auditory and vestibular analyzer**

pr.tr.39 "Auditory and vestibular analyzer" (full-time course)

General characteristics of the auditory analyzer. Functions of the outer and middle ear. Structural and functional organization of the inner ear. Mechanisms of sound perception. Analysis of the frequency and power of sounds. Characteristics of sound sensations. Structural and functional organization of the vestibular analyzer. Vestibular reactions. The study of this topic involves theoretical work in the classroom, the use of virtual simulation (watching a film on the specified topic) with further discussion.

**Topic 40. Study of the properties of visual, auditory and vestibular analyzers**

pr.tr.40 "Study of the properties of visual, auditory and vestibular analyzers" (full-time course)

Studying this topic involves determining in the classroom: visual acuity and hearing, field of vision, studying the pupillary reflex, studying air and bone conduction of sounds, studying the vestibular analyzer.

**Topic 41. Physiological bases of behavior**

pr.tr.41 "Physiological bases of behavior" (full-time course)

Physiological bases of behavior. Congenital and acquired forms of behavior, their importance for the adaptive activity of the organism. Patterns of formation and storage of conditioned reflexes (I.P. Pavlov). Inhibition of conditioned reflexes. Learning and memory, its types, mechanisms. Sleep. Its phases. Mechanisms of sleep development. The importance of sleep for the body. Needs and motivations, their physiological mechanisms, role in the formation of behavior. Functional behavior system. The structure of a complete behavioral act according to P.K. Anokhin. Emotions, their types, formation mechanisms, biological role. Theories of emotions. The study of this topic involves theoretical work in the classroom, defense of essays with further discussion.

#### **Topic 42. Higher nervous activity of a person**

pr.tr.42 "Higher nervous activity of a person" (full-time course)

Types of higher nervous activity, their classification, physiological bases, research methods. Thinking. The role of brain structures in the thinking process. Consciousness. Physiological foundations of consciousness. The concept of signaling systems. Comparative characteristics of I and II signaling systems. Formation of the II signaling system in ontogenesis. Language functions. Language centers. Types of higher nervous activity of people depending on the level of functioning of signaling systems. The main provisions of the teaching of I.P. Pavlov on the types of higher nervous activity of humans and animals.

#### **Topic 43. Study of cognitive processes and types of higher human nervous activity**

pr.tr.43 "Study of cognitive processes and types of higher human nervous activity" (full-time course)

Types and mechanisms of memory. Assessment of the capacity of various types of short-term memory (visual, auditory, logical). The concept of attention, its types and disorders. Methods of studying attention. Conducting and evaluating the proofreading test. Typological properties of the human nervous system (strength, speed, balance). Evaluation of the mobility of nervous processes. The concept of temperament, its types. Methods of studying human temperament. Determining the type of temperament using the Eysenck questionnaire

#### **Topic 44. Individual work of students from module 4 "Physiology of analyzers and VND"**

pr.tr.44 "Individual work of students from module 4 "Physiology of analyzers and VND" (full-time course)

Prepare a project on one of the selected topics. The study of this topic involves theoretical work in the classroom, presentations with further discussion.

#### **Topic 45. Final lesson from module 4 "Physiology of analyzers and HNA".**

pr.tr.45 "Final lesson from the content module 4 "Physiology of analyzers and HNA"." (full-time course)

Computer testing and oral examination from the module "Physiology of analyzers and HNA".

#### **Topic 46. Physico-chemical properties of blood**

lect.5 "General characteristics of the blood system" (full-time course)

Physiological blood system. Its structure. General characteristics and composition of peripheral blood. The main functions of the physiological blood system. Functional significance of water and blood plasma electrolytes. Blood plasma proteins. Their composition and main functions. Basic physical and chemical properties of blood: osmotic pressure, density, viscosity, blood reaction. General characteristics of erythrocytes, their function. Hematocrit. Factors on which its value depends. Osmotic resistance of erythrocytes. Its meaning. Hemolysis of erythrocytes. Types and mechanisms of hemolysis. Hemoglobin as the main component of the erythrocyte. Calculation of color indicator and oxygen capacity of blood. Mechanisms of formation and physiological destruction of erythrocytes. Regulation of the content of erythrocytes in peripheral blood. Leukocytes, their distribution in the body. Quantitative and qualitative composition of peripheral blood leukocytes. The main functions of certain types of leukocytes. Mechanisms of phagocytosis. Characteristics of non-specific and specific immunity. Regulation of leukopoiesis and activity of leukocytes. is held in the form of multimedia lectures (in case of quarantine - in online mode).

pr.tr.46 "Physico-chemical properties of blood." (full-time course)

General characteristics of liquid media. Physiological blood system. Its structure. General characteristics and composition of peripheral blood. The main functions of the physiological blood system. Functional value of water and electrolytes of blood plasma. Blood plasma proteins. Their composition and main functions. Basic physical and chemical properties of blood: osmotic pressure, density, viscosity, blood reaction. The study of this topic involves theoretical work in the classroom, the use of virtual simulation (watching a movie on this topic) with further discussion.

#### **Topic 47. Determination of ESR**

pr.tr.47 "Determination of ESR." (full-time course)

Erythrocyte sedimentation rate (ESR). Factors influencing this indicator. ESR research methods in the clinic. The study of this topic involves laboratory research in the classroom: determination of ESR by the method of Panchenkov, evaluation of the indicator.

#### **Topic 48. Properties and functions of erythrocytes**

pr.tr.48 "Properties and functions of erythrocytes." (full-time course)

General characteristics of erythrocytes. Their function. Hematocrit. Factors on which its value depends. Osmotic resistance of erythrocytes. Its significance. Hemolysis of erythrocytes. Types and mechanisms of hemolysis. Hemoglobin as the main component of erythrocytes. The structure of hemoglobin. Calculation of color index and oxygen capacity of blood. The main forms and compounds of hemoglobin. Color index, its definition. Mechanisms of formation and physiological destruction of erythrocytes. Regulation of erythrocyte content in peripheral blood. The study of this topic involves theoretical work in the classroom, the use of virtual simulation (watching a movie on this topic) with further discussion.

#### **Topic 49. Counting the number of erythrocytes. Determination of hemoglobin level**

pr.tr.49 "Counting the number of erythrocytes. Determination of hemoglobin level." (full-time course)

Methods of counting the number of erythrocytes in the blood in the clinic. Methods for assessing the content of hemoglobin in the blood in the clinic. The study of this topic involves laboratory tests in the classroom: counting the number of erythrocytes using Goryaev's camera, evaluation of the indicator; determination of hemoglobin content using Sally hemometer, evaluation of the indicator.

#### **Topic 50. Protective properties of blood**

pr.tr.50 "Protective properties of blood." (full-time course)

Leukocytes, their distribution in the body. Quantitative and qualitative composition of peripheral blood leukocytes. The main functions of certain types of leukocytes. Mechanisms of phagocytosis. Characteristics of nonspecific and specific immunity. Regulation of leukopoiesis and leukocyte activity. The study of this topic involves theoretical work in the classroom, the use of virtual simulation (watching a movie on this topic) with further discussion.

#### **Topic 51. Determination of blood groups**

pr.tr.51 "Determination of blood groups." (full-time course)

The concept of blood groups. Agglutinogens and agglutinins. Characteristics of blood groups of the AB0 system. Modern ideas about blood groups of the AB0 system. Characteristics of blood groups of the CDE system. Blood transfusion (blood transfusion), its stages. The study of this topic involves laboratory tests in the classroom: determination of blood groups in the ABO system and rhesus factor using standard sera and coliclons, discussion of the results.

#### **Topic 52. Hemostasis system**

pr.tr.52 "Hemostasis system." (full-time course)

The concept of hemostasis and its two main mechanisms. The structure of the hemostasis system. The role of the vascular wall and platelets in hemostasis. Mechanisms of vascular-platelet hemostasis: arteriole spasm, adhesion, platelet aggregation, release reaction, thrombus consolidation. Mechanisms of coagulation hemostasis. Blood clotting system. Phases of blood clotting, their essence. Characteristics of the anticoagulant blood system. Characteristics of the fibrinolysis system. Regulation of blood clotting. Physiological bases of methods of research of a condition of a hemostasis. Age-related changes in the hemostasis system. Mechanisms for maintaining the liquid state of the blood. The study of this topic involves theoretical work in the classroom, the use of virtual simulation (watching a movie on this topic) with further discussion.

#### **Topic 53. Evaluation of clinical blood test. Calculation work from the content module 5 "Physiology of blood".**

pr.tr.53 "Evaluation of clinical blood test. Calculation work from the content module 5 "Physiology of blood"." (full-time course)

Age and sex characteristics of blood parameters. Changes in blood parameters during pregnancy and under conditions of pathological processes. The study of this topic involves theoretical work in the classroom: the implementation of calculation tasks (calculation of the direction of fluid movement in the capillary, blood oxygen capacity, color index) with further discussion of the results and interpretation of laboratory research methods (clinical blood tests).

**Topic 54. Solving situational problems from the content module 5 "Physiology of blood".**

pr.tr.54 "Solving situational problems from the content module 5 "Physiology of blood"." (full-time course)

The study of this topic involves theoretical work in the classroom, solving situational problems in the section "Physiology of blood" with further discussion of the results.

**Topic 55. Final lesson from module 5 "Physiology of the blood system".**

pr.tr.55 "Final lesson from the content module 5 "Physiology of blood"." (full-time course)

Computer testing and oral examination from the module "Physiology of blood"

**Topic 56. General characteristics of the circulatory system**

lect.6 "General characteristics of the circulatory system" (full-time course)

General characteristics of the circulatory system, its structure. Functional departments of the circulatory system. Basic and additional functions of the circulatory system. Functional properties of heart muscle. Conductive system of the heart, its meaning. Structural and functional elements of the heart as a pump. Valve apparatus of the heart, its functions. The concept of the cycle of cardiac activity. Phase structure of the cardiac cycle. Systolic and minute volumes of blood, cardiac index. Basics of hemodynamics. Patterns of blood circulation in arterial and venous vessels. Regulation of the work of the heart, local and systemic blood circulation. Teaching is carried out in the form of multimedia lectures (in case of quarantine - in online mode).

pr.tr.56 "General characteristics of the circulatory system." (full-time course)

General characteristics of the circulatory system, its structure. Basic and additional functions of the circulatory system. Comparative characteristics of atypical and typical muscle fibers. Conductive system of the heart, its meaning. Mechanisms of spontaneous pulse generation in the conducting system. The law of "gradient automatism". Functional properties of contractile muscle fibers of the heart. Action potential of contractile myocytes. Ionic mechanisms of the emergence of its main phases. Periods of absolute and relative refractoriness in the myocardium. Mechanisms of electromechanical coupling in cells of the contracting myocardium. Features of the actual contraction and relaxation processes in myocytes. The study of this topic involves theoretical work in the classroom, the use of virtual simulation (watching a film on the specified topic) with further discussion.

**Topic 57. Study of the functioning of the conduction system of the heart of a frog. Ligatures of Stanius**

pr.tr.57 "Study of the conduction system of the heart of a frog" (full-time course)

The study of this topic involves laboratory research in the classroom: the study of the localization of elements of the conduction system in the heart of a frog, the frequency of PD generation in various nodes.

**Topic 58. Mechanical work of the heart. Phase analysis of the cardiac cycle**

pr.tr.58 "Mechanical work of the heart. Phase analysis of the cardiac cycle" (full-time course)

Structural and functional elements of the heart as a pump. Functions of atria and ventricles. Valve apparatus of the heart, its functions. Modes of contractions of the heart and types of loads on it. The concept of the cycle of cardiac activity. Phase structure of the cardiac cycle. Characteristics of ventricular systole: periods of tension and expulsion. Characteristics of ventricular diastole: periods of relaxation and filling. Systolic and minute volumes of blood, cardiac index. The study of this topic involves theoretical work in the classroom, the use of virtual simulation (watching a film on the specified topic) with further discussion.

#### **Topic 59. Examination of the apical impulse and heart tones**

pr.tr.59 "Examination of the apical impulse and heart tones." (full-time course)

The concept of heart tones and methods of their study. The study of this topic involves laboratory research in the classroom: the study of the properties of the apical impulse and heart sounds by auscultation.

#### **Topic 60. Regulation of the heart**

pr.tr.60 "Regulation of the heart" (full-time course)

Myogenic mechanisms of heart regulation. Frank-Starling law. Immediate mechanisms of heart adaptation to volume and resistance loads. The nature and mechanisms of the influence of the parasympathetic nervous system on the work of the heart. The nature and mechanisms of influence of the sympathetic nervous system on the work of the heart. The role of the metasympathetic nervous system in the regulation of heart activity. Intracardiac reflexes. The influence of factors of humoral regulation on the work of the heart. The study of this topic involves laboratory studies in the classroom: Martin's orthostatic test, Shalkov's functional test (with physical load).

#### **Topic 61. Electrical work of the heart. Study methods**

pr.tr.61 "Electrocardiography" (full-time course)

Removal of electrical potentials from isolated muscle fibers, separate areas of the myocardium and the heart as a whole. Electrocardiogram elements (teeth, segments, intervals) and their characteristics. Electrocardiogram (ECG) registration methods. Fundamentals of vector ECG analysis. The concept of the total instantaneous vector of the heart. ECG lead axes. Vector analysis of the origin of ECG waves. Electric axis of the heart. Causes of deviation of the electrical axis of the heart under normal conditions. The study of this topic involves theoretical work in the classroom, the use of virtual simulation (watching a film on the specified topic) with further discussion.

#### **Topic 62. Fundamentals of vector ECG analysis**

pr.tr.62 "Fundamentals of vector ECG analysis" (full-time course)

The study of this topic involves the study of vector analysis of the origin of ECG waves. Electric axis of the heart. Causes of deviation of the electrical axis of the heart under normal conditions.

#### **Topic 63. Calculation work "ECG registration and analysis".**

pr.tr.63 "Calculation work "ECG registration and analysis"." (full-time course)

The study of this topic involves laboratory tests in the classroom and calculation work: registration of human ECG; ECG examination of the main segments, intervals, teeth, duration of the cardiac cycle, heart rate, systolic index; ECG evaluation of heart rate, sources of excitation, myocardial conduction; determining the direction of the electrical axis of the heart. Interpretation of the obtained results.

#### **Topic 64. Basics of hemodynamics.**

pr.tr.64 "Basics of hemodynamics" (full-time course)

Laws of hemodynamics. Hemodynamic indicators: volume of blood in vessels, speed of blood movement, blood pressure, hemodynamic resistance, blood viscosity, nature of blood movement, hemodynamic factors of the vascular wall. Functional classification of blood vessels according to Folkov. The study of this topic involves theoretical work in the classroom, the use of virtual simulation (watching a film on the specified topic) with further discussion.

#### **Topic 65. Patterns of blood circulation in arterial and venous vessels**

pr.tr.65 "Patterns of blood circulation in arterial and venous vessels" (full-time course)

Peculiarities of mechanisms of microcirculatory vessel regulation. Myogenic, metabolic and histomechanical mechanisms of local blood circulation regulation. Concept of physiological arterial hyperemia. Nervous regulation of local blood circulation. Humoral mechanisms of local blood circulation regulation. Vascular tone and its regulation, nervous and humoral mechanisms. Regulation of systemic blood circulation. Cardiovascular center, its structure, afferent and efferent connections. The concept of a single hemodynamic center (Frolkis V.V.). The main reflexogenic zones, baroreceptors and chemoreceptors of the carotid sinus and aortic arch, their role. Reflexes from the receptors of the atria and large veins. Pressor and depressor reflexes. Interrelated mechanisms of nervous and humoral regulation of heart activity, vascular tone, and circulating blood volume during various adaptive reactions. Physiological prerequisites for blood pressure disorders. Nervous and humoral mechanisms of blood pressure regulation. The study of this topic involves theoretical work in the classroom with further discussion.

#### **Topic 66. Measurement of blood pressure in humans.**

pr.tr.66 "Measurement of blood pressure in humans." (full-time course)

Blood pressure: systolic, diastolic, pulse, average. Methods of measuring blood pressure. The study of this topic involves laboratory research in the classroom: measuring blood pressure in humans by the methods of Riva-Rocha and Korotkov.

#### **Topic 67. Regulation of local and systemic blood circulation**

pr.tr.67 "Regulation of the heart, local and systemic circulation (defense of abstracts)." (full-time course)

Local, nervous and humoral mechanisms of regulation of heart function, local and systemic circulation. The study of this topic involves theoretical work in the classroom, defense of abstracts with further discussion.

#### **Topic 68. Investigation of functional tests of the cardiovascular system.**

pr.tr.68 "Investigation of functional tests of the cardiovascular system." (full-time course)

Changes in blood circulation during the transition from horizontal to vertical position and during exercise. The study of this topic involves laboratory research in the classroom: conducting and evaluating orthostatic test Martinat, Shalkov test (with exercise).

**Topic 69. Solving situational problems from the content module 6 "Physiology of the cardiovascular system".**

pr.tr.69 "Solving situational problems from the content module 6 "Physiology of the cardiovascular system"." (full-time course)

The study of this topic involves theoretical work in the classroom, solving situational problems in the section "Physiology of the cardiovascular system" with further discussion of the results.

**Topic 70. Final lesson from module 6 "Physiology of the cardiovascular system".**

pr.tr.70 "Final lesson from the content module 6 "Physiology of the cardiovascular system"." (full-time course)

Computer testing and oral examination from the module "Physiology of the cardiovascular system".

**Topic 71. General characteristics of the respiratory system. Research of indicators of external respiration.**

lect.7 "General characteristics of the respiratory system." (full-time course)

Stages of breathing. The general structure and main functions of the external respiratory system. Functional characteristics of structural elements of the external respiratory system: chest, respiratory muscles, pleural cavity, airways, lungs. Concept of transpulmonary, pleural and alveolar pressure. Elastic traction of the lungs. Surfactants, their meaning. Biomechanics of breathing. Inhalation and exhalation mechanisms. Static indicators of lung ventilation. Concepts of lung volumes and lung capacities. Dynamic indicators of lung ventilation. Minute volume and lung capacity. Dynamic indicators of lung ventilation. Minute volume of breathing, its definition. Spirometry. Spirography. Composition of inhaled, exhaled, alveolar air. Partial pressure of gases (PCO<sub>2</sub>, PO<sub>2</sub>) in alveolar air. Mechanisms of gas exchange between inhaled air and alveolar gas mixture, between alveoli and blood in pulmonary capillaries. Diffusion capacity of the lungs. Relationship between pulmonary circulation and lung ventilation. Anatomical and physiological "dead space". Forms of oxygen transport by blood. Transport of oxygen physically dissolved in blood plasma. The influence of mechanical factors on the activity of the respiratory center. The influence of chemical factors on the activity of the respiratory center. Central and p Teaching is carried out in the form of multimedia lectures (in case of quarantine - in online mode).

pr.tr.71 "General characteristics of the respiratory system. Research of indicators of external respiration." (full-time course)

Stages of respiration. General structure and main functions of the external respiratory system. Functional characteristics of the structural elements of the external respiratory system: chest, respiratory muscles, pleural cavity, airways, lungs. Respiratory biomechanics: mechanisms of inhalation and exhalation. Static and dynamic indicators of lung ventilation. The study of this topic involves theoretical work in the classroom, the use of virtual simulation (watching a movie on this topic) with further discussion.

**Topic 72. Calculation work "Registration and analysis of spirogram".**

pr.tr.72 "Calculation work "Registration and analysis of SPG"." (full-time course)

The study of this topic involves the implementation of calculation tasks (determination of LNG tidal volume, reserve volume of inspiration, reserve volume of exhalation, vital capacity of the lungs, respiratory rate, minute tidal volume, minute alveolar ventilation, minute O<sub>2</sub> consumption; calculation according to Harris-Benedict tables of the appropriate value of these indicators by the value of basal metabolism) and interpretation of the obtained indicators).

### **Topic 73. Gas exchange in the lungs. Blood gas transport. Regulation of respiration.**

pr.tr.73 "Gas exchange in the lungs. Blood gas transport. Regulation of respiration." (full-time course)

Mechanisms of gas exchange between inhaled air and alveolar gas mixture, between alveoli and blood in pulmonary capillaries. Forms of transport of oxygen and carbon dioxide by blood. Influence of mechanical factors on the activity of the respiratory center. Hering-Breyer reflexes. Influence of chemical factors on the activity of the respiratory center. The study of this topic involves theoretical work in the classroom, the use of virtual simulation (watching a movie on this topic) with further discussion.

### **Topic 74. Investigation of functional tests of the respiratory system**

pr.tr.74 "Investigation of functional tests of the respiratory system." (full-time course)

The study of this topic involves laboratory research in the classroom: conducting a test of Christie and assessing the results of the elasticity of lung tissue; performing the Votchall test and evaluating the width of the small bronchi and the tone of the bronchial muscles based on its results; study of the Stange-Gench test with respiratory arrest; measurement with a dry spirometer of vital capacity of the lungs and interpretation of the results.

### **Topic 75. General characteristics of the digestive system**

lect.8 "General characteristics of the digestive system." (full-time course)

Structure and functions of the digestive system. Digestive tract and digestive glands. The main functions of the digestive system: secretion, motility, absorption. Digestion: its types (cavity, membrane, intracellular), main stages. Basic principles and mechanisms of digestion regulation. Gastrointestinal hormones. Phases of secretion of the main digestive glands. Periodic activity of the digestive system. Digestive tract motility. Features of the structure and functions of the smooth muscles of the digestive tract. Physiological bases of methods of research of functions of the digestive tract. Physiological bases of hunger and satiety. Nutritional motivation, ideas about the food center. The contour of regulation of maintaining the stability of the content of nutrients in the internal environment. Teaching is conducted in the form of multimedia lectures (in the presence of quarantine - on-line).

pr.tr.75 "General characteristics of the digestive system." (full-time course)

Structure and functions of the digestive system. Types of digestion. Basic principles and mechanisms of digestion regulation. Gastrointestinal hormones. Periodic activity of the digestive system. Digestive tract motility. Physiological bases of methods of research of functions of the digestive tract. Physiological bases of hunger and satiety. Nutritional motivation, ideas about the food center. The contour of the regulation of maintaining the stability of the content of nutrients in the internal environment. The study of this topic involves theoretical work in the classroom, the use of virtual simulation (watching a movie on this topic) with further discussion.

**Topic 76. Digestion in the mouth and stomach**

pr.tr.76 "Digestion in the mouth and stomach." (full-time course)

The value of the oral cavity as the initial part of the digestive system. Composition, properties and significance of saliva. Mechanisms and regulation of salivation. Mechanical processing of food. Mechanisms of chewing and swallowing. Taste analyzer, its structure and value. The importance of the stomach in the processes of digestion. Gastric juice, its composition, properties and values

**Topic 77. Digestion in the intestines. The role of the liver and pancreas in digestion processes**

pr.tr.77 "Digestion in the intestines. The role of the liver and pancreas." (full-time course)

Pancreatic juice, its composition, properties and importance of the main components. The influence of various food substances on the secretion of pancreatic juice. Nervous and humoral mechanisms of regulation of pancreatic secretion. Bile, its composition, properties and significance of the main components. Mechanisms of bile secretion and regulation of this process. Protective (barrier and antitoxic), metabolic and hemodynamic functions of the liver. Intestinal secretion, composition and properties of intestinal juice, its role in digestion. Research methods. Regulation of intestinal secretion. Cavity and membrane hydrolysis of 18 food substances. Motor activity of the small intestine, its role in digestion. Types of motility, its regulation. The role of the metasymphathetic system in the regulation of the secretory and motor functions of the intestines. Digestion in the colon. The role of gut microflora. Colon motility, its regulation. The act of defecation. The study of this topic involves theoretical work in the classroom, the use of virtual simulation (watching a film on the specified topic) with further discussion.

**Topic 78. Individual work of students from module 8 "Physiology of the digestive system".**

pr.tr.78 "Absorption in the gastrointestinal tract (discussion of presentations)" (full-time course)

Absorption processes. Research methods. Absorption of substances in different departments of the alimentary canal, its mechanisms. Features of absorption of water, salts, carbohydrates, proteins, fats, vitamins, and other substances. Adjustment of suction. The study of this topic involves theoretical work in the classroom, presentations with further discussion

**Topic 79. Thermoregulation**

pr.tr.79 "Thermoregulation" (full-time course)

The concept of core and shell as temperature zones of the body. Periodic fluctuations in body temperature, changes in body temperature under physiological conditions. Mechanisms of heat generation. The concept of contractile and non-contractile thermogenesis. Mechanisms of heat transfer. Environmental factors affecting heat transfer. Properties and physiological reactions of the body that determine the intensity of heat transfer. The center of thermoregulation, its structure and basic principles of functioning. Afferent and efferent link of thermoregulation. Significance of small intestines in digestive processes. The study of this topic involves theoretical work in the classroom, the use of virtual simulation (watching a film on the specified topic) with further discussion.

**Topic 80. Exchange of substances and energy**

pr.tr.80 "Exchange of substances and energy" (full-time course)

Physiological significance of proteins, fats and carbohydrates. Energy conversion in the body. Methods of studying energy metabolism: direct and indirect calorimetry. The concept of basic exchange. Factors influencing its value. Determination of basal metabolism according to indirect calorimetry and proper basal metabolism according to Harris-Benedict tables. Specific-dynamic action of food. Energy expenditure of the body during physical and mental activity. Physiological bases of a rational food. The concept of the nucleus and shell as the temperature zones of the organism. Periodic fluctuations in body temperature, changes in body temperature under physiological conditions. Mechanisms of heat generation. Heat transfer mechanisms. Thermoregulation center, its structure and basic principles of operation. Afferent and efferent links of thermoregulation. The study of this topic involves theoretical work in the classroom, the use of virtual simulation (watching a movie on this topic) with further discussion.

**Topic 81. Estimated work "Compilation of food ration".**

pr.tr.81 "Estimated work "Compilation of food ration"." (full-time course)

The study of this topic involves theoretical work in the classroom: calculation tasks (determination of basic human metabolism according to Harris-Benedict tables; determination of daily energy consumption by incomplete gas analysis; determination of daily human energy consumption in various activities; preparation of diet) and discussion of results.

**Topic 82. General characteristics of the allocation system.**

lect.9 "General characteristics of the allocation system" (full-time course)

The allocation system, its structure, functions. Excretory organs (kidneys, skin, lungs, alimentary canal), their participation in maintaining body homeostasis. Kidneys as the main organs of the excretory system. Nephron as a structural and functional unit of the kidney. Blood circulation in the kidney, its features. The main processes of urine formation: filtration, reabsorption, secretion. Mechanisms of filtration, composition of primary urine. Filter speed adjustment. Reabsorption in tubules, its mechanisms. The rotary-countercurrent-multiple system, its role. Secretory processes in proximal and distal tubules and collecting tubules. Final urine, its composition, quantity. Urination and its regulation. Physiological basis of methods of research of kidney function. Assessment of clinical urinalysis. Determination and evaluation of glomerular filtration rate, water reabsorption rate, maximum glucose reabsorption rate, and renal excretion pathways. Age-related changes in urine formation and urination. Teaching is conducted in the form of multimedia lectures (in case of quarantine - in online mode).

pr.tr.82 "General characteristics of the allocation system. Regulation of kidney function" (full-time course)

The allocation system, its structure, functions. Excretory organs (kidneys, skin, lungs, alimentary canal), their participation in maintaining body homeostasis. Kidneys as the main organs of the excretory system. Nephron as a structural and functional unit of the kidney. Blood circulation in the kidney, its features. The main processes of urine formation: filtration, reabsorption, secretion. Filtering mechanisms, composition of primary urine. Filter speed adjustment. Reabsorption in tubules, its mechanisms. The rotary-countercurrent-multiple system, its role. Secretory processes in proximal and distal tubules and collecting tubules. Final urine, its composition, quantity. Physiological basis of methods of research of kidney function. Assessment of clinical urinalysis. The study of this topic involves theoretical work in the classroom, the use of virtual simulation (watching a film on the specified topic) with further discussion.

**Topic 83. The main processes of urine formation**

pr.tr.83 "The main processes of urine formation" (full-time course)

The main processes of urine formation: filtration, reabsorption, secretion. Filtering mechanisms, composition of primary urine. Filter speed adjustment. Reabsorption in tubules, its mechanisms. The rotary-countercurrent-multiple system, its role. Secretory processes in proximal and distal tubules and collecting tubules. Diuresis. The composition of primary and secondary urine. The study of this topic involves theoretical work in the classroom, the use of virtual simulation (viewing a film on the specified topic) with further discussion.

**Topic 84. Calculation work "Determination of filtration and reabsorption in the kidneys."**

pr.tr.84 "Calculation work "Determination of filtration and reabsorption in the kidneys"." (full-time course)

The study of this topic involves theoretical work in the classroom: calculation tasks (study of glomerular filtration rate by inulin clearance, water reabsorption, maximum glucose reabsorption, reabsorption and secretion of various substances) and interpretation of the obtained indicators.

**Topic 85. Regulation of kidney function**

pr.tr.85 "Regulation of kidney function" (full-time course)

Mechanisms of regulation of kidney function. Secretory function of the kidneys. Renin-angiotensin-aldosterone system, mechanisms of activation, physiological significance. The role of kidneys in the regulation of water-salt exchange. The role of the kidneys in the regulation of acid-base balance. The study of this topic involves theoretical work in the classroom, the use of virtual simulation (watching a film on the specified topic) with further discussion.

**Topic 86. Solving situational problems from the content modules 7 - 10 "Physiology of the respiratory system", "Physiology of the digestive system", "Physiology of metabolism". Thermoregulation ", " Physiology of selection ".**

pr.tr.86 "Solving situational problems from the content modules 7 - 10 "Physiology of the respiratory system", "Physiology of the digestive system", "Physiology of metabolism". Thermoregulation ", " Physiology of selection "." (full-time course)

The study of this topic involves theoretical work in the classroom, solving situational problems in the section "Physiology of the respiratory system", "Physiology of the digestive system", "Physiology of metabolism". Thermoregulation ", " Physiology of selection "with the subsequent discussion of results.

**Topic 87. Final lesson from modules 7 - 10 "Physiology of the respiratory system", "Physiology of the digestive system", "Physiology of metabolism and energy". Thermoregulation ", " Physiology of the excretory system ".**

pr.tr.87 "Final lesson on content modules 7 - 10 "Physiology of the respiratory system", "Physiology of the digestive system", "Physiology of metabolism". Thermoregulation ", "Physiology of selection ". (full-time course)

Computer testing and oral examination of the modules "Physiology of the respiratory system", "Physiology of the digestive system", "Physiology of metabolism and energy. Thermoregulation ", "Physiology of the excretory system ".

#### **Topic 88. Practical skills from the course "Physiology".**

pr.tr.88 "Practical skills from the course "Physiology"." (full-time course)

Be able to determine the absolute strength of the muscles of the hand. To be able to determine the working capacity of the muscles of the hand. Be able to recognize the indicator of the decrease in the working capacity of the muscles of the hand. Be able to determine the type of muscle contraction. Be able to determine the reflex time. To be able to determine the type of response of a neuron upon its stimulation. Be able to reproduce clinically important reflexes. Be able to identify the leading part of the body and the dominant hemisphere. Be able to determine the vegetative tone of the patient. Be able to determine the type of vegetative reactivity. Be able to determine the type of intersystem relations at rest and during physical exertion. Be able to determine the sensitivity of different parts of the body. Describe the general blood test. Be able to investigate the erythrocyte sedimentation rate (ESR), evaluate the obtained value and determine the factors that do not affect it. To be able to examine the hemoglobin content in the blood according to Sali's method and evaluate the obtained value. Be able to examine the number of red blood cells in the blood and estimate the obtained value. Be able to calculate the color index (CP) and evaluate the obtained value. Be able to calculate the oxygen capacity of the blood (COC). Be able to investigate the blood group in the ABO and Rh system using standard serums.

#### **Topic 89. Practical skills from the course "Physiology"**

pr.tr.89 "Practical skills from the course "Physiology"." (full-time course)

The study of this topic involves laboratory work, evaluation of the results of functional tests, interpretation of laboratory data (clinical blood test) and instrumental (ECG, SPG) research methods.

#### **Topic 90. Preparation for the license exam "KROK-1".**

pr.tr.90 "Preparation for the license exam "KROK-1"." (full-time course)

Computer testing

#### **Topic 91. Practical indicative exam**

assessm.91 "Practical indicative exam" (full-time course)

Conducting the exam in accordance with the regulations

## **9. Teaching methods**

### 9.1 Teaching methods

Course involves learning through:

TM1	Interactive lectures
-----	----------------------

TM2	Demonstration method
TM3	Search laboratory work
TM4	Educational discussion
TM5	Case-based learning (CBL). Learning based on the analysis of specific situations
TM6	Team Based Learning
TM7	Problem-based learning
TM8	Practical training
TM9	Self-study
TM10	Electronic learning

The discipline is taught using modern teaching methods (CBL, TBL), which contribute not only to the development of professional abilities, but also stimulate creative and scientific activity and are aimed at training practice-oriented specialists.

The discipline ensures that students acquire the following soft skills: ZK 2. The ability to learn and master modern knowledge, ZK 3. The ability to apply knowledge in practical situations, ZK 4. Knowledge and understanding of the subject area and understanding of professional activity, ZK 10. The ability to use information and communication technologies . and society and in the development of society, equipment and technologies, to use various types and forms of physical activity for active recreation and leading a healthy lifestyle.

## 9.2 Learning activities

LA1	Self-learning
LA2	Preparation for practical classes.
LA3	Completion of obligatory homework: preparation of presentations on topics 2, 44.78
LA4	Solving situational problems on topics 13, 27, 35, 54, 69, 86.
LA5	Laboratory studies on topics 6,8,12,16,18,20,24,26,37,40,43,47,49,51,59,60,66,68,71,74,80.
LA6	Calculation works on topics 10, 27, 54, 63, 72, 81, 84
LA7	Interpretation of laboratory (clinical analysis of blood and urine) and instrumental (ECG, SPG) examination methods
LA8	E-learning in systems (Zoom, Google Meet, MIX.sumdu.edu.ua)
LA9	Exam preparation
LA10	Individual research project (student research paper, article, thesis)
LA11	Work with textbooks and relevant information sources

## 10. Methods and criteria for assessment

### 10.1. Assessment criteria

Definition	National scale	Rating scale
Outstanding performance without errors	5 (Excellent)	$170 \leq RD \leq 200$
Above the average standard but with minor errors	4 (Good)	$140 \leq RD < 169$
Fair but with significant shortcomings	3 (Satisfactory)	$120 \leq RD < 139$
Fail – some more work required before the credit can be awarded	2 (Fail)	$0 \leq RD < 119$

## 10.2 Formative assessment

	Description	Deadline, weeks	Feedback
FA1 Peer assessment	Partnership interaction aimed at improving the results of educational activities by comparing one's own current level of success with previous indicators. Provides the possibility of finding one's own educational activity	During the entire period of studying the discipline	Adjustment of approaches to learning together with students, taking into account the results of the assessment
FA2 Protection of presentations	Writing works involves demonstrating the ability to work with literature, consolidation of practical skills, evaluation and analysis of medical documentation. Defense of works is foreseen, when the student must provide answers to questions on the chosen topic.	During the entire period of study of the discipline, defense - in accordance with the calendar and t	Teacher consultation during performance with verbal comments. The winner receives an assessment for writing a presentation (5 points maximum) and defense (5 points maximum)
FA3 Testing	A method of effective verification of the level of assimilation of knowledge, abilities and skills from each subject of an educational discipline. Testing allows you to check the assimilation of educational material from each subject.	During the entire period of studying the discipline	The maximum number of points for the test is 10 points, provided that 100% of the answers are correct. The minimum score for successfully passing the tests is 6 points (60% of correct answers)

<p>FA4 Defense of an individual research project (presentation at a conference, competition of student research papers)</p>	<p>An important factor in the formation of professional qualities of future specialists is the research work of students. Involvement of the latter in research activities contributes to the formation of their scientific worldview, industriousness, work capacity, initiative, etc.</p>	<p>During the entire period of studying the discipline</p>	<p>Teacher's oral comments. The student is given additional incentive points (from 5 to 10), depending on the type of research project</p>
<p>FA5 Teacher's instructions in the process of performing practical tasks</p>	<p>The guidelines reveal the methods of pedagogical control over the professional activities of applicants. Efficiency is determined by compliance with all stages of practical tasks. The effectiveness of the formation of the necessary practical skills and abilities depends on the level of formation of practical competence.</p>	<p>During the entire period of studying the discipline</p>	<p>Counseling of students in the interpretation of laboratory results, direct and indirect observation of the work of applicants during the implementation of instrumental research methods with further determination of the level of practical training</p>
<p>FA6 Interviews and oral comments of the teacher on his results</p>	<p>It provides an opportunity to identify the state of educational experience acquired by students in accordance with the set goals, to find out the prerequisites for the state of formation of the obtained results, the causes of difficulties, to adjust the learning process, to track the dynamics of the formation of learning results and to forecast their development.</p>	<p>During the entire period of studying the discipline</p>	<p>According to the obtained data on the results of training, based on their analysis, it is proposed to determine the evaluation as an indicator of the achievements of the educational activities of the applicants</p>

FA7 Checking and evaluating written assignments	Assessment of acquired theoretical knowledge on the subject of the discipline. Justification of own opinion.	During the entire period of studying the discipline	Feedback is aimed at supporting students' independent work, identifying shortcomings and assessing the level of acquired theoretical knowledge
FA8 Solving situational problems	Evaluation of the acquired theoretical and practical knowledge of the subject of the discipline.	During the entire period of studying the discipline	Feedback is aimed at supporting students' independent work, identifying shortcomings and assessing the level of acquired theoretical knowledge
FA9 Checking the results of laboratory work	Practicing practical skills and involving analytical abilities, independence in decision-making, skills in working with a sufficiently large amount of information.	During the entire period of studying the discipline	Assessment of the student's ability to perform laboratory work, justification of their decisions, to clearly express their opinions, determination of the level of theoretical training, which is reflected in the corresponding assessment

### 10.3 Summative assessment

	Description	Deadline, weeks	Feedback
--	-------------	-----------------	----------

SA1 Final control: exam	Passing a practical-oriented exam. Candidates who have successfully mastered the subject material, passed practical skills and final computer testing are allowed to take the exam.	According to the schedule	The applicant can get 80 points for the exam. The minimum number of points a student must receive is 48 points
SA2 Final testing	A method of effective verification of the level of assimilation of knowledge, abilities and skills from an educational discipline. Testing allows you to check the results of training during the cycle and determine the level of knowledge at the end of the discipline.	According to the schedule	It is an admission to take the exam
SA3 Evaluation of written works, surveys, solutions and implementation of practical tasks	Includes an oral interview, interpretation of laboratory and instrumental examination methods. Students who are involved in research activities have the opportunity to present the results of their own research at conferences, student research competitions, etc. (incentive activities, additional points)	During the entire period of studying the discipline	Held at each class, the result of performing the ND affects the comprehensive assessment for the practical class

#### Form of assessment:

	Points	Minimum points	Можливість перескладання з метою підвищення оцінки
<b>4 semester</b>	<b>200 scores</b>		
SA1. Final control: exam	<b>80</b>		
	80	48	No
SA2. Final testing	<b>20</b>		
	20	12	No
SA3. Evaluation of written works, surveys, solutions and implementation of practical tasks	<b>100</b>		
	100	60	No

A student is admitted to the exam on the condition that the requirements of the curriculum are met, if he scored at least 72 points for the current educational activity (including at least 39.6 points for the current practical classes and 32.4 - for the final classes) and passed the positive assessment of final testing Step-1 and practical skills from the course. Incentive points are added to the grade in the discipline for the implementation of an individual research project (defense of a student thesis 12 points, speech at a conference 5 points, poster presentation at a conference 4 points, theses of reports 3 points).

## 11. Learning resources

### 11.1 Material and technical support

MTS1	Information and communication systems
MTS2	Library funds, archive of spiromograms, electrocardiograms, results of laboratory research methods
MTS3	Computers, computer systems and networks
MTS4	Laboratory equipment (electrical stimulators, galvanic tweezers, aesthesiometers, dissection kits, dynamometers, chemical reagents, microscopes, Goryaev cameras, Panchenkov tripods, hemometers))
MTS5	Multimedia, video and audio, projection equipment (video cameras, projectors, screens, smart boards, etc.)
MTS6	Software (to support distance learning)
MTS7	Medical equipment (neurological hammers, electrocardiographs, spirometers, phonendoscopes, tonometers, scales, height meter)

### 11.2 Information and methodical support

<b>Essential Reading</b>	
1	Textbook of medical physiology Arthur C. Guyton, John E. Hall.—16th ed., 2020. – 1116 p. ; cm
2	Ganong - Review of Medical Physiology, - Twenty sixth Edition 26th Edition, - 2019.
<b>Supplemental Reading</b>	
1	Y. Dubovyk, T. Oleshko, V. Harbuzova, A. Ataman Positive Association between EDN1 rs5370 (Lys198Asn) Polymorphism and Large Artery Stroke in a Ukrainian Population // Disease Markers. – 2018. Vol. 2018, Article ID 1695782, 9 pages.
2	Garbuzova V. Yu. The general and cellular basis of medical physiology / V. Yu. Garbuzova, O.A. Obukhova // Суми: Вид-во СумДУ. – 2013. – 132 с.
3	Trull, T. & Prinstein, M. (2013) Clinical Psychology (8th Edition)
4	USMLE Step 1 Lecture Notes 2018: 7-Book Set Physiology -Kaplan Medical 2018: P 3-425.
5	Obukhova, V.Yu. Test problems in physiology state licensing examination KROK-1 [Електронний ресурс] : for the second-year students in speciality 7.110101 "Medicine" / O. A. Obukhova, V.Y. Harbuzova. - Електронне видання каф. Фізіології і патофізіолог
6	The associason of vitamin D receptor gene (VDR)polymorphisms with high blood pressure in stroke patients of ukrainian population / Obukhova O.A., Ataman A.V., Zavadzka M.M., Piven S.M., Levchenko Z.M.// Wiadomosci lekarskie (Warsaw, Poland : 1960). –
7	USMLE Step 1: Physiology [Текст] : Lecture Notes / Editors L.B. Wilson, R. Dasgupta, F.P.Noto. — New York : Kaplan, 2019. — 425 p.

8	Lukavenko, I., Kolnoguz, A., Levchenko, Z., Harbuzova, V. (2021). Positive Association between SRA1 rs801460-Variant and Proliferative Type of Benign Breast Disease with Atypia in Ukrainian Females. <i>Exp Oncol</i> , 43(4), 1-5.
9	Physiology of sensory systems: lecture notes for stud. of the 2nd year of majors 221 "Dentistry", 222 "Medicine", 228 "Pediatrics" full-time education / M. M. Demenko, V. Yu. Harbuzova, O. A. Obukhova. — Sumy : Sumy State University, 2022. — 48 p.
10	5676 Practicum on the course "Physiology" [Текст] : for students of the specialty 222 "Medicine" full-time course of study / O. A. Obukhova, V. Yu. Harbuzova. — Sumy : Sumy State University, 2023. — 160 p.
<b>Web-based and electronic resources</b>	
1	Physiology - <a href="https://ocw.sumdu.edu.ua/content/990">https://ocw.sumdu.edu.ua/content/990</a>