MEDICAL UNIVERSITY - PLEVEN

FACULTY OF MEDICINE

PROGRAM

OF

PHYSIOLOGY

FOR ELE MEDICAL STUDENTS

2017/2018 ACADEMIC YEAR

In the uniform State requirements -binding

In curricula of MU-Pleven -binding

School semester : The second and third

Workload: 195 hours: 75 hours lectures and 120 hours of practical exercises

Maximum number of credits: 11

Academic teaching staff: Assoc. Prof. Boryana Ruseva - Kancheva, MD, PhD, Head of Division of "Physiology", Tel. 884 221; Assoc. Prof. Zdravka Radionova, MD, PhD, Tel. 884 135; assistant Lyudmila Ivanova Halacheva, MD, Tel. 884 216; assistant Tsvetelina Petkova – Marinova, MD, Tel. 884 182; assistant Ivelina Ivanova Himcheva, MD, Tel. 884 218

PURPOSE AND TASKS OF TRAINING

Training in Physiology is one of the main in the pre-clinical training of students of medicine. Students have to obtain basic knowledge on the functioning of the human organism as a unified whole. This includes:

a/the study of sub cellular and cellular mechanisms of individual functions, mechanisms of the functioning of individual organs and systems; b/the study of the coordination of the functions of individual cells, organs and systems; c/the study of regulation of functions and their adaptation to changing conditions. In the course of training in Physiology students seized a number of clinical research methods and be acquainted with the physiological bases of these methods.

The educational content is created in the following sections: **General Physiology** (includes elements of cell physiology with emphasis on transport through membranes regulation of functions in human beings and in particular the maintenance of body homeostasis, General Physiology of excitable tissue) **Physiology of systems:** muscles, cardiovascular system, blood and lymph, respiratory system, gastrointestinal system, metabolism and energy, electrolyte and water balance, endocrine system, reproductive system and nervous system.

Training in Physiology must achieve the following ***tasks*** in students, masters in medicine:

- To acquire the required volume of knowledge of the physiology, set out in the educational content
- To apply your knowledge of chemistry, biochemistry, physics, biophysics, general biology and morphology in answering questions and solving of tasks in the field of Physiology
- To apply your knowledge of the different sections of Physiology in resolving problems relating to the adaptation of human body to different States and conditions.

- To acquire skills for performing experiments on animals, provided for in the program, and to interpret the experiment results.
- To carry out the following clinical research methods:
  - registration of ECG
  - auscultation of the heart sounds
  - measurement of arterial pressure
  - measurement of lung volumes and capacities
  - determining the gas composition of the exhaled air
  - determination of metabolic rate by the method of indirect calorimetry
  - clearance method for the study of kidney function
  - determining the parameters of acid-base balance and correction of deviations
  - diagnosis of early pregnancy
  - study of clinically important reflexes in human
  - audiometry
  - study of visual acuity
  - study of color vision
  - study of pupil reflexes
  - perimetry
  - electroencephalography
  - ergography.
  - determining the number of WBC and RBC; hemoglobin, haematocrit and calculation of hematological indices
  - determination of ESR
  - determination of clothing and bleeding time
  - determining the blood groups
- To carry out an analysis of the results of the clinical research methods
- To know the physiological intervals of fundamentals of composition of body fluids and of parameters characterizing the basic functions in the human organism.

FORMS OF TRAINING:

- Lectures

- Exercises

TRAINING METHODS:

- lecture presentation
- practical exercises
- discussions
- individual and group practical tasks
- study of scientific literature
- self-study

CONTROL AND ASSESSMENT OF KNOWLEDGE:

- Current assessment with tests and colloquiums
- The final assessment by a practical examination and theoretical written and oral examination

DISTRIBUTION OF THEACHING MATERIAL ON TOPICS

PHYSIOLOGY TEACHING PROGRAM OF LECTURES

Second semester, first - year ELE students of medicine

2017/2018 academic year

(2 academic hours per week)

1. Introduction to Physiology. Principles of control and regulation in the human body. Homeostasis. Function of the cell membrane. Transport through the cell membrane - passive and active transport. Transport through cellular sheets.

2. Excitable tissues. Resting membrane potential. Nerve action potentials. Propagation of the action potential.

3. Mechanisms of cell-to-cell signaling. Synaptic transmission. Functional anatomy. Chemical transmission of synaptic activity. Chemical substances - synaptic transmitters.

4. Skeletal muscle. Physiological anatomy of skeletal muscle. Mechanism of muscle contraction. Motor unit. Characteristics of whole skeletal muscle contraction. Length – tension and force – velocity curve.

5. Energy of muscle contraction. Smooth muscle. Types of smooth muscle. Morphology and function.

6. CVS - cardiac muscle, morphology and function. Electrical activity of the heart. Electrocardiogram /ECG/.

7. Cardiac cycle. Function of the valves. Work output of the heart. Heart sounds. Intrinsic and extrinsic regulation of myocardial performance.

8. The circulation. Physical characteristics of the circulation. Dynamic of blood pressure, flow and resistance. Microcirculation. Veins and their functions.

9. Neuronal regulation of the circulation. Rapid control of the arterial pressure. Long-term regulation of arterial pressure. Circulation through special regions.

10. Blood components. Functional role of plasma proteins. Blood components. Red blood cells, hemoglobin. Hemopoesis.

11. Resistance of the body to infection. Leukocytes. Hemostasis and blood coagulation. Blood groups

12. Respiration. Pleural and alveolar pressure. Compliance of the lungs. Surfactant. Lung volumes and capacities. Pulmonary and alveolar ventilation. Physical principles of gas exchange. Gas exchange through respiratory membrane. Gas transport between the lungs and tissues.

13. Regulation of respiration. Control of breathing - central organization of breathing, chemoreceptor control of breathing, chemical control of breathing. Effects of high altitude and sea diving physiology.

14. General principles of gastrointestinal tract. Neuronal and hormonal control of functions, blood flow. Propulsion and mixing of food in the alimentary tract. Secretory functions of the alimentary tract.

15. Digestion and absorption in the gastrointestinal tract. Functions of the liver. Physiology of gastrointestinal disorders.

PHYSIOLOGY TEACHING PROGRAM OF LECTURES

Third semester, second year - ELE students of medicine

2017/2018academic year

(3 academic hours per week)

1. Metabolism of carbohydrates, and formation of adenosine triphosphate. Lipid and protein metabolism and their regulation. Energetics and metabolic rate. Body temperature regulation
2. Urine formation by the kidneys. Glomerular filtration, renal blood flow and their control. Tubular reabsorption and secretion. Urine concentration and dilution. Micturition
3. The body fluid compartments: extracellular and intracellular fluids. Regulation of the fluid volume and osmolarity – renal and hormonal control. Acid-base regulation
4. Introduction to endocrinology – chemical structure, synthesis, secretion, transport, and mechanism of action of hormones. Pituitary hormones and their control by the hypothalamus. Thyroid metabolic hormones
5. Insulin, glucagon and diabetes mellitus. Parathyroid hormone, calcitonin, vitamin D - calcium and phosphate metabolism
6. Adrenocortical hormones. Reproductive and hormonal functions of the male
7. Female physiology before pregnancy and female hormones. Pregnancy and lactation.
8. The nervous system: sensory receptors, neural circuits for processing information. Somatic sensations: general organization, the tactile and position senses, pain and thermal sensation
9. The eye: optics and vision, receptor and neural function of the retina. Central neurophysiology of vision
10. The sense of hearing. The chemical senses – taste and smell
11. The nervous system. Motor functions of the spinal cord. The cord reflexes. Cortical and brain stem control of motor function
12. Vestibular sensations and maintenance of equilibrium. Motor control by the cerebellum and basal ganglia
13. Cerebral cortex, intellectual functions of the brain, learning and memory. Behavioral and motivational mechanisms of the brain – the limbic system and hypothalamus. States of brain activity – sleep, brain waves
14. The autonomic nervous system and the adrenal medulla

15. Sports physiology. Changes in the organism during exercises

	PHYSIOLOGY PRACTICAL EXERCISES 2017/2018 ACADEMIC YEAR	
	TOPIC	**Hours**
1.	White blood cells.	4
2.	Red blood cells. Hemoglobin. Hematocrit. Hematological indices.	4
3.	Blood groups. Hemostasis and blood coagulation.	4
4.	***Colloquium: Blood***	4
5.	Skeletal muscles.	4
6.	***Colloquium: Cellular physiology. Muscles.***	4
7.	Structure of the heart in relation to function. Effect of temperature on the sinus venosus. Stanius ligatures	4
8.	Extrasystoles. Cardiac control.	4
9.	ECG- recording.	4
10.	ECG – analysis.	4
11.	Heart sounds. Pulse. Arterial pressure.	4
12.		4

	Colloquium: Cardiovascular system.	
13.	Respiration. Lung volumes and capacities. Pulmonary ventilation.	4
14.	Control of breathing. Gas exchange.	4
15.	***Seminar: Respiratory system.***	4
16.	Metabolic Rate. Basal metabolic rate.	4
17.	***Colloquium: Digestive system.***	4
18.	Clearance.	4
19.	Acid- Base balance.	4
20.	***Colloquium: The Body Fluids and Kidneys.***	4
21.	Endocrine system.	4
22.	**Colloquium: Endocrine system.**	4
23.	Reflex function of the Nervous system.	4
24.	Somatic sensations. The auditory system. The chemical sense of taste.	4
25.	The visual system.	4
26.		4

	Colloquium: The special senses.	
27.	The autonomic nervous system. EEG.	4
28.	***Seminar : Nervous system***	4
29.	Changes in the organism during exercises.	4
30.	***Revision.***	4
	TOTAL	120

THESES OF LECTURES AND EXERCISES

THESES OF LECTURES

1. Introduction to Physiology. Principles of control and regulation in the human body. Homeostasis. Function of the cell membrane. Transport through the cell membrane - passive and active transport. Transport through cellular sheets.

The subject of Physiology. Importance of Physiology for medical practice and for the prevention of diseases, for the organisation of the various types of activity, teaching, sport. Basic principles of regulation in the human organism. Homeostasis. Structural and functional features of the cell membrane. Transport through the cell membrane-passive transport (diffusion, facilitated diffusion, osmosis, filtration) and active transport (primary and secondary active transport, Endo-and exocytosis).

2. Excitable tissues. Resting membrane potential. Nerve action potentials. Propagation of the action potential

Equilibrium potential. Resting membrane potential. Local response. Action potential - mechanism of generation and properties. Propagation of the action potential. Classification of nerve fibres.

3. Mechanisms of cell-to-cell signaling. Synaptic transmission. Functional anatomy. Chemical transmission of synaptic activity. Chemical substances- synaptic transmitters. Mechanisms of cell-to-cell signaling. Cell-to-cell signaling with the participation of membrane and intracellular receptors. Synaptic transmission.Types of synapses. Chemical synapses. Postsynaptic potentials .Synaptic transmitters. Transmitter receptors in the postsynaptic membrane. Neuropeptides.

4. Skeletal muscle. Physiological anatomy of skeletal muscle. Mechanism of muscle contraction. Motor unit. Characteristics of whole skeletal muscle contraction. Length –tension and force – velocity curve.

Physiologic anatomy of skeletal muscle. General mechanism and molecular mechanism of muscle contraction. Neuromuscular junction. Muscle action potential. Motor unit. Excitation - contraction

coupling. Types of muscle contractions: single muscle twitch, incomplete and complete tetanus. Relation between muscle length, tension and velocity of contraction.

5. Energy of muscle contraction. Smooth muscle. Types of smooth muscle. Morphology and function.

Sources of energy for muscle contraction. Muscle fatigue. Physiology of smooth muscle. Types of smooth muscle. Smooth muscle contraction in comparison with skeletal muscle contraction. Regulation of muscle contraction.

6.Physiology of the cardiovascular system. Cardiac muscle, morphology and function. Electrical activity of the heart. Electrocardiogram /ECG/.

Circulatory system. Physiology of cardiac muscle. Action potentials in cardiac muscle. Contraction of cardiac muscle. Specialized excitatory and conductive system of the heart. Ionic basis of automaticity. Electrical activity of the heart. Spread of the cardiac impulse through the heart. The normal electrocardiogram origin and characteristics .

7.Cardiac cycle. Function of the valves. Work output of the heart. Heart sounds. Intrinsic and extrinsic regulation of myocardial performance.

The cardiac cycle. The atrial, ventricular and aortic pressure curves. Function of the valves. Heart sounds. Auscultation. Work output of the heart. Stroke volume output. Cardiac output. Factors controlling cardiac output. Intrinsic regulation of heart pumping (the Frank-Starling mechanism). Extrinsic regulation of heart. Control of the heart by autonomic nervous system. Chemical control.

8.The circulation. Physical characteristics of the circulation. Dynamic of blood pressure, flow and resistance. Microcirculation. Veins and their functions.

Physical characteristics of the circulation. Interrelationships among pressure, flow and resistance. Laminar and turbulent flow. Arterial pressure. Pressure in the various portions of the circulation. Measurement and recording of the arterial pressure. Normal values. Transmission of the pressure pulses. Microcirculation. Exchange through the capillary wall. Regulation of the microcirculation. Venous circulation. Functions of the veins. Venous pressure.

9. Neuronal regulation of the circulation. Rapid control of the arterial pressure. Long-term regulation of arterial pressure. Circulation through special regions.

Nervous and humoral regulation of the circulation. Role of the nervous system for rapid control of arterial pressure. Reflex Mechanisms for Maintaining Normal Arterial Pressure . Long - term regulation of arterial pressure. Role of ADH and renin-angiotensin-aldosteron system The integrated system for arterial pressure regulation. Circulation through special regions - coronary, cerebral and pulmonary circulation.

10. Blood components. Functional role of plasma proteins. Blood components. Red blood cells, hemoglobin. Hemopoiesis. Blood groups.

Functions of the blood. Composition and properties of blood. Plasma. Plasma proteins. Physiological functions of plasma proteins. Red blood cells. Production of red blood cells and its regulation. Reactions of hemoglobin. Iron metabolism. Hemopoiesis –regulation.

11. Resistance of the body to infection. Leukocytes. Hemostasis and blood coagulation.

Resistance of the body to infection. Innate and acquired immunity. . Leukocytes (white blood cells). Types of white blood cells. Defensive properties of neutrophils and macrophages. Events in hemostasis. Mechanism of blood coagulation. Blood groups.

12. Respiration. Pulmonary ventilation. Pleural and alveolar pressure. Compliance of the lungs. Surfactant. Lung volumes and capacities. Alveolar ventilation. Physical principles of gas exchange. Gas exchange through respiratory membrane. Gas transport between the lungs and tissues.

Functional devices of the respiratory system. Functions of the respiratory system. Factors affecting the smooth muscles of the Airways. Mechanics of breathing, respiratory muscles. Pleural Pressure. Alveolar pressure . Surfactant. Compliance of the Lungs. Pulmonary volumes and capacities Minute Respiratory Volume. Alveolar ventilation . Functions of the Respiratory Passageways.
Physical principles of gas exchange. Diffusion of oxygen and carbon dioxide through respiratory membrane. Diffusing capacity of the respiratory membrane. Composition of Alveolar Air. Uptake of oxygen by the pulmonary blood. Transport of oxygen in the blood. Ventilation-Perfusion Ratio. Oxygen - hemoglobin dissociation curve. Diffusion of carbon dioxide from the tissue into the tissue capillaries and from the pulmonary capillaries into alveoli. Transport of carbon dioxide in the blood. Carbon dioxide dissociation curve. Respiratory exchange ratio.

13. Regulation of respiration. Control of breathing - central organization of breathing, chemoreceptor control of breathing, chemical control of breathing. Effects of high altitude and sea diving physiology.

Regulation of respiration. Respiratory center. Chemical control of respiration - direct chemical control of respiration and peripheral chemoreceptor system. Regulation of respiration During exercise. Breathing at high altitude and hyperbaric conditions.

14. General principle of gastrointestinal tract. Neuronal and hormonal control of functions blood flow. Transport and mixing of food in the gastrointestinal tract. Secretory function of the alimentary tract. Secretion of saliva, gastric secretion. Pancreatic secretion. Liver and bilary system. Intestinal secretion.

General principles of gastrointestinal function. Physiologic Anatomy of the Gastrointestinal Wall. Electrical Activity of GastrointestinalSmooth Muscle Motility. Functional Types of Movements in the Gastrointestinal TractEnteric nervous system. Nervous Control of Gastrointestinal Blood Flow. Autonomic and hormonal control of the gastrointestinal tract. Gastrointestinal Blood Flow. Mastication and swallowing. Motor function of the stomach. Regulation. Movements of the small intestine. Movements of the colon. Defecation. General Principles of Alimentary Tract Secretion. Basic Mechanism of Secretion by Glandular Cells. Secretion of the saliva. Composition and function of the saliva. Regulation of salivary secretion. Gastric secretion. Phases of Gastric Secretion. Regulation of gastric secretion. Pancreatic secretion. Regulation. Secretion of the bile by the liver. Secretion of the small intestine. Regulation.

15. Digestion and absorption of carbohydrate, proteins and fats in the gastrointestinal tract. Absorption of water, ions and vitamins. Functions of the liver. Physiology of gastrointestinal disorders.

Basic principles of gastrointestinal absorption. Anatomical Basis of Absorption. Digestion and

absorption of proteins in the gastrointestinal tract. Digestion and absorption of fats in the gastrointestinal tract. Digestion and absorption of carbohydrates in the gastrointestinal tract. Absorption of water and ions. Absorption of vitamins. Liver. Metabolic functions of the liver. Excretion of bilirubin in the bile. Gastrointestinal disorders.

16.Whole body metabolism. Role of the hormones of the thyroid, pancreatic, adrenal glands and pituitary in the regulation of the whole body metabolism. Temperature regulation.

Carbohydrate metabolism. General role of glucose in carbohydrate metabolism. Storage of glycogen in liver and muscle - glycogenesis. Glycogenolysis. Gluconeogenesis. Protein metabolism. Basic Properties. Hormonal regulation of protein metabolism.Lipid metabolism. Regulation of fat utilization. Vitamins. Daily requirements and storage of vitamins. Basic functions of vitamins. Mineral metabolism. Dietary balances. Energy available in foods. Body temperature. Heat production and heat loss. Sweating and its regulation. Regulation of body temperature - role of the hypothalamus.

17. The kidney. Functional anatomy. Renal circulation. Clearance. Tubular processing of glomerular filtration. Urine concentration and dilution. Micturition.

Functions of the kidneys in homeostasis. Physiological anatomy of the kidneys. The nephron. Renal blood supply. Glomerular filtration - the first step in urine formation. Physiological control of glomerular filtration and renal blood flow.Urine formation. Reabsorption and secretion along different parts of the nephron. Regulation of tubular reabsorption. Glomerulotubular balance. Hormonal control of tubular reabsorption. Renal clearance. Renal mechanism for excreting a dilute urine. Urine concentrating mechanism for excreting a concentrated urine. Role of ADH. Urine volume. Obligatory urine volume. Micturition. Endocrine function of the kidney.

18. Control of body fluid osmolality and volume. Role of the hormones of the thyroid, pancreatic, adrenal glands and pituitary in the regulation of the body fluid osmolality and volume. Regulation of acid-base balance.

Body fluid compartments. Balance of fluid intake and output. Regulation of extracellular fluid composition (ionic composition) and volume. Role of the hormones of the thyroid, pancreatic, adrenal glands and pituitary in the regulation of the body fluid osmolality and volume .Renal regulation of potassium, calcium, phosphate, and magnesium. Integration of renal mechanisms for control of blood volume and extracellular fluid volume .Regulation of acid - base balance. The chemical acid - base buffer systems of the body fluids. Respiratory and renal control of acid - base balance. Clinical causes of acid-base disorders**.**

19. Endocrine physiology – general principles. Mechanism of hormonal action. The pituitary hormones and their control by the hypothalamus. The thyroid metabolic hormones.

The common characteristic of the endocrine system. Classification of hormones. The synthesis of hormones. General principles of hormonal regulation. Chemistry of hormones. Storage and secretion of hormones. Mechanisms of hormonal action. Function of the anterior pituitary gland. Control of pituitary secretion by the hypothalamus. Physiological functions of growth hormone. The posterior pituitary gland and its relation to the hypothalamus. Physiological function of antidiuretic hormone and oxytocin. The thyroid gland. Synthesis and Secretion of the Thyroid Metabolic Hormon. Reselease of Thyroxine and Triiodothyronine from the Thyroid Gland. Functions of the thyroid metabolic hormones. Regulation of thyroid hormone secretion. Diseases of the Thyroid.

20. The hormones of the pancreatic islets. Parathyroid hormone, calcitonin, vit D, and calcium-phosphate metabolism

Endocrine function of the pancreas. Insulin and its metabolic effects. Glucagon and its functions. Regulation of the blood glucose concentration. Diabetes Mellitus. Parathyroid hormone, calcitonin, vit D, and calcium-phosphate metabolism

21. The adrenocortical hormones. Reproductive and hormonal functions of the male.

The adrenal glands. Functions of the mineralocorticoids, of the glucocorticoids and adrenal androgens. Abnormalities of adrenocortical secretion. Physiologic Anatomy of the Male Sexual Organs. Spermatogenesis. Reproductive and hormonal function of the male. Male Sexual Act. Functions of testosterone. Functions of Testosterone During Fetal Development . Control of male sexual functions by hypothalamus and anterior pituitary gland. Effect of Testosterone on Development of Adult Primary and Secondary Sexual Characteristics.

22. Reproductive and hormonal functions of the female.

Physiologic anatomy of the female sexual organs. Female hormonal system. Monthly ovarian cycle;function of the gonadotropic hormones. Functions of the ovarianhormones—estradioland progesterone. Chemistry of th functions of progesteronee sex hormones. Functions of the estrogens—their effects on the primary and secondary female sex characteristics. Monthly endometrial cycle and menstruation. Regulation of the female monthly rhythm—interplay
Between the ovarian and hypothalamic-pituitary hormones. Abnormalities of secretion by the ovaries. Puberty. Menopause. Pregnancy, childbirth, lactation.

23. The nervous system: sensory receptors, neural circuits for processing information. Somatic sensations: general organization, the tactile and position senses, pain and thermal sensation

Overview of the functions of the nervous system. Functional morphology of the nervous . General design of the nervous system. Major levels of central nervous system function.Physiologic anatomy of the neuron. Transmission and processing of signals in neuronal pools. Neuronal circuits. Instability and stability of neuronal circuits. Types of sensory receptors. Receptor potentials. Adaptation of receptors. . Somatic sensations. General organization. The tactile and position senses. Sensory pathways for transmission of somatic signals into the central nervous system. Somatic sensory cortex. Thermal sensations. Pain sensation, pain suppression, referred pain, visceral pain and headache.

24. The eye: optics and vision, receptor and neural function of the retina. Central neurophysiology of vision

The eye. Optics of vision.The visual system. Receptor and neural function of the retina. Receptive field organization. Visual pathway. Organization and function of the visual cortex.
The visual system. Fields of vision, perimetry. Eye movements and their control. Fusion of the visual images from the two eyes. Light and dark adaptation. Color vision.

25. The sence of hearing. The cemical senses – taste and smell.

The auditory system. External, middle and inner ear. Sound transmission. Function of the organ of Corti. Central auditory pathway. Functional organization of central auditory system. Determination of

sound direction. Taste and smell.

26. Motor control – general principles. Motor function of spinal cord. The cord reflexes. Cortical and brainstem control of motor function.

General scheme of regulation of movements. Motor function of the spinal cord. Principles of spinal organization. Muscle sensory receptors. Spinal reflexes - myotatic, flexor and withdrawal. Reflexes of posture and locomotion.

27. Vestibular sensations and maintenance of equilibrium. Motor control by the cerebellum and basal ganglia

Role of the brain stem in controlling motor function. Vestibular postural reflexes. Motor functions The cerebellum . The basal ganglia and their motor functions. Diseases of the basal ganglia. Cortical control of motor function. The vestibular apparatus and vestibular sensations. The maintenance of equilibrium.

28. Cerebral cortex, intellectual functions of the brain, learning and memory. Behavioral and motivational mechanisms of the brain – the limbic system and hypothalamus. Activating-driving systems of the brain. States of brain activity, sleep. The electroencephalogram.

Functional anatomy of the limbic system. Behavioral functions of hypothalamus and associated limbic structures. Function of the hippocampus and the amygdale.
Cerebral cortex. Functions of specific cortical areas. Cerebral dominant.
Intellectual functions of the brain. Learning and memory. Short-Term Memory.
Intermediate Long-Term Memory. Long-Term Memory. Consolidation of Memory. Hypothalamus.
Vegetative and endocrine control functions of the hypothalamus.
Activating - driving systems of the brain. Brain electrical activity. Origin of Brain Waves States of brain activity. Sleep - basic theories of sleep, the cycle between sleep and wakefulness. Sleep – types. . EEG.

29. The autonomic nervous system. The adrenal medulla.

General Organization of the Autonomic Nervous System. Basic characteristics of sympathetic and parasympathetic function. Effects of Sympathetic and Parasympathetic Stimulation on Specific Organs. Function of the Adrenal Medullae. ”Alarm” or “stress” response of the sympathetic nervous system. Autonomic Reflexes. Medullary, Pontine, and Mesencephalic Control of the Autonomic Nervous System. Pharmacology of the ANS.

30.Sports physiology. Changes in the organism during exercises

Changes of cardiovascular and respiratory systems, Water-electrolyte balance, Blood and hormonal secretion.

THESES OF PRACTICAL EXERCISES

1. White blood cells.

Introduction. Leucocytes: function and regulation. Sampling blood for testing. Determining the number of leucocytes. Differential WBC count. Normal values and changes in different

physiological states.

2. Red blood cells. Hemoglobin. Hematocrit
Red Blood Cell Counting. Determination of the Hematocrit. Hematological indices. Determination of the Osmotic Resistance of the RBC.

3. Erythrocyte Sedimentation Rate (ESR). Clotting Time. Blood Typing
Determination of erythrocyte sedimentation rate. Normal values and physiological variations Bleeding and clotting time determination. Blood typing with test-sera. Principle of blood transfusions.

4. Colloquium: Blood.

5. Skeletal muscle.

Contraction of skeletal muscle**.** Excitation of skeletal muscle. Neuromuscular transmission. Excitation – contraction coupling. Registration of a single muscle twitch; registration of tetanic contractions; muscle fatigue. Ergography.

6. Colloquium: Cellular physiology. Muscles.

7. Structure of the heart in relation to function. Effect of temperature on the sinus venosus. Stanius ligatures
Registration and analysis of cardiomechanogram of the frog heart. Effect of temperature on the sinus venosus. Stannius ligatures**.**

8. **Extrasystoles. Cardiac Control.**

Action potential of the myocardium. Extrasystoles. Regulation of the heart (intrinsic and extrinsic). Recording of Ventricular Extrasystoles. Nervous control of heart rate (effect of the n. vagus stimulation). Humoral control (effect of adrenalin, effect of hypercalcemia, effect of hyperkalemia).

9. **ECG recording.**
Physiological bases of ECG. Bipolar limb leads. Augmented unipolar limb leads. Unipolar chest leads**.** Preparation of the electrocardiograph for registration. Connecting of the patient with patient cable. ECG registration**.**

10. ECG Analysis
Measurement of the ECG elements**.** Determination of the duration of cardiac cycle. Determination of the heart rate. Electrical axis of the heart. Determination of the mean electrical axis of the heart.

11. Heart sounds. Pulse. Arterial pressure.
Auscultation of the heart sounds. Auscultatory sites. Pulse investigation. Measuring of the arterial pressure. Simultaneous record of ECG, PCG, SPHG. Analysis.

12. Colloquium: Cardiovascular system.

13. Respiration. Lung volumes and capacities. Pulmonary ventilation.
Mechanics of pulmonary ventilation. Pulmonary volumes and capacities. Minute respiratory volume. Alveolar ventilation. Measuring of pulmonary volumes, capacities, minute respiratory volume and alveolar ventilation. Normal values and physiological variations.

14. Gas exchange. Control of breathing.
Physical principle of gas exchange. diffusion of oxygen and carbon dioxide through the respiratory membrane. transport of o_2 and co_2 in the blood and body fluids. Regulation of respiration. Registration of the spirogram. Control of respiration. Effect of n. Vagus stimulation. Effects of ph changes .investigation of the gas exchange.

15. Seminar: Respiratory system.

16. Metabolic Rate. Basal metabolic rate.

Determination of Metabolic Rate according to data of "Spirolyt" and according to composition of expired air. Determination of Basal Metabolic Rate - Actual and standard.

17. Colloquium: Digestive system.

18. Clearance.
Physiological anatomy of the Kidneys. Glomerular filtration, Tubular reabsorption, Tubular secretion. Clearance method to quantify kidney function: GFR, Tubular reabsorbtion, Tubular secretion, RBF, filtration fraction.

19. Acid-base balance.
Buffering of H^+ in the body fluids. Respiratory regulation of acid - base balance. Renal control of acid - base balance. Clinical measurements and analysis of acid - base disorders. Treatment of acidosis and alkalosis.

20. Colloquium: Body fluids and Kidneys.

21.Endocrine System.
Mechanisms of hormonal action. The pituitary gland and its relationship to the hypothalamus. Physiologic functions of the pituitary hormones. Water load test. Thyroid hormones – functions. Hypothyroid state in white rats after thyroid removal. Insulin. Insulin effect on blood sugar level - hypoglycemic shock. Hormonal factors in pregnancy.Early pregnancy tests (Galli-Mainini test).

22. Colloquium: Endocrine system.

23. Reflex Function of the Nervous system.
General design of the nervous system. The spinal cord reflexes.
Unconditioned reflexes in a spinal frog. Analysis of the reflex arc. Determination of the reaction time. Clinically important reflexes - superficial and deep reflexes.

24. Somatic sensations. Auditory system. Chemical sense of taste.
Hearing tests. Audiometry. Rinne and Weber tests. Determination of threshold of taste sensation. Two point discrimination test.

25. The visual system.
Optics of vision and function of the retina. Neurophysiology of vision. Visual acuity testing. Pupil's reactions. Eye movements. Visual field examination. Color Vision Testing.

26. Colloquium: The special senses.

27. Autonomic Nervous System. EEG.
General Organization of the ANS. Basic characteristics of sympathetic and parasympathetic function. Effects of Sympathetic and Parasympathetic Stimulation on Specific Organs.
Demography. Pupillary reflexes. Aschner -Dagnini reflex. Orthostatic test Registration and analysis of the EEG.

28. Seminar: Nervous system.

29.Changes in the organism during exercises.
Changes in CVS: pulse rate, systolic and diastolic pressure. Changes in respiratory system: MRV, Tidal volume, vital capacity. Changes in blood: White blood cells, Hemoglobin,
Hematocrit, clotting time.

30.Revision.
Revision of the practical tasks involved in the synopsis for the practical examination.

METHODS OF CONTROL

CURENT CONTROL
During the school year are held seven Colloquiums. The final assessment of the current control is calculated as the arithmetic mean of Colloquiums.

FINAL CONTROL
The final assessment is complex and evaluates the overall performance and acquired knowledge and skills during the training in the Department of Physiology.
The final score shall be rounded to the unit and entered in school records.

SYSTEM FOR THE GATHERING OF CREDITS
Total number of credits: 11
Total credit assessment is formed by:
1. Credits from the presence of lectures
2. Credits from the presence and participation of the exercises
3. Credits from self preparation for practical classes
4. Credits from continuous control (colloquiums)

5. Credits from self training for colloquiums
6. Credits from individual preparation for final exam

LOCATION OF DISCIPLINE IN THE OVERALL TRAINING EXPERIENCE

Physiology is ***fundamental*** discipline in education in medicine. Knowledge in Physiology is absolutely necessary for the understanding of the mechanisms of disease. Physiology forms the basis of the clinical thinking. It is the basis and basic Pharmacology-knowledge in Physiology is absolutely necessary for studying the mechanisms of action of medicinal substances. Physiology is the basis of preventive medicine. It provides knowledge and methods for optimal organization of all human activities with a view to preserving human health.

EXPECTED RESULTS

It is known that the fundamental training of medical students, a substantial part of which is preparation of Physiology, presupposes the horizon of future doctors. We expect good preparation in Physiology to raise the overall training of students and future physician.

SYNOPSIS
FOR THE PHYSIOLOGY EXAMINATION
2017/2018 academic year

1. Homeostasis. Functional systems of the body. Control systems of the body. Negative and positive feedback loops.
2. Structure of the cell membrane. Membrane composition. Cell membrane proteins. Transport through the cell membrane - passive transport.
3. Active transport through the cell membrane - primary and secondary active transport. Ingestion by the cell - endocytosis. Transport through cellular sheets.
4. Basic physics of membrane potentials. Resting membrane potential of nerves. Generation of action potential.
5. Propagation of the action potential. Re - establishing sodium and potassium ionic gradients after action potentials. Special characteristics of signal transmission in nerve trunks.
6. Synaptic transmission. Types of synapses. Chemical synapses. Postsynaptic potentials. Summation of synaptic inputs - temporal and spatial.
7. Synaptic transmitters. Transmitter receptors in the postsynaptic membrane. Neuropeptides.
8. Physiologic anatomy of skeletal muscle. General mechanism and molecular mechanism of muscle contraction. Neuromuscular junction. Muscle action potential. Motor unit. Excitation - contraction coupling.
9. Characteristics of whole skeletal muscle contraction.
10. Relation between muscle length, tension and velocity of contraction. Sources of energy for muscle contraction. Muscle fatigue.
11. Physiology of smooth muscle. Types of smooth muscle. Smooth muscle contraction in comparison with skeletal muscle contraction. Nervous and hormonal control of smooth muscle contraction

12. Blood components. Plasma. Physiological functions of plasma proteins.
13. Red blood cells. Production of red blood cells and its regulation. Reactions of hemoglobin. Iron metabolism.
14. Leukocytes (white blood cells). Types of white blood cells. Defensive properties of neutrophils and macrophages.
15. Events in hemostasis. Mechanism of blood coagulation. Intravascular anticoagulants.
16. Resistance of the body to infection. Innate and acquired immunity.
17. Blood groups. Transfusion reactions resulting from mismatched blood types.
18. Physiology of cardiac muscle. Specialized excitatory and conductive system of the heart. Ionic basis of automaticity. Action potentials in cardiac muscle. Contraction of cardiac muscle.
19. Electrical activity of the heart. Spread of the cardiac impulse through the heart. The normal electrocardiogram.
20. The cardiac cycle. The atrial, ventricular and aortic pressure curves. Function of the valves. Heart sounds.
21. Work output of the heart. Stroke volume. Cardiac output. Factors controlling cardiac output. Intrinsic regulation of heart pumping (the Frank-Starling mechanism).
22. Extrinsic regulation of heart. Control of the heart by autonomic nervous system. Chemical control.
23. Physical characteristics of the circulation. Interrelationships among pressure, flow and resistance.
24. Arterial pressure. Pressure in the various portions of the circulation. Transmission of the pressure pulses.
25. Microcirculation. Exchange through the capillary wall. Formation of lymph. Rate of lymph flow.
26. Local, nervous and humoral regulation of the circulation.
27. Veins and their function.
28. Role of the nervous system in rapid control of arterial pressure.
29. Long - term control of arterial pressure.
30. The integrated system for arterial pressure regulation.
31. Circulation through special regions - coronary, cerebral and pulmonary circulation.
32. Respiration. Mechanics of pulmonary ventilation. Pulmonary volumes and capacities.
33. Physical principles of gas exchange. Diffusion of oxygen and carbon dioxide through the respiratory membrane. Diffusing capacity.
34. Uptake of oxygen by the pulmonary blood. Transport of oxygen in the blood. Oxygen - hemoglobin dissociation curve.
35. Diffusion of carbon dioxide from the tissue into the tissue capillaries and from the pulmonary capillaries into alveoli. Transport of carbon dioxide in the blood.
36. Regulation of respiration. Respiratory center. Chemical control of respiration - direct chemical control of respiration and peripheral chemoreceptor system.
37. Respiratory physiology of high altitude, aviation and hyperbaric conditions.
38. General principles of gastrointestinal function. Motility. Enteric nervous system. Autonomic and hormonal control of the gastrointestinal tract.
39. Mastication and swallowing. Motor function of the stomach. Regulation.
40. Movements of the small intestine. Movements of the colon. Defecation.

41. Secretion of the saliva. Composition and function of the saliva. Regulation of salivary secretion.
42. Gastric secretion. Regulation of gastric secretion.
43. Pancreatic secretion. Regulation.
44. Secretion of the bile by the liver. Secretion of the small intestine. Regulation.
45. Basic principles of gastrointestinal absorption. Absorption of water, ions and vitamins.
46. Digestion and absorption of proteins in the gastrointestinal tract.
47. Digestion and absorption of fats in the gastrointestinal tract.
48. Digestion and absorption of carbohydrates in the gastrointestinal tract.
49. Liver. Metabolic functions of the liver. Excretion of bilirubin in the bile.
50. Dietary balances. Energy available in foods. Daily requirements for proteins, fats and carbohydrates. Energetics and metabolic rate.
51. Vitamins and minerals. Functions and daily requirements. Trace elements.
52. Carbohydrate metabolism. General role of glucose in carbohydrate metabolism. Storage of glycogen in liver and muscle (glycogenesis). Glycogenolysis. Gluconeogenesis. Hormonal regulation.
53. Protein metabolism. Hormonal regulation of protein metabolism.
54. Lipid metabolism. Regulation of fat utilization.
55. Body temperature. Heat production and heat loss. Regulation of body temperature - role of the hypothalamus.
56. Functions of the kidneys in homeostasis. Physiological anatomy of the kidneys - the nephron as a functional unit of the kidney. Renal blood supply. Glomerular filtration - the first step in urine formation. Physiological control of glomerular filtration.
57. Urine formation. Reabsorption and secretion along different parts of the nephron.
58. Regulation of tubular reabsorption. Glomerulotubular balance. Hormonal control of tubular reabsorption.
59. Urine concentration and dilution. Micturition. Use of clearance methods to quantify kidney function.
60. Body fluid compartments. Balance of fluid intake and output. Regulation of extracellular fluid composition (ionic composition) and volume.
61. Regulation of acid - base balance. The chemical acid - base buffer systems of the body fluids. Respiratory and renal control of acid - base balance.
62. General principles of hormonal regulation. Chemistry of hormones. Storage and secretion of hormones. Mechanisms of hormonal action.
63. Function of the anterior pituitary gland. Control of pituitary secretion by the hypothalamus. Physiological functions of growth hormone.
64. The posterior pituitary gland and its relation to the hypothalamus. Physiological function of antidiuretic hormone and oxytocin.
65. The thyroid gland. Functions of the thyroid metabolic hormones. Regulation of thyroid hormone secretion.
66. Parathyroid hormone, Calcitonin, calcium and phosphate metabolism.
67. Endocrine function of the pancreas. Insulin and its metabolic effects. Glucagon and its functions. Regulation of the blood glucose concentration.
68. The adrenal glands. Functions of the mineralcorticoids.
69. The adrenal glands. Functions of the glucocorticoids.

70. Adrenal androgens. Abnormalities of adrenocortical secretion. The prostaglandins.
71. Reproductive and hormonal function of the male. Functions of testosterone. Control of male sexual functions by hypothalamus and anterior pituitary gland.
72. Female physiology before pregnancy. The monthly ovarian cycle and function of the gonadotropic hormones. Functions of the ovarian hormones. The monthly endometrial cycle and menstruation. Interplay between the ovarian and hypothalamic - pituitary hormones.
73. General design of the nervous system. Major levels of central nervous system function. Physiologic anatomy of the neuron. Transmission and processing of signals in neuronal pools. Neuronal circuits. Cerebrospinal fluid.
74. Types of sensory receptors. Receptor potentials. Adaptation of receptors.
75. Somatic sensations. General organization. The tactile and position senses. Sensory pathways for transmission of somatic signals into the central nervous system. Somatic sensory cortex.
76. Somatic sensations. Thermal sensations. Pain sensation, pain suppression, referred pain, visceral pain and headache.
77. The vestibular system. The vestibular apparatus and vestibular sensations. The maintenance of equilibrium.
78. The auditory system. External, middle and inner ear. Sound transmission. Function of the organ of Corti.
79. The auditory system. Central auditory pathway. Functional organization of central auditory system. Determination of sound direction.
80. The eye. Optics of vision.
81. The visual system. Receptor and neural function of the retina. Receptive field organization. Visual pathway. Organization and function of the visual cortex.
82. The visual system. Fields of vision, perimetry. Eye movements and their control. Fusion of the visual images from the two eyes. Light and dark adaptation. Color vision.
83. The chemical senses - taste and smell.
84. Motor function of the spinal cord. Principles of spinal organization. Muscle sensory receptors. Spinal reflexes - myotatic, flexor and withdrawal.
85. Reflexes of posture and locomotion. Role of the brain stem in controlling motor function. Vestibular postural reflexes.
86. The cerebellum and its motor functions.
87. The basal ganglia and their motor functions. Diseases of the basal ganglia.
88. Cortical control of motor function.
89. Activating - driving systems of the brain. Brain electrical activity.
90. States of brain activity. Sleep - basic theories of sleep, the cycle between sleep and wakefulness.
91. The autonomic nervous system - basic characteristics of sympathetic and parasympathetic function. Functions of the adrenal medulla. ”Alarm” or “stress” response of the sympathetic nervous system.
92. Vegetative and endocrine control functions of the hypothalamus.
93. Functional anatomy of the limbic system. Behavioral functions of hypothalamus and associated limbic structures. Function of the hippocampus and the amygdale.
94. Cerebral cortex. Functions of specific cortical areas. Cerebral dominant.
95. Cerebral cortex. Intellectual functions of the brain. Learning and memory.

96. The cardiovascular system in exercise. Muscle blood flow and cardiac output during exercise.
97. Respiration and oxygen consumption in exercise.
98. Body heat production, fluids and salts in exercise.

RECOMMENDED LITERATURE:

1. Guyton & Hall, Textbook of Medical Physiology, 13th edition, SAUNDERS ELSEVIER Inc., Philadelphia, USA, 2016
2. Linda S. Constanzo, Physiology, 5th edition, SAUNDERS ELSEVIER Inc., Philadelphia, USA, 2014
3. Ganong's Review of Medical Physiology, 25th edition, International edition, Singapore, 2016

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01.09.2017 г...…… /дата, подпис/	01.09.2017 г..... /дата, подпис/	01.09.2017 г ..... /дата, подпис/	Валиден от: 11.09.2017г.