Physiology with the basics of anatomy

Teachers: PhD Telina Evelina Nicolaevna

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Total hours – 252 h:
Lectures: 38 h;
Practical classes: 102 h;
Independent work – 76 h;
Control – 36 h

Course description:

Lecture is an oral presentation of particular branch of science or discipline by the teacher. It is usually held for the course of students at the same time.
Workshop is usually devoted to detailed study of specific topics and it is being held in each academic group separately. The workshop involves active participation of students in problem discussion. It requires preliminary preparation by the student.
Practical training is aimed to apply theoretical knowledge in practice. The skills are developed in problem solving process under the supervision of a teacher.
Laboratory classes contain experimental scientific research activities. It requires the use of special equipment, facilities and materials. To be held in teaching laboratories.
Self-study is work with the special literature or teaching materials (literary sources, video and audio material, multimedia programs and simulators) on the educational portal of the University https://e.kazangmu.ru/enrol/index.php?id=1919

Course objectives: The purpose of mastering the discipline

The goals of mastering the **Physiology with the basics of anatomy** discipline are formation of systematic knowledge about the vital functions of the whole organism and it's individual parts and the mechanisms of their regulation in interaction with each other and with environmental factors, on the physiological bases of research methods used in the functional diagnosis and the study of body functions; formation the skills of interpretation of basic physiological principles and basic methods of physiological functions examination, which submitted to the activities of the all organism systems.

Tasks of the discipline:

To form knowledge in the field of:

- the basic physiological principles, which submitted to the activities of the all organism, it's systems, tissues and cells;
- the common biological mechanisms of regulation of the vital activity of the human, that providing the adaptation, homeostasis and health care;
- formation of the skills with the educational and scientific literature by themselves, acquaint with a basic methods of physiological functions examination;

Course topics:

- Section 1. Membrane Physiology, Nerve and Muscles,
- Section 2. The Central Nervous System.
- Section 3. The Sensory System.
- Section 4. The Heart and Circulation.
- Section 5. The Blood.
- Section 6. The Respiratory System.
- Section 7. The Digestive System.
- Section 8. The Urinary System.
- Section 9. The Endocrine System.

Calendar plan of lectures

I semester

1. The biological membrane. Transport through the cell membrane.
2. Physiology of the skeletal and smooth muscles.
3. Mechanisms of transmission in synapses.
4. General principles of coordination of body functions by central nervous system.
5. Functions of the spinal cord, medulla oblongata, pons, midbrain.
6. Functions of diencephalon. Autonomic nervous system.
7. The Sensory System. Perception.
8. Morphological and functional features of the organization of the heart.
9. Cardiac cycle. ECG.

II semester

10. Physiology of blood vessels. Arterial pulse. Venous pulse. Microcirculation.
11. Arterial pressure regulation.
12. The role of the blood in maintaining homeostasis. Red blood cells. Hemoglobin.
13. White blood cells. Immune system.
14. Hemostasis.

III semester

15. The respiratory physiology.
16. The gastrointestinal system. Digestion in the oral cavity, stomach.
17. Digestion in the small, large intestine.
18. Kidney Structure and Function.
19. Physiology of the Endocrine system.

Calendar plan of practical classes

1. Physiology of the excitable cells. The cell membrane structure. Basic mechanisms of passive and active transport (the concentration difference, diffusion, ionic pump, secondary active transport).
2. Membrane potential. Equilibrium K+ potential. Microelectrode and patch-clamp methods. Action potential. The phases of action potential. The threshold. The refractory period. The «all-or-none» law. The phenomenon of accommodation. The strength-duration curve.
3. Physiology of the skeletal and smooth muscles. Structure, morphological (sarcomere) and physiological (motor units) units of skeletal muscles. Excitation-contraction coupling. Cross-bridges formation. Role of the calcium ions and ATP in the mechanism of muscle contraction. Rigor mortis.
4. Morphological and physiological features of the nerve fibers. Propagation of the action potential along myelinated and unmyelinated nerve fibers. The laws of propagation of AP. The neuromuscular junction. Releasing of acetylcholine from axon terminals. The "end-plate potential" and excitation of the skeletal muscle fiber. Role of cholinesterase Pre- and postsynaptic mechanisms of the effects of the biological active drugs.
5. Ionotropic and metabotropic receptors.
6. Module on topics 1-5.
7. The main functions of central nervous system CNS. Neuronal theory of CNS structure. Interneuronal synapses. Neurotransmitters in CNS. Excitation and Inhibition in CNS. The neural centers (occlusion, spatial facilitation, convergence, divergence, reverberation). Reflex arch.
8. Reflexes of spinal cord. The vital centers of the medulla oblongata: vasomotor center, cardiac control center, respiratory center. Reflexes of medulla oblongata. Static and statokinetic reflexes. Midbrain. The role of Cerebellum and Basal nuclei in motor control. Clinical abnormalities of the Cerebellum.
9. The significance of the Thalamus in processing and transmission of sensory signals. The significance of the Hypothalamus in regulation of autonomic, endocrine, somatic and emotional functions. Hypothalamohypophysial system and its functional significance.
10. Structure and functions of the basal nuclei. Structure and functions of the Cerebral cortex. Motor, sensory and associative areas. Cerebral lateralization. Electroencephalogram. Clinical use of the electroencephalogram.
11. Structures and functions of the limbic system. The role of limbic system in formation of emotions, behavior and memory. Memory, and its types. classification of memories. Physiological mechanisms underlying memory formation. Sleep. Slow wave sleep and paradoxical (REM) sleep. Basic theories of sleep: role of the reticular activating system, neuronal centers, transmitters, etc.
12. Module on topics 7-11.
13. Somatosensory perception. Receptive field of sensory neuron. Touch and temperature sensitivity.
14. Thermal balance. Energy metabolism and calorimetry.
15. Physiology of the Heart. Electrical activity of the heart. The cardiac cycle. Pressure changes during the cardiac cycle. Atrioventricular and semilunar valves. Conducting tissues of the heart. Excitation - contraction coupling in cardiac muscle.
16. Intrinsic and extrinsic control of the cardiac functions. Intrinsic autoregulation of the heart (Frank-Starling law). Intracardial and extracardial reflexes. Sympathetic and parasympathetic effects.
17. Module on topics 15-16.
18. The classification of the blood vessels. Parameters of hemodynamics. The Poiseuille's equation. Blood flow in different parts of vascular bed. Laminar and turbulent blood flow. Arterial blood pressure. Blood pressure measurement. Systolic, diastolic, pulse, mean arterial pressures.

19. Arterial blood-pressure curve. Endothelial exchange processes (Starling's relationship). Exchange of fluids via capillaries and venules. Causes of edema.
20. Regulation of the circulation. Vasoconstriction and vasodilatation. Local regulation of blood flow. Neuronal and hormonal control of circulation.
21. Module on topics 18-20.
22. Composition and function of blood. plasma. Flow properties of blood. Red blood cells. The formation of blood cells.
23. White blood cells. Immune system. Nonspecific and specific immunity.
24. Blood groups: AB0 system, Rh system. Blood transfusion.
25. Hemostasis. Platelet-mediated hemostasis. Blood clotting. Fibrinolysis. Anticoagulants.
26. Module on topics 22-25.
27. Lung function, respiration. External respiration. Mechanics of breathing. Respiratory muscles. Pleural pressure. Surface tension, surfactant. Lung volumes and their measurement.
28. Pulmonary gas exchange. O_2 and CO_2 transport in blood. O_2 dissociation curve: Respiratory control.
29. Saliva (functions, production, secretion). Mechanism and control of saliva secretion. Deglutition.
30. Stomach structure and motility. Gastric juice. HCl secretion by parietal cells. Small Intestinal Function. Pancreas. Pancreatic secretions. Pancreatic enzymes. Control of pancreatic juice secretion.
31. Liver. Bile components and hepatic secretion of bile. Enterohepatic circulation of bile salts. Digestion and absorption. Large intestine, defecation. Endocrine and paracrine hormones and neurotransmitters control GI functions.
32. Kidney Structure and Function. Renal Circulation. Glomerular filtration and clearance. Transport processes at the nephron.
33. Reabsorption, excretion and urine concentration. The kidney and acid–base balance. Renin–angiotensin system.
34. Endocrine system. Humoral signals: control and effects. Hypothalamic–pituitary system. Hormonal control of blood glucose concentration. Thyroid hormones. Calcium and phosphate metabolism. Adrenal gland. Hormonal control of the menstrual cycle.

Text books and required supplies:

1. Ganong's Review of Medical Physiology. 26th Edition. MC Graw Hill. 2019. 1792p. ISBN-10: 978-1-26-012241-1.
2. Hall J. Guyton and Hall Textbook of Medical Physiology. 13rd Edition. Elsevier. 2016. 1046p. ISBN 13:9781455770052.
3. W., Boulpaep E. Medical Physiology. 3rd Edition. Elsevier. 2016. 1312p. eBook ISBN: 9780323391597
4. Educational portal course: Normal Physiology for faculty of General Medicine https://e.kazangmu.ru/course/view.php?id=1919

Evaluation and grading:

Monitoring progress is carried by the end of each module (colloquia/written papers/oral examination/test/laboratory works assessment/abstracts/reports/medical records, reports or other).

Routine performance assessment (homework, practical work, tests during classes, etc.) is carried out using 10 point scale, where 0-6 – "poor", 7 – "satisfactory", 8 – "good", 9 – "excellent" and 10 – "splendid". Unsatisfactory mark during routine performance evaluation or absenteeism (including lectures) is considered to be a student academic debt. In order to rework the debt the student can attend missed/failed class with a different academic group (the teacher is to be notified in advance) or to do the rework using e-learning or distance technologies or in other ways determined by the teacher. Abandoned academic debt is leading to dismissal from the University.

Midterm assessment is a form of knowledge and skills evaluation on the discipline or on a part of it (test/oral exam/paper). Grading: 0–69 points – noncredit; 70–100 points – credit. Student is given not more than 2 attempts to pass midterm assessment within one year. Failure is leading to dismissal from the University.

Exams are held in forms of MCQ test (one correct answer). Grading: 0–69 – "poor", 70-79 – "satisfactory", 80-89 – "good", 90-100 – "excellent".

Overall student rating is build up from class attendance, module and test results, midterm assessment results.

Classroom rules:

- Be respectful
- Be careful with equipment
- Be disciplined
- Be prepared for the classes
- Be involved, do not hesitate to ask questions
- Look professional: you have to wear clean white coat and change shoes
- Eating is allowed only during brakes
- Using phone is allowed only during brakes

Example of module No. 1. Membrane Physiology, Nerve and Muscles

1. The structure and the functions of the cell membrane. Ion channels, their types, functions and mechanisms of activation.
2. The mechanisms of active and passive ion transport through the cell membrane. Ion pumps, their types and functions.

3. Resting membrane potential. The factors underlying causing the formation and maintenance of resting membrane potential. Measurement of the membrane potential. The Nernst equation. The values of membrane potential in different cells.
4. The excitability. The threshold for excitation. The excitability curve. Accommodation.
5. Action potential. The phases of action potential. Changes in sodium and potassium conductances during the course different stages of the action potential. The mechanisms of action potential propagation on the cell membrane. The refractory period.
6. The structure and classification of nerve fibers.
7. Propagation of the action potential in myelinated and non-myelinated nerve fibers. The laws of propagation of the action potential along the nerve fibers.
8. The neuromuscular junction. The mechanisms of quantal acetylcholine release at the neuromuscular synapses.
9. The "end-plate potential" and excitation of the skeletal muscle fiber. Miniature end-plate potentials. Role of acetylcholine-esterase. Drugs that affect transmission at the neuromuscular junction.
10. The types of muscle fibers. Neuromotor unit. Structure of skeletal muscle fibers and myofibrills.
11. Types of contractions of skeletal muscle. Single muscle twitch. Summation of muscle contraction (incomplete and complete muscle tetanic contraction). Isometric and isotonic contraction.
12. Mechanism of skeletal muscle contraction.
13. Excitation-contraction coupling. Role of the calcium ions and ATP in muscle contraction. Rigor mortis.
14. The mechanisms of fatigue in the nerves, muscles and in neuromuscular junction.
15. The smooth muscle. The structure and the types of smooth muscle. Innervation of smooth muscle.
16. Membrane potential and action potentials in smooth muscle. Mechanism of contraction and relaxation in smooth muscle.

Evaluation on the module answer

The question card of the module consists of 2 questions: problem cases, practical exercises, oral and written questions or their combination.

1 correct answer - 50 points

Total for module: **100 points**

Example of exam ticket

Card N1

1. Which part of the ECG corresponds to ventricular repolarization? a. The P wave; b. The QRS duration; c. The T wave

2. The second heart sound is caused by: a. closure of the aortic and pulmonary valves; b. vibrations in the ventricular wall during systole; c. ventricular filling; d. closure of the mitral and tricuspid valves.

3. The main important excitatory neurotransmitter in CNS is: a. glycine; b. GABA; c. glutamate; d. acetylcholine

4. Which of these statements about hypothalamic-releasing hormones is **false**? a. They are synthesized in the hypothalamus; b. They are transported by portal veins to the anterior pituitary; c. They stimulate the secretion of some specific hormones from the posterior pituitary.

5. What type of nerve fiber has the highest conduction velocity? a) Autonomic fibers; b) Sensory fibers; c) Somatic motor fibers

Evaluation of exam answer

The question card of the exam (MCQ) consists of 50 questions (only one correct answer).
1 correct answer - 2 points.
Total for exam: 100 points.