

Ministry of Health of the Republic of Belarus  
Education Establishment  
"Gomel State Medical University"  
Normal Physiology Department

It was discussed at the department meeting 30.08.16  
The protocol № 8

**METHODICAL INSTRUCTION**

for carrying out classes by teachers with the 2nd course students  
of Faculty for training specialists for foreign countries (teaching in English)  
on normal physiology

**Topic:** Test class

The general time of the class – 4 hours

**1. THE STUDYING AND EDUCATIONAL PURPOSES, MOTIVATION FOR ASSIMILATION OF THE SUBJECT, REQUIRMENT TO THE INITIAL LEVEL OF KNOWLEDGE**

**Purpose of the class**

To form at students integrated idea of the role of blood, excitable tissues, CNS, endocrine system and system of respiration in ensuring normal functioning of an organism.

**Tasks of the class**

Check of level of knowledge of students of the subjects "Blood Physiology", "Physiology of Excitable Tissues", "Central Nervous System", "Endocrine System", "Respiration Physiology".

As a result of holding occupation the student has to

**To know:**

– patterns of functioning of excitable tissues, blood system, respiratory, endocrine system, central nervous system of a healthy organism and mechanisms of their regulation considered from positions of the general physiology, partial physiology and integrative behavioural activity of the person;

– essence of techniques of functions research of nervous, muscular, endocrine, respiratory systems of a healthy organism which are widely used in applied medicine, the principles of the modern automated methods of research of structure and properties of blood.

To be able:

1) to explain the information value of various indicators (constants) and mechanisms of regulation of activity of nervous, muscular, endocrine, respiratory systems.

2) to own the main clinical-physiological techniques:

- technology of capture of a capillary blood
- hemoglobin definition
- calculation of quantity of erythrocytes
- calculation of color parameter
- calculation of quantity of leucocytes
- definition of blood group (ABO system)
- definition of rhesus-factor of blood
- definition of ESR
- definition of blood clotting time and stopping of bleeding
- dynamometry
- definition of physical working capacity by step test method and PWC170 test

- research of reflex reactions of the person
- definition of state and reactivity of the autonomic nervous system by cardiointervalography method

## 2. CONTROL QUESTIONS ON THE CLASS SUBJECT:

1. Normal physiology – science about mechanisms and processes of vital activity of the healthy person. Communication of physiology with other sciences. Physiology as scientific fundamentals of medicine and assessment of the state of health of the person.
2. Subject, tasks and methods of physiology. Main stages of development of physiology, the major opening and methodical approaches. An experiment as the main method of research in physiology. Value of works of the academician I. P. Pavlov in development of world physiology.
3. A concept about physiological functions, and processes. Levels of the structurally functional organization of a human body. Bases of intercellular communication, information exchange and regulation of functions of a cell.
4. General principles of functioning of an integrated organism (correlation, regulation, reflex and self-regulation). Nervous and humoral mechanisms of regulation of functions, their characteristic. A concept about the systemic principle of the organization. Functional system (P. K. Anokhina).
5. Physiological ideas of a homeostasis as about constancy of internal medium of an organism and mechanisms of its regulation. Neurohumoral mechanisms of maintenance of constancy of organism internal medium.
6. A concept about internal medium of an organism. Liquid mediums of an organism (blood, lymph, intercellular liquid, intracellular liquid, liquor, etc.), their volume distribution in an organism. A concept about system of blood. Main functions of blood.
7. Quantity of blood at the person. The blood circulating and deposited. Hypovolemia and hypervolemia, their types. Hemorrhage consequences. Hematocrit, its size and changes at different types hyper- and hypovolemia. Diagnostic value.
8. Blood plasma, its structure and properties. Proteins of blood plasma, their characteristic, quantity and functions. Oncotic pressure of blood plasma, its size and physiological value.
9. Physical and chemical properties of blood. Osmotic pressure, the factors determining it size. Hyper-, hypo - and isotonic (physiological) solutions. The viscosity and relative density of blood, factors defining them, the size and physiological value.
10. Acid and base condition of blood. Active reaction (pH) of blood. Buffer systems of blood. Alkaline reserve. Acidosis, alkalosis, their types and origin.
11. Erythrocytes, features of their structure, property, composition, functions, quantity. Hyperglobulia. Anemia. Hemoglobin, its structure, properties, functions and quantity. Hemoglobin bonds. Kinds of hemoglobin, their distinctive properties.
12. Hemolysis, its types. Osmotic resistance of erythrocytes, its size. Diagnostic value. The Erythrocyte sedimentation rate (ESR), factors influencing its size. Diagnostic value.
13. Leucocytes, their classification, properties and functions. Leukocytic formula, its diagnostic importance. Leukocytosis, its types.
14. Thrombocytes, their structure, properties, quantity and functions. Vascular and platelet hemostasis, its phases.
15. Coagulation hemostasis. Plasma factors of blood coagulation. Factors of blood coagulation of uniform elements. Phases of coagulation hemostasis.
16. Fibrinolysis, factors it providing. Anticoagulation mechanisms. Anticoagulants, classification, physiological role. Regulation of blood coagulation and fibrinolysis.
17. Blood groups. ABO system. The factors defining group accessory of blood. Biological test. Rh factor. Essence of anti-D-prophylactic. Basic principles of hemotransfusion.
18. Regulations of hematopoiesis and system of a blood. Neurohumoral mechanisms.
19. Blood-substituting solutions and the main requirements imposed to them. Saline solutions. Colloidal solutions. Blood preparations. Their positive and negative properties.

20. The concept about irritability and excitability as the basis of response of a tissue (cell) to irritation. Stimuli, their classification. History of their opening (L. Galvani, A. Volt, Ch. Matteucci). Modern ideas of a structure and functions of membranes, ion channels. Active and passive transport of ions through membranes.

21. The electric phenomena in excitable tissues. Membrane resting potential, its origin and size.

22. Action potential, mechanism of its origin. Change of excitability in the course of excitation.

23. Laws of response of excitable tissues to irritation. Excitability assessment. Rheobase. Chronaxia, its value in clinical practice.

24. Carrying out excitation on unmyelinated and myelinated nervous fibers. Types of nervous fibers, their characteristic.

25. Parabiosis according to N. E. Vvedensky.

26. Structure and morphofunctional classification of neurons.

27. Physiology of synapses. Synapse, its structure, properties, classification.

28. The mechanism of transfer of excitation in CNS synapses. Exciting and inhibition synapses and their mediator mechanisms (EPSP, PTP, IPSP). The mechanism of transfer of excitation in neuromuscular synapses

29. Structure, properties and functions of neuromuscular synapses.

30. Striated muscles, their value, structure and physiological properties.

31. Neuromotor units, their classification (on a structure and functional value).

32. Forms (dynamic, static, auxotonic) and types of muscular contraction (isotonic, isometric and eccentric).

33. Phases of single muscular contraction. Origin of tetanic and smooth tetanus. Concept of an optimum and pessimum of frequency (modes of muscular contraction).

34. Mechanism of muscular contraction. Structure of myofibrils. Sarcomere. A role of myosin, actin, ATP and calcium ions in muscular contraction.

35. Force and work of muscle fiber.

36. Fatigue, its mechanisms. Orbeli-Ginetsinsky's phenomenon. Hypertrophy and atrophy of muscles.

37. Unstriated muscles, features of their structure, functions and properties. Classification. Plasticity of unstriated muscles, its value.

38. Central nervous system. Its functions and the role in ensuring vital activity of an integrated organism and its relationship with the external environment. Levels of integration in CNS.

39. Neurone. Functional classification of neurons. Physiological properties of nervous cells and function of structural elements of a neuron (soma, axon, dendrites). Features of appearance and distribution of excitation in neuron. Functions of neuroglia. Hematoencephalic barrier, its functions. Cerebrospinal liquid, its structure.

40. Reflex principle of functioning of a nervous system (R. Descartes, G. Prokhorov, I. M. Sechenov, I. P. Pavlov, P. K. Anokhin). Reflex. Types of reflexes. Structure of a reflex arch. Feedback, its value. Multilevel organization of a reflex.

41. Physiological concept of the nervous center, function of the nervous centers, their properties (spatial and temporary summation, transformation of rhythm of excitation, tonus, plasticity, fatigue of the nervous centers). Age changes in CNS.

42. Inhibition in CNS. Definition, classification. Primary postsynaptic inhibition (Sechenov's, lateral, reciprocal, antidromic). Secondary inhibition (pessimal and "inhibition after excitation").

43. Mechanisms of interaction of processes of excitation and inhibition — a basis of coordination activity of a CNS. Basic principles and features of distribution of excitation in CNS. (principles of coordination activity of CNS: induction, feedback, reciprocity, "a final pathway", dominant).

44. Spinal cord, its reflex and conduction functions. Law of Bella-Mazhandi. Clinically important spinal reflexes. Spinal shock.
45. Medulla and pons varolii, their centers and participation in processes of regulation of functions.
46. Midbrain. Reflex and conduction functions. Decerebrate rigidity.
47. Multilevel system of regulation of muscle tone, pose and movements. A role of cerebellum, basal nuclei and cerebral cortex in mechanisms of maintenance of muscle tonus, poses and exercise of movements.
48. Reticular formation of brainstem, its descending influence on activity of spinal cord and the ascending activating influence on cortex of larger hemispheres.
49. Thalamus, its functions. Nonspecific and specific nuclei. Thalamo-cortical relationship, their value in integrative activity of nuclei.. Participation of thalamus in formation of painful sensitivity. Hypothalamus and its cores.
50. Hypothalamus as the highest subcortical vegetative center providing integration of somatic, vegetative and endocrine functions.
51. Limbic system of brain. Its role in formation of biological motivations, emotions, the organizations of memory.
52. Basal nuclei. Their participation in formation of muscle tone and complex motive acts. Functions of a corpus striatum, caudate nuclei.
53. Cortex of cerebrum. Modern idea of localization of functions in cortex. Morphofunctional organization of cortex. Sensory, associative and motor areas of cortex.
54. Functional asymmetry of hemispheres at the person, value in activity of cortex of cerebrum. Electric implications of activity of cortex. Interhemispheres relationship
55. Autonomic nervous system, its structural organization and functional features. Metasympathetic department of autonomous nervous system. Mediators of the autonomic nervous system.
56. Comparative characteristic of sympathetic and parasympathetic departments of an autonomous nervous system: synergy and functional antagonism of their influences on organs. Arch of autonomous vegetative reflex. Vegetative reflexes. Axon reflex.
57. The concept about endocrine glands. General characteristic of endocrine glands, their functions. Interaction of nervous and humoral mechanisms of functions regulation at the hypothalamic level.
58. Hormones, their chemical nature, classification and properties. Mechanisms of reception of hormones and their action on target cells. Daily frequency. The principles of interrelations in endocrine system.
59. Hormones of anterior lobe of hypophysis and their physiological role. Regulation of function of adenohypophysis. Role of hypothalamic factors. Effects of hypo - and hyperproduction of separate hormones of adenohypophysis.
60. Hormones of medium and posterior lobes of hypophysis, their physiological role. The role of hypothalamus in a regulation of function of neurohypophysis.
61. Thyroid gland, its structural organization. The iodated hormones (T3 and T4), their biosynthesis, transport by blood, physiological role. Influence of hormones of thyroid gland on processes of body height and development of CNS. Participation of thyroid hormones in adaptation processes. Regulation of secretion of hormones.
62. Hyper-and hypothyroid states. Cretinism, myxedema. Bazedov's disease. Physiological hyperfunction of thyroid gland. Endemic goiter and its prophylaxis.
63. Contours of neurohumoral regulation of thyroid gland function. Methods of diagnostic of a functional condition of thyroid gland.
64. Regulation of homeostasis of calcium and phosphorus in an organism. Influence of calcitonin, parathormone and D3 vitamin on exchange of calcium and phosphorus. The daily need for calcium and sources of its entering in an organism. Hypo - and hyperparathyreosis.

65. Adrenals. Hormones of cortical substance of adrenals. Mechanisms of action of hormones and effects caused by them. Regulation of secretion of hormones. Characteristic manifestations of excess or insufficient secretion of hormones.

66. Hormones of medullar substance of adrenals. Mechanisms of action of hormones and effects caused by them. Regulation of secretion of hormones. Characteristic manifestations of excess or insufficient secretion of hormones.

67. Endocrine function of pancreas. The role of hormones of pancreas in regulation of carbohydrate, fat and protein metabolism. Regulation of secretion of hormones. A concept about states of hypo - and hyperglycemia and their reasons.

68. Gonads. Androgens and their physiological role. Mechanisms of regulation of secretion of hormones. Characteristic manifestations of excess or insufficient secretion of hormones.

69. Estrogens and their physiological role. Mechanisms of regulation of secretion of hormones. Hormone of yellow body progesterone, physiological role. Placenta hormones.

70. Endocrine function of an epiphysis and thymus.

71. Hormones of gastro-intestinal system and physiological role.

72. Values of respiration for an organism. Sequence of processes of gas exchange. External and internal respiration. Adaptive features of lungs for respiration. Not respiratory functions of lungs.

73. Physiological role of respiratory tracts and lungs. Respiratory cycle. Respiratory movements. Mechanism of an inspiration and exhalation. Respiration types, its frequency.

74. Pressure in a pleural cavity, its origin, size and physiological value. Pneumothorax.

75. Elastic traction and elastic properties of thorax and lungs. Surfactant, its role in change of surface tension of alveoli. Pressure in pleural cavity, its origin, size and physiological value. Pneumothorax.

76. Indicators of external respiration - pulmonary volumes and capacities and methods of their measurement. Anatomic and functional dead space. Alveolar ventilation. MVR. MVL.

77. Gas exchange in lungs. Partial pressure of oxygen and carbon dioxide ( $pO_2$  and  $pCO_2$ ) in the inhaled, alveolar and exhaled air. Voltage of gases in blood. The factors influencing on process of diffusion of oxygen and carbon dioxide between alveolar air and a blood. Ventilation-perfusion coefficient. Diffusion ability of lungs for gases.

78. Oxygen transport by blood. Transport forms of oxygen blood. Analysis of dissociation curve of oxyhemoglobin. The factors influencing affinity of hemoglobin to oxygen, their physiological value. Oxygen capacity of blood.

79. Gas exchange between blood and tissues. Efficiency (utilization) of oxygen by tissues at rest and at physical exercise.

80. Transport of carbon dioxide by blood. Transport forms of carbon dioxide in blood. Diffusion of carbon dioxide from tissues in blood. Carbonic anhydrase role. Interrelation between gas exchange of oxygen and a carbon dioxide.

81. Respiratory center. Modern idea of its structure and localization. Humoral regulation of respiration. The role of carbonic acid. Receptors of pH,  $pCO_2$  and  $pO_2$  in an organism, their localization and role in respiration regulation. Automaticity of the respiratory center and its features. Role of the pneumotoxic center.

82. Reflex self-regulation of respiration. Mechanism of change of respiratory phases. Receptors of lungs, respiratory tract and respiratory muscles. Participation in regulation of respiration of mechanoreceptors of lungs (Goering-Breyer's reflexes), irritant receptors, I-receptors, proprioceptors of respiratory muscles, receptors of the upper airways, baroreceptors of aorta and carotid sinus. Their physiological value.

83. Periodic of respiration and its regulation. Regulatory influences on the respiratory center from the highest departments of brain (hypothalamus, limbic system, cortex of cerebrum). Coordination activity of respiratory and cardiovascular systems.

84. Mechanism of the first inspiration of the newborn, theories.

85. Features of respiration in different conditions. Respiration with the lowered atmospheric pressure. Hypoxia, its types. Mountain (altitude) disease. Effective thresholds of a hypoxia. Respiration at the increased pressure of air. Caisson disease, its mechanism, prophylaxis. Respiration by pure oxygen.

### 3. THE COURSE OF THE CLASS

- *Introduction*: The teacher answers questions of students which caused certain difficulties in the course of mastering of education material.

- *Discussion of the main questions on sections*.

- *Computer testing according to sections*: "Blood physiology", "Physiology of excitable tissues", "Central nervous system", "Endocrine system", "Respiration physiology".

- *Protection of protocols of laboratory researches*.

- *Conclusion of the teacher*: At the end of occupation the teacher makes the conclusion about the carried-out work and sums up the results of progress of students for a semester.

Note: time of breaks of 15 minutes during the class.

### LITERATURE

#### Basic

1. Human physiology: textbook for overseas students = Физиология человека: учеб. пособие для иностранных студентов, обучающихся на английском языке / А. И. Киеня [и др.]; под ред. проф. Э. С. Питкевича; пер. на англ. яз. Р. А. Карпов, В. А. Мельник. — Гомель: УО ГoГМУ, 2009. — 352 с.
2. Text of lectures.

#### Alternate

1. Textbook of medical physiology // C. Guyton, 2006. — 1116 p.
2. Human anatomy and physiology // Alexander P., Spence-Elliott B. Masson.
3. Human physiology. The mechanisms of body function // Arthur J. Vander James H Sherman Dorothy S. Luciano, 1986. — 715 p.
4. Lecture notes on human physiology // John J Bray, Patricia A. Cragg, Anthony D.C. Macknight, Roland G. Mills and Douglass W. Taylor.
5. Human anatomy and physiology // Elaine N. Marieb, 1989. — 995 p.
6. Review of medical Physiology, International edition, 2003. — 912 p.