



PHYSIOLOGY EXAMINATION SYLLABUS

Theoretical exam

1. Cell membranes. Transport of substances through cell membranes.
2. Membrane potentials. Resting membrane potential of nerves.
3. Nerve action potential. Propagation of the action potential. Rhythmicity.
4. Signal transmission in nerve fibers. Excitation - the process of eliciting the action potential. Threshold for excitation, refractory period. Inhibition of excitability.
5. Organization and functions of the nervous system. Sensory and motor parts, integrative function. Major levels of central nervous system function. The neuron.
6. Synapses. Types of synapses. Structure of the synapse. Characteristics of transmission in chemical synapses.
7. Membrane receptors. Synaptic transmitters.
8. Postsynaptic potentials - types. Generation of action potentials in the axon. Neuronal inhibition - types. Neuroglia.
9. Time course of postsynaptic potentials. Spatial and temporal summation. "Facilitation" of neurons. Functions of dendrites for exciting neurons. Fatigue of synaptic transmission. Effect of drugs.
10. Transmission and processing of signals in neuronal pools. Neuronal circuits - convergence, divergence, reverberating circuits, inhibitory circuits.
11. Reflexes - definition, types. Reflex arch. Classification of reflexes. Spinal reflexes.
12. General organization of the autonomic nervous system. Characteristics of sympathetic and parasympathetic function - transmitters, receptors.
13. Sympathetic and parasympathetic tone. Denervation effects. Autonomic reflexes. Function of the adrenal medullae.
14. Effects of autonomic nervous system on specific organs. "Stress" response of the sympathetic nervous system. Control of the autonomic nervous system.
15. Physiologic anatomy of skeletal muscle. General and molecular mechanism of muscle contraction.
16. Energetics of muscle contraction. Characteristics of whole muscle contraction.
17. The neuromuscular junction. Excitation-contraction coupling.
18. Characteristics of smooth muscle. Excitation and contraction of smooth muscle.
19. Nervous and hormonal control of smooth muscle contraction.
20. Physiology of cardiac muscle. Action potentials. Excitation-contraction coupling. Control of heart activity by autonomic nerves.
21. Excitatory and conductive system of the heart. Velocity of conduction of the impulse. Control of excitation and conduction in the heart.
22. The electrocardiogram (ECG). Characteristics of the normal ECG. ECG leads. Mean electrical axis. Cardiac arrhythmias.
23. Cardiac cycle. Function of atria and ventricles as pumps. Pressure and volume changes in the heart chambers. Cardiac volumes.
24. Heart valves. Heart sounds. Relationship of the heart sounds to heart pumping. Heart murmurs caused by valvular lesions.
25. Basic principles of circulatory function. Interrelationships of pressure, flow and resistance. Laminar and turbulent blood flow.
26. Functional parts of the circulation. Volumes of blood and pressures in the different parts of the circulation. Cross sectional areas and velocities of blood flow.
27. Arterial pressure. Aortic pressure curve. Arterial pulse. Transmission of pulse wave.

28. Veins and their functions. Venous pressures. Effect of gravity on venous pressure. Specific blood reservoirs.
29. Cardiac output (CO). Control of CO by venous return. Frank-Starling mechanism. Factors affecting venous return.
30. Preload, afterload, contractility. Cellular mechanisms involved in regulation of myocardial contractility. Inotropic agents.
31. Effects of total peripheral resistance, blood volume and nervous stimulation on the CO. Cardiac and non-cardiac factors affecting CO.
32. Structure of the microcirculation. Types of capillaries. Exchange of water and substances through the capillary membrane. Role of pressures and filtration coefficient in fluid filtration.
33. Lymphatic system – structure, function. Formation of lymph. Mechanism of lymph flow. Functions of the lymph nodes, spleen and thymus.
34. Local control of blood flow. Control of blood flow by endothelial factors.
35. Humoral control of the circulation.
36. Nervous regulation of the circulation. Vasomotor center.
37. Rapid control of arterial pressure. Reflex mechanisms. CNS ischemic response.
38. Role of the kidneys in long-term regulation of arterial pressure. Renin-angiotensin system.
39. Coronary circulation. Phasic changes in coronary blood flow during cardiac cycle. Control of coronary blood flow. Ischemic heart disease.
40. Blood - functions, properties, composition. Blood volume. Plasma - volume, composition. Functional roles of plasma proteins.
41. Red blood cells (RBC) – count, functions, life span. Hemoglobin – types, functions, degradation.
42. Production of blood cells (hematopoiesis) in bone marrow. Production of RBC. Regulation of erythropoiesis – role of erythropoietin, vitamin B12 and folic acid.
43. Iron metabolism. Types of anemia. Polycythemia. Effects of anemia and polycythemia on the circulatory function.
44. White blood cells (WBC). Types of WBC. Life span, production, functions. Role of neutrophils and macrophages in inflammation.
45. Defense mechanisms of the organism. Innate immunity. Nonspecific immune defenses.
46. Adaptive immunity. Specific immune defenses.
47. Events in hemostasis. Role of platelets.
48. Mechanism of blood coagulation. Pathways.
49. Intravascular anticoagulants. Lysis of blood clot. Conditions that cause excessive bleeding, thromboembolic conditions.
50. Blood types. ABO and Rh system. Blood type tests, transfusion, transfusion reactions.
51. Respiratory system – functions. Mechanics of pulmonary ventilation. Pressures that cause movement of air. Respiratory muscles.
52. Lung compliance, surface tension, surfactant.
53. Minute respiratory volume. Alveolar ventilation. Effect of dead space on alveolar ventilation.
54. Function of the respiratory passageways. Control of the bronchioles.
55. Pulmonary circulation. Regional pulmonary blood flow. Effect of decreased alveolar oxygen on pulmonary blood flow distribution. Pleural fluid pressure.
56. Gas exchange. Diffusion of gasses, pressure gradients. Composition of alveolar air. Diffusion of gasses through the respiratory membrane.
57. Factors that affect the rate of gas diffusion through the respiratory membrane. Diffusing capacity for oxygen. Effect of the ventilation-perfusion ratio on alveolar gas concentration.
58. Transport of oxygen in blood and tissues. Role of hemoglobin in oxygen transport. Oxygen-hemoglobin dissociation curves. Factors affecting O₂ content.
59. Transport of carbon dioxide (CO₂) in the blood. Diffusion of CO₂. Chemical forms for transport of CO₂. CO₂ dissociation curve. Respiratory exchange ratio.
60. Regulation of respiration. Respiratory center. Factors that affect respiration.
61. Chemical control of respiration.

62. Gastrointestinal (GI) function. General principles of GI motility. Control of GI function. Enteric nervous system. GI hormones.
63. Functional types of movements in the GI tract. Splanchnic circulation.
64. Chewing. Swallowing – phases. Function of the lower esophageal sphincter.
65. Motor functions of the stomach. Regulation of stomach emptying. Vomiting.
66. Movements of the small intestine. Movements of the colon. Defecation.
67. General principles of alimentary tract secretion. Secretion of saliva - composition, functions, control of secretion.
68. Gastric secretion – composition, functions, control of secretion.
69. Pancreatic secretion - composition, functions, control of secretion.
70. Biliary secretion. Bile - composition, functions, control of secretion.
71. Secretions of the small intestine - composition, functions, control of secretion. Secretion of the large intestine.
72. Digestion of carbohydrates, fats and proteins.
73. Basic principles of gastrointestinal absorption. Absorption of water and ions in the small intestine.
74. Absorption of nutrients in the small intestine. Absorption in the large intestine.
75. Role of glucose in carbohydrate metabolism. Transport of glucose through the cell membranes. Glucose utilization, storage, and production.
76. Control of blood glucose concentration.
77. Lipid metabolism. Transport of lipids. Fat deposits. Hormonal regulation of fat storage and fat utilization. Risk factors for atherosclerosis.
78. Protein metabolism. Transport of amino acids in the intestines and renal tubules. Nitrogen balance. Degradation of amino acids. Hormonal regulation of protein metabolism.
79. Liver functions.
80. Energy utilization by the cells. ATP as an energy source. Anaerobic and aerobic energy.
81. Energy metabolism - factors that influence energy output rate. Basal metabolic rate (BMR). Factors, affecting BMR.
82. Dietary balances. Regulation of food intake and energy storage.
83. Role of vitamins and minerals.
84. Body temperature. Balance of heat production and heat loss.
85. Regulation of body temperature.
86. Functions of the kidneys in homeostasis. Physiologic anatomy of the kidneys. Renal blood supply. The structure of a nephron.
87. Composition of urine. Micturition. Urinary bladder - structure, innervation. Micturition reflex.
88. Glomerular filtration. Composition of glomerular filtrate. Glomerular capillary membrane. Determinants of the glomerular filtration.
89. Control of glomerular filtration rate and renal blood flow. Clearance methods.
90. Renal tubular reabsorption - passive and active mechanisms. Reabsorption and secretion along different parts of the nephron.
91. Regulation of tubular reabsorption - glomerulotubular balance, pressure diuresis, hormonal control.
92. Urine concentration and dilution. Renal mechanisms for excreting dilute urine.
93. Fluid balance - fluid intake and output. Body fluid compartments. Constituents of fluid compartments.
94. Osmolarity of the body fluids. Principles of osmosis, osmotic pressure. Maintenance of osmotic equilibrium between intracellular and extracellular fluids.
95. Control of extracellular fluid osmolarity and sodium concentration.
96. Renal mechanisms for control of sodium excretion and extracellular fluid volume.
97. Regulation of extracellular fluid potassium concentration.
98. Acid base balance (ABB) – parameters, buffer systems.
99. Acid base balance – respiratory and renal control of pH. Disorders of ABB.
100. Endocrine system – general considerations. Types of hormones – characteristics and physiologic effects. Mechanisms of hormone action. Control of hormone secretion.

101. Pituitary gland – functional morphology. Hormones of the posterior pituitary gland – physiologic effects, control of secretion. The pineal gland.
102. Hormones of the anterior pituitary gland. Hypothalamic hormones. Hypothalamic – pituitary axis and feedback control.
103. Growth hormone – physiologic effects, control of secretion.
104. Thyroid hormones – synthesis, physiologic effects, control of secretion.
105. Insulin and glucagon - physiologic effects, control of secretion.
106. Adrenocortical hormones. Mineralocorticoids - physiologic effects, control of secretion. Adrenal androgens.
107. Adrenocortical hormones. Glucocorticoids - physiologic effects, control of secretion.
108. Calcium and phosphate balance. Role of calcium and phosphorus. Absorption and excretion of calcium (Ca^{++}) and phosphate (PO_4^-). Bone and its relation to extracellular Ca^{++} and PO_4^- .
109. Vitamin D, parathyroid hormone and calcitonin - physiologic effects, control of secretion.
110. Physiologic anatomy of the male sexual organs. Spermatogenesis - hormonal control. Function of the seminal vesicles, prostate gland. Semen. Capacitation and acrosome reaction.
111. Testosterone and other male sex hormones – secretion, physiologic effects, control.
112. Physiologic anatomy of the female sexual organs. Ovarian cycle. Function of the gonadotropic hormones.
113. Ovarian hormones - synthesis, physiologic effects. Endometrial cycle and menstruation. Regulation of female monthly rhythm.
114. Pregnancy. Hormonal factors in pregnancy. Parturition. Lactation.
115. Sensory nervous system. Steps in processing sensory information. Transduction of sensory stimuli into nerve impulses. Sensory receptors, classification.
116. Somatic senses. Classification. Detection of tactile sensations, types of receptors, transmission of signals in peripheral nerve fibers. Thermal sensations.
117. Position senses. Somatosensory pathways. Somatosensory cortex.
118. Pain. Types of pain. Pain receptors. Dual pathways for transmission of pain signals into the CNS.
119. Pain suppression system. Referred pain. Visceral pain. Headache.
120. Visual system. Optics of the eye. Accommodation. Presbyopia. Errors of refraction. Control of accommodation and pupillary diameter.
121. Receptor and neural function of the retina. Structural elements of the retina. Photochemistry of vision. Light and dark adaptation. Color vision.
122. Neural circuitry in the retina. Visual pathways. Visual cortex. Eye movements.
123. Auditory system. Conduction of sound to the cochlea. Cochlea - functional anatomy. Transmission of sound waves in the cochlea.
124. Function of the organ of Corti. Determination of sound frequency and loudness. Central auditory mechanisms.
125. Vestibular sensations and maintenance of equilibrium.
126. Sense of taste. Sense of smell.
127. Motor functions of the spinal cord. Organization of the spinal cord for motor function. Muscle sensory receptors and their roles in muscle control.
128. Cortical control of motor function. Corticospinal tract.
129. Function of brain stem, cerebellum and basal ganglia in motor control.
130. Functions of specific cortical areas. Association areas. Wernicke's area. Concept of the dominant hemisphere. Functions of the prefrontal association areas.
131. Memory. Sensitization and habituation. Classification of memories. Long-term memory. Role of hippocampus.
132. Activating-driving systems of the brain. Control of cerebral activity from the brain stem. Neurohormonal control of brain activity.
133. Limbic system. Control functions of the hypothalamus.
134. Behavioural functions of the hypothalamus and associated limbic structures. "Reward" and "Punishment" function of the limbic system. Functions of the the amygdala.
135. States of brain activity. Sleep - types, theories of sleep, physiologic effects of sleep.
136. Electroencephalography. Brain waves - origin, clinical significance.

137. Cerebral blood flow - regulation. Cerebrospinal fluid. Brain metabolism.
138. Cardiovascular system, respiration, muscle activity, body fluids, body heat in exercise.

Practical exam

1. Reflex testing. Deep tendon reflexes. Superficial reflexes.
2. Orthostatic test. Heart rate response to deep breathing.
3. Cardio-inhibitory reflexes. Sustained isometric handgrip test.
4. Electromyography. Nerve conduction velocity test.
5. Electrocardiography. The 12 lead ECG.
6. Determination of heart rate and heart rhythm. Determination of the mean electrical axis.
7. Interpretation of a normal electrocardiogram.
8. Auscultation of heart sounds. Phonocardiography. Heart murmurs.
9. Blood pressure determination.
10. Effects of postural changes on blood pressure. Valsalva maneuver.
11. Assessment of arterial pulse. Sphygmography. Photoplethysmography.
12. Assessment of myocardial function. Ejection fraction. Evaluation of left ventricular function.
13. Functional tests assessing the cardiovascular response to exercise.
14. Renal clearance. Methods to estimate glomerular filtration rate.
15. Methods to estimate renal plasma flow and renal blood flow.
16. Assessment of acid-base balance (ABB). ABB parameters.
17. Assessment of plasma osmolarity and body fluid volume.
18. Estimation of blood volume. Hematocrit determination.
19. Hemoglobin determination.
20. Red blood cell count. Red blood cell indices.
21. White blood cell count. White blood cell differential count.
22. Total serum protein test. Hemolysis.
23. Erythrocyte sedimentation rate.
24. Blood type testing. ABO and Rh typing. Pretransfusion compatibility testing.
25. Platelet count. Bleeding time tests. Coagulation time tests.
26. Prothrombin time (PT). Activated partial thromboplastin time (aPTT).
27. Spirometry. Lung volumes and capacities.
28. Minute ventilation, alveolar ventilation, dead space ventilation.
29. Factors, affecting oxygen content (CaO_2), oxygen saturation of hemoglobin (SaO_2) and arterial PO_2 .
30. Assessment of body weight. Body mass index. Waist-hip ratio (WHR).
31. Indirect calorimetry. Calculation of basal metabolic rate.
32. Sensory system examination.
33. Hearing testing. Tuning fork tests. Audiometry.
34. Assessment of coordination and gait.
35. Balance evaluation.
36. Assessment of visual acuity. Visual field testing-perimetry. Assessment of colour vision.
37. Testing the pupil reflexes to light and during accommodation. Ophthalmoscopy.
38. Electroencephalography. Brain waves.

Recommended literature:

1. Guyton and Hall Textbook of Medical Physiology, 11th edition, 2006; 12th edition, 2012
2. Ganong's Review of Medical Physiology, 23rd edition (2009); 24th edition (2012)
3. Human Physiology: From Cells to Systems, Lauralee Sherwood, 6th edition (2006); 7th edition, (2012)
4. Human Physiology, Stuart Ira Fox, 8-12th edition (2006 - 2011)
5. Physiology, Linda Costanzo, 3rd edition (1995); 4th edition (2006); 5th edition (2010)
6. Physiology: Laboratory Manual, N. Negrev, M. Ivanova, Varna, 2010