

## **DEPARTMENT OF PHYSIOLOGY**

### **SYNOPSIS FOR THE FINAL EXAM IN PHYSIOLOGY FOR MEDICAL STUDENTS**

#### **ACADEMIC YEAR 2019/2020**

1. Homeostasis and homeostatic regulation. Control systems, negative feedback, and levels of physiological regulation.
2. Structure and function of the cellular membrane. General characteristics of membrane transport. Passive transport across the cellular membrane.
3. Active transport across the cellular membrane. Transport of macromolecules and particles. Transport across epithelial cell layers.
4. Intercellular communication: general characteristics. G-proteins, second messengers and protein kinases.
5. Physiology of excitable tissues. Transmembrane potential and resting membrane potential. Voltage-gated and ligand-gated channels.
6. Local response and electrotonic potentials. Action potential. Ionic mechanisms of the action potential.
7. Excitability and excitation: general characteristics. Propagation of action potentials along the nerve fibers. Nerve fiber types.
8. Physiology of synapse. Types of synapses. Neurotransmitter release by the presynaptic terminal.
9. Postsynaptic membrane receptors: ionotropic and metabotropic receptors. Postsynaptic potentials.
10. Neurotransmitters. Low molecular neurotransmitters and neuropeptides.
11. Skeletal muscle. Mechanism of muscle contraction. Electromechanical coupling.
12. Types of muscle contraction. Length-tension and force-velocity relationship in the skeletal muscle. Types of muscle fibers, muscle work and muscle fatigue. Electromyography.
13. Smooth muscle: morphological characteristics and types. Excitation and contraction mechanism in smooth muscle.
14. Blood: functions and properties. Blood plasma. Plasma proteins. Hemopoiesis. Regulation of hemopoiesis.
15. Red blood cells: general characteristics. Hemoglobin and iron metabolism. Blood types.
16. White blood cells: types and general characteristics. Functions of the different types of leukocytes.
17. Hemostasis and blood coagulation: phases. Platelet role in hemostasis and blood clotting.
18. Fibrinolytic system and physiological inhibitors of blood coagulation.
19. Innate and acquired immunity. Humoral and cell-mediated immunity.
20. Lymphatic system. Formation and composition of the lymph. Functions of the spleen.
21. General overview of the cardiovascular system. Physiology of cardiac muscle. Excitatory events in cardiomyocytes. Refractory periods.
22. Conduction of excitation in cardiac muscle. Electrocardiography.
23. Excitation - contraction coupling in the working myocardium. Mechanics of cardiac contraction.
24. Cardiac cycle. Heart sounds. Pressure-volume diagram for the left ventricle. Cardiac work.
25. Major determinants of myocardial function: preload, afterload, contractility. Stroke volume and cardiac output.
26. Regulation of cardiac function. Intracardial autoregulation. Cardiac function curves.
27. Extracardial regulation of cardiac performance: neural and humoral regulation.
28. Principles of hemodynamics. Pressure-flow relationship. Vascular resistance.

29. Functional morphology of blood vessels. Blood flow in the arterial system. Determinants of arterial blood pressure.
30. Microcirculation. Transport across the capillary wall. Blood flow in the veins.
31. Regulation of blood flow. Local and systemic control of blood flow.
32. Regulation of arterial pressure: short-term and long-term control.
33. Pulmonary circulation. Special circulations: coronary, cerebral, splanchnic, cutaneous.
34. Respiration: general overview. Structure and function of the airways and alveoli. Control of bronchial tone.
35. Mechanics of respiration. Pressures in the respiratory system (alveolar, pleural and transpulmonary). Elastic resistance to breathing. Surface tension; surfactant. Pressure-volume relationship.
36. Pulmonary ventilation. Pulmonary volumes and capacities. Minute ventilation and alveolar ventilation.
37. Non-elastic resistance to breathing. Flow-volume relationship. Work of breathing.
38. Gas diffusion. Physical basis of gas diffusion. Composition of the atmospheric, inspired, alveolar and expired air. Gas diffusion in the lungs and tissues.
39. Ventilation-perfusion ratio. Matching of ventilation and perfusion.
40. Transport of oxygen in the blood. Oxyhemoglobin dissociation curve. Oxygen delivery to the tissues.
41. Transport of carbon dioxide in the blood. Dissociation curve of carbamino-hemoglobin.
42. Regulation of respiration. Medullary respiratory centre. Chemical control of respiration: central and peripheral chemoreceptors. Reflex (non-chemical) control of respiration.
43. General overview of the gastrointestinal system. Motor function of the gastrointestinal system: segmenting and peristaltic movements, migrating myoelectric complex.
44. Chewing and swallowing. Gastric motor activity.
45. Motor activity of the small intestine and the colon. Vomiting. Defecation.
46. Secretory activity of the digestive system—overview. Mechanisms of secretion of electrolytes, water, mucus and gastrointestinal hormones.
47. Composition and functions of the saliva and gastric juice. Regulation of saliva and gastric juice secretion.
48. Composition and functions of the pancreatic juice, bile and intestinal secretions. Regulation.
49. Digestion in the gastrointestinal system: general characteristics. Digestion of carbohydrates, proteins, nucleic acids and lipids.
50. Absorption in the gastrointestinal system: general characteristics. Absorption of the carbohydrates, proteins and lipids in the gastrointestinal tract.
51. Absorption of electrolytes, water, vitamins and bile acids in the gastrointestinal tract.
52. Functions of the liver.
53. Metabolism: general characteristics. Carbohydrate metabolism. Regulation of blood glucose level.
54. Protein and lipid metabolism. Regulation.
55. Energy metabolism and energy balance. Basal metabolic rate. Control of body mass.
56. General principles of nutrition. Essential nutrients.
57. Vitamins and minerals.
58. Body temperature and thermal balance in the body. Mechanisms of thermoregulation.
59. Thermoregulation in warm and cold environment and during acclimatization. Fever.
60. Renal functions. Functional morphology and blood supply to the kidneys. Major processes of urine formation. Glomerular filtration.
61. Tubular transport mechanisms. Transport in the various elements of the tubular system of the nephron. Renal clearance.

62. Concentration and dilution of urine. Volume and composition of urine. Diuretics.
63. Regulation of renal functions. Intrinsic renal control mechanisms. Hormonal and neural regulation of renal functions. Renal control of arterial pressure.
64. Physiology of the skin.
65. Volume and composition of body fluids. Water and electrolyte balance in the body.
66. Body fluid volume and osmolality dynamics. Regulation of fluid and electrolyte balance.
67. Regulation of acid-base balance. Buffer systems. Respiratory and renal control of pH.
68. General principles of endocrine regulation. Chemical classes of hormones and hormonal mechanism of action. Regulation of hormonal secretion.
69. Hypothalamo-hypophyseal system. Hormones of the posterior pituitary.
70. Adenohypophyseal hormones: physiological effects and control of their secretion.
71. Thyroid hormones: mechanism of action, physiological effects and control of their secretion.
72. Adrenal cortex: hormones, physiological effects and control of their secretion.
73. Adrenal medulla: hormones, physiological effects and control of their secretion.
74. Hormones of the endocrine pancreas: physiological effects and control of their secretion.
75. Control of calcium-phosphate balance: parathyroid hormone, calcitonin and vitamin D3.
76. Male reproductive system. Endocrine function of the testes and its control. Spermatogenesis.
77. Female reproductive system. Endocrine and reproductive functions of the ovaries. Regulation of the ovarian and uterine cycle.
78. Female reproductive system. Pregnancy and childbirth. Lactation.
79. General overview of the functions of the nervous system. Physiology of the neuron: amplitude and frequency encoding of information, axonal transport. Glia.
80. Reflex activity of the nervous system. Organization of neurons in neural networks. Inhibition in the central nervous system.
81. Functional organization of the sensory systems. Processing of sensory information.
82. Somatosensory system: general overview. Mechanoreceptors. Thermoreceptors. Nociceptors.
83. Somatosensory system: afferent pathways and central processing of information.
84. Physiology of pain. Primary and secondary pain. Visceral pain. Antinociceptive system.
85. Auditory system. Functional morphology of the ear. Sound transmission in the middle and inner ear. Organ of Corti.
86. Auditory system. Sound transduction. Central processing of the auditory information. Encoding of sound frequency, loudness and localization.
87. Visual sensory system. Functional morphology of the eye. Image formation. Accommodation. Refraction abnormalities.
88. Visual receptors. Light transduction mechanisms. Organization of the retinal neural network.
89. Central processing of visual information. Light adaptation. Visual acuity.
90. Color vision. Eye movements and binocular vision.
91. Olfactory sensory system.
92. Gustatory sensory system.
93. Control of movement. Spinal control of movement.
94. Vestibular apparatus.
95. Brain stem control of movement. Regulation of muscle tone. Regulation of posture.
96. Motor functions of the cerebral cortex, basal ganglia, and cerebellum.
97. Bioelectrical brain activity. Origin and characteristics of the electroencephalogram. Reticular activating system: descending and ascending effects.
98. Physiology of sleep. Control of the sleep-wake cycle. Biological rhythms.

99. Autonomic nervous system. Functional organization of the autonomic nervous system. Characteristics of the sympathetic and parasympathetic division. Neurotransmitters and receptors.
100. Autonomic control of the visceral organs. Autonomic reflexes.
101. Integration of the autonomic functions. Hypothalamus. Limbic system. Physiological bases of emotions and motivation.
102. Higher functions of the nervous system. Association areas of cortex. Lateralization of cerebral functions: human speech.
103. Neurophysiological basis of learning and memory.
104. Physiology of exercise. Cardiovascular adaptation. Body fluids and electrolytes during exercise.
105. Respiratory adaptation to exercise. Neuroendocrine and thermoregulatory response to exercise.
106. Effects of hypobaric and hyperbaric conditions, acceleration and weightlessness on the body.

**Signed by the Head of the Department of Physiology**  
**Professor Dr. R. Girchev, Md, PhD, DSci**