

CURRICULUM

IN THE SUBJECT OF: PHYSIOLOGY

**INCLUDED IN THE LEARNING SYLLABUS OF SPECIALTY:
„DENTAL MEDICINE“**

DEGREE OF STUDY: „MASTER“

COURSE DURATION: TWO SEMESTERS

**EVALUATION FORMS: SEMESTER EXAMINATION, PRACTI -CAL
EXAM, TESTS, ORAL EXAMINATIONS, PRACTICAL TOPIC
EXAMINATIONS.**

SEMESTER EXAMINATION: YES

**FORMS AND METHODS OF EDUCATION: LECTURES,
LABORATORY PRACTICAL TOPICS**

CREDITS (ECTS): 7.6

LEADING INSTRUCTOR: PROF. DOCTOR R. GIRCHEV, DSCI

DEPARTMENT: PHYSIOLOGY

ANNOTATION: The learning plan in the course is constructed of 90 academic hours of practical topics, and 60 academic hours of lectures, for the second and third semester of study. The objectives of learning physiology are for students to acquire in detail basic knowledge about the main physiological processes in the organism and their regulation. Students get acquainted thoroughly with the functions of main organs and systems of the body during lectures. In laboratories, students work independently and perform experimental practical tasks, using modern devices. The results from experiments are being discussed and recorded in protocols.

DESCRIPTION OF THE COURSE: The course of learning consists of 150 academic hours, distributed as follows:

- > Lectures: 60 hours;
- > Practical laboratory topics: 90 hours.

Student examination is performed according to the Law for Academic Education and the interior regulations of the Medical University of Sofia. Students are being assessed in laboratory practical topics throughout the academic year, and get an average score out of their scores in laboratories and double the scores they get in 4 preliminary examinations throughout the year. There are two preliminary examinations in the winter semester - one covering the unit on "Excitable tissues, synapses and muscles", and the other - on "Cardiovascular system". Preliminary examinations in the summer semester are also two - "Excretory system, body fluids and acid-base balance" and on "Sensory systems". Preliminary examinations include a test in the MCQs format and a practical task performance.

The year exam in physiology for students in *dental medicine* includes the following:

- A test containing 25 questions from different units of medical physiology, duration of the test: 30 minutes.
- Practical examination with two tasks: it is done in the department immediately after the test.
- Theoretical examination with three topics from different units, the third one being written by the examinee.

Forming the score is complex via:

- > Assessment of student involvement throughout the course;
- > Assessment of the knowledge and practical skills students demonstrate in the preliminary examinations;
- > Assessment in test examinations;
- > Assessment of practical skills of students;
- > Examination result in the exam session.

The exam is being conducted by a board of examiners who are being drawn lots for on the day of the examination and the board of examiners consists of at least two instructors having academic rank.

TEACHING RESOURCES: The department possesses a wide range of educational resources to illustrate the material being taught:

- > Slides;
- > Teaching boards for illustration and visualizing;
- > Multimedia slide projector;
- > Computer programs for interactive learning;
- > Educational films on digital media;
- > Demonstration and simulation software;
- > Materials for distance learning, presented on the website of the department of physiology.

Various medical, laboratory and experimental technical devices are used during teaching sessions to record and analyze basic body functions. Experiments and demonstrations are conducted on laboratory animals and on volunteering persons. Records of basic vital functions are analyzed and calculation tasks are worked on.

STUDY PLAN PURPOSE: The program has the purpose of making students thoroughly acquainted with the basic physiological processes in the body and their physiological regulation.

OBJECTIVES OF THE CURRICULUM:

To shape the essential for the dental medic:

- > fundamental theoretical knowledge;
- > practical skills;
- > analytical capability;
- > handiness

BACKGROUND REQUIREMENTS: In order for students to start this learning course in physiology, it is necessary that they have basic knowledge in biology, chemistry, physics and anatomy.

EXPECTED RESULTS: After completing the educational course in physiology, students are expected to have gained detailed theoretical knowledge about body functioning and regulation of basic vital processes in the organism, to be able to work with the most frequently used medical devices, to analyze and interpret the received data, to be acquainted with basic clinical parameters and biological constants, and their diagnostic significance.

Synopsis for the Final Exam in Physiology for Students in Dental Medicine

1. Major principles of control in the body: homeostasis. Cell membrane: structural and functional characteristics.
2. Transport across the cellular membrane. Passive transport: diffusion, osmosis. Active transport across the cellular membrane: primary and secondary active transport. Exocytosis and endocytosis. Transport across epithelial cell layers.
3. Mechanisms for intercellular communication: membrane and cellular receptors. G- proteins. Secondary messengers. Protein kinases.
4. Transmembrane potential. Electrochemical gradient, equilibrium potential.
5. Excitable cell membranes: voltage-gated and ligand-gated channels. Local response. Action potential: ion mechanisms.
6. Excitability. Refractory periods. Propagation of action potentials along the different types of nerve fibers.
7. Synapses. Chemical and electrical synapses. Neurotransmitter release by the presynaptic terminal. Postsynaptic potentials: types and characteristics.
8. Postsynaptic membrane receptors: ionotropic and metabotropic receptors. Mechanism of action.
9. Neurotransmitters. Low molecular neurotransmitters and neuropeptides.
10. Functional morphology of skeletal muscle. Mechanism of muscle contraction. Excitation-contraction coupling in the skeletal muscle.
11. Types of muscle contraction. Motor unit. Regulation of the force of muscle contraction. Electromyography. Length-tension and force-velocity relationship in the skeletal muscle. Energy metabolism of muscle contraction. Muscle fatigue.
12. Smooth muscle: morphological and functional characteristics. Mechanism of smooth muscle contraction.
13. Blood: functions and properties. Blood plasma. Plasma proteins.
14. Red blood cells: number, production and functions. Hemoglobin. Iron metabolism. Hemopoiesis. Erythropoietin: secretion, mechanism of action and effects. Hemolysis.
15. White blood cells: number, types and leukocyte formula. Origin and site of production of leukocytes. Functions of the different types of leukocytes. Functions of the spleen. The lymph: composition and generation.
16. Hemostasis: phases. Platelets. Coagulation phase of hemostasis. Intrinsic and extrinsic pathway for prothrombin activator generation. Fibrinolytic system. Physiological inhibitors of blood coagulation. Anticoagulants.
17. Blood types. ABO-system. Agglutination. Rh-system. Blood typing. Hemotransfusion.
18. Immunity. Innate and acquired immunity. Types of acquired immunity: humoral and cell-mediated immunity.
19. Functional morphology of the cardiac muscle. Cardiac action potentials. Refractory periods. Cardiac automaticity. Conduction of the action potential in cardiac muscle. Premature beats. Excitation-contraction coupling in the cardiomyocytes: role of Ca^{2+} . Myocardial contractility.
20. Electrocardiography. Generation of ECG. Normal ECG.
21. Cardiac cycle. Functions of the cardiac valves. Heart sounds. Pressure-volume relationship in the ventricles during the cardiac cycle. Myocardial metabolism and oxygen consumption.
22. Heart sounds. Auscultation. Stroke volume and cardiac output. Factors, which determine stroke volume and cardiac output.
23. Intracardial regulation of cardiac performance. Autoregulation in response to changes in preload and afterload. Extracardial regulation of cardiac performance: neural and humoral

regulation.

24. Functional morphology of the circulation and blood distribution. Hemodynamic principles. Factors, which determine blood flow. Linear velocity and blood flow.
25. Blood pressure in the circulation. Factors, which determine arterial pressure. Arterial pressure. Pressure and blood flow in veins.
26. Microcirculation. Transport across the capillary wall. Control of microcirculation.
27. Regulation of circulation: medullary cardiovascular center. Arterial baroreceptor, volume receptor and chemoreceptor role in the reflex control of circulation. Supramedullary regulation. Regulation of vascular tone.
28. Short-term and long-term mechanisms of arterial pressure regulation.
29. Special circulations: pulmonal, cerebral, myocardial and splanchnic circulation. Typical characteristics of the circulation in the facial region and in the oral cavity.
30. Respiration. Structure and function of the respiratory system. Function of the airways.
31. Pulmonary ventilation. Mechanisms of inspiration and exhalation. Pulmonary volumes and capacities. Respiratory minute volume and alveolar ventilation.
32. Elastic and non-elastic resistance to breathing. Factors, which determine the resistance of breathing. Control of bronchial tone. Work of breathing.
33. Gas exchange in the body. Composition of the inspired, alveolar and exhaled air. Gas diffusion through the respiratory membrane.
34. Exchange and transport of oxygen. Oxyhemoglobin dissociation curve. Oxygen consumption. Exchange and transport of carbon dioxide.
35. Regulation of respiration.
36. Structure and functions of the digestive system. Regulation of digestion: typical characteristics; neural and humoral control mechanisms.
37. Chewing. Cycles and periods of mastication. Control of mastication.
38. Deglutition. Deglutition phases. Neural regulation.
39. Motor activity of the stomach, small intestine and colon. Regulation. Vomitus. Defecation.
40. Production, composition and functions of saliva. Control of salivary secretion.
41. Role of saliva in teeth mineralization. Salivary effect on the microflora in the oral cavity.
42. Gastric and pancreatic juice: volume, composition and regulation of the secretion.
43. Bile and intestinal secretion: volume, composition and regulation of the secretion.
44. Digestion and absorption of carbohydrates, lipids and proteins.
45. Absorption of electrolytes, water and vitamins in the gastrointestinal tract. Regulation of intestinal absorption
46. Liver functions.
47. Carbohydrate metabolism. Control of blood glucose level.
48. Protein metabolism. Regulation of protein metabolism.
49. Lipid metabolism. Regulation of lipid metabolism.
50. Energy metabolism. Basal metabolism and energy output in different physiological conditions. Physiological standards for nutrition and energy balance. Physiological standards for protein, carbohydrate and lipid intake.
51. Vitamins: physiological significance and sources. Minerals (macro- and micro-): physiological significance.
52. Thermal regulation. Body temperature and thermal balance. Mechanisms of thermal regulation. Fever.
53. Functional morphology. Glomerular filtration. Tubular function. Transport in the proximal tubule, in Henle's loop, and in the distal and collecting tubules.
54. Concentration and dilution of urine. Volume and composition of urine. Excretion of exogenous substances. Regulation of renal functions: intrinsic renal control mechanisms, hormonal and neural regulation.
55. Physiology of the skin.
56. Volume and composition of body fluids. Water balance in the body. Major electrolytes in the body: physiological significance and balance. Regulation of fluid- electrolyte homeostasis.
57. Acid-base balance in the body: major mechanisms.
58. Hormones: classification and mechanism of action. General principles of regulation of

hormonal secretion.

59. Hypothalamo-hypophyseal system. Neurosecretion. Neurohypophyseal and adenohypophyseal hormones: physiological effects and regulation of the secretion.

60. Control of calcium-phosphate balance.

61. Calcium-phosphate balance in the teeth: typical characteristics.

62. Thyroid hormones: mechanism of action, physiological effects and control of their secretion.

63. Endocrine pancreas. Pancreatic hormones: physiological effects and control of their secretion.

64. Adrenal glands. Glucocorticoids, mineralcorticoids and adrenal androgens: physiological effects, mechanism of action and control of their secretion. Adrenal medullary hormones. Sympatho-adrenal system. Stress reactions.

65. Male reproductive function. Testicular hormonal function. Control of hormonal secretion.

66. Female reproductive function. Ovarian hormonal function. Menstrual cycle.

67. Body changes during pregnancy. Childbirth. Lactation.

68. General overview of the nervous system functions. Physiology of the neuron: types of neurons. Axonal transport. Amplitude and frequency encoding of information. Glia and glial role in nervous system functioning.

69. Reflex activity of the nervous system. Neural networks. Inhibition in the central nervous system.

70. Sensory systems. Receptors, receptor potentials. Receptive fields. Encoding of information in sensory systems. Cortical sensory system representation.

71. Somatosensory system. Mechanoreceptors. Thermoreceptors. Nociceptors. Afferent pathways and central processing of information. Physiology of pain. Primary and secondary pain. Visceral pain. Antinociceptive system.

72. Somatic sensations in the facial region and in the oral cavity: typical characteristics. Receptors in the periodontal ligaments and in the muscles of mastication. Tooth pain.

73. Auditory system. Outer and inner hair cells. Sound transduction. Central processing of auditory information. Encoding of frequency, loudness and localization of the sound.

74. Optic system of the eye. Image formation. Accommodation. Refraction abnormalities. Visual acuity. Visual receptors. Light transduction.

75. Organization of the retinal neural network. Light adaptation. Central processing of visual information. Color vision. Eye movements and binocular vision.

76. Olfactory sensory system.

77. Gustatory sensory system.

78. Control of movement: general overview. Spinal control of movement. Myotatic reflex. Inverse myotatic reflex. Flexor reflex. Upper and lower motor neuron.

79. Vestibular apparatus. Functions of the maculae and semicircular canals. Brain stem control of movement. Regulation of muscle tone. Control of posture. Decerebration and decortication rigidity.

80. Motor functions of the cerebral cortex. Cerebellar and basal ganglia control of movement.

81. Bioelectrical brain activity. Origin and characteristics of the electroencephalogram. Reticular formation: descending and ascending effects. Reticular activating system. Sleep and awake state. Types of sleep. Physiology of sleep. Control of the sleep-wake cycle. Biological rhythms.

82. Autonomic nervous system. Characteristics of the sympathetic and parasympathetic division.

83. Autonomic effects on the activity of different organs and systems.

84. Centers, which control autonomic functions. Physiology of the hypothalamus. Autonomic reflexes. Limbic system. Physiological basis of emotions and motivations.

85. Cerebral cortex: physiological characteristics. Physiology of the frontal and parietal lobe. Cerebral cortical plasticity. Lateralization of cerebral functions. Neurophysiological basis of learning, memory, thinking and consciousness. Neurophysiological basis of language and human behavior.

86. Physiology of exercise. Changes in the cardiovascular system and in the respiratory

system during exercise. Oxygen debt. Changes in the volume and composition of body fluids, in thermal regulation and hormonal profile during exercise.

87. Changes in the body in response to hypobaric and hyperbaric conditions; to acceleration and weightlessness.

Synopsis

Practical exam in physiology for students of dental medicine

1. Blood type testing
2. Hemoglobin concentration measurement
3. Calculation of erythrocyte indices
4. Blood pressure measurement
5. Auscultation and analysis of a phonocardiogram
6. Left ventricular systole analysis by means of a simultaneous recording of a sphygmogram, phonocardiogram and electrocardiogram
7. Calculation of pulse wave conduction velocity
8. Recording and analysis of an electrocardiogram
9. Spirogram analysis: calculation of tidal volume, inspiratory reserve volume, expiratory reserve volume and vital capacity. Calculation of actual vital capacity as a % from its reference value
10. Spirogram analysis: calculation of tidal volume, tidal rate, minute lung volume and alveolar ventilation. Calculation of actual minute lung volume and alveolar ventilation as % from their reference values
11. Spirogram analysis: calculation of the Tiffeneau index
12. Calculation of metabolic rate on the basis of expiratory air composition and minute lung volume
13. Calculation of basal metabolic rate
14. Evaluation of a daily menu according to the principles of balanced nutrition
15. Reflex testing
16. Testing the pupillary reflex to light
17. Testing the pupillary reflex in accommodation. Convergence testing
18. Estimation of visual acuity
19. Perimetry
20. Color vision estimation
21. Audiometry
22. Esthesiometry
23. Calculation and clinical significance of the clearances of inulin, creatinine and urea
24. Calculation of renal plasma and blood flow
25. Calculation of renal transport maximum of glucose
26. Calculation of plasma and blood volume
27. Calculation of sodium balance
28. Problems from acid-base balance

NO	TOPIC	Hours
WINTER SEMESTER		
1.	The subject of physiology. The role of physiology in medicine. Homeostasis. Feedback. Transmembrane transport. Ion channels. Resting transmembrane potential	2
2.	Action potential. Conduction of excitation along the nervous fibres. Changes in excitability during excitation.	2
3.	Synapses. Main neurotransmitter substances.	2
4.	Physiology of striated muscle. Functional morphology. Mechanism of muscle contraction of smooth muscles and skeletal muscles.	2
5.	The heart. Specialized excitatory and conductive system of the heart. Cardiac cycle	2
6.	Regulation of cardiac performance. Hemodynamics. Pressure in the circulatory system.	2
7.	Systemic circulation. Microcirculation. The lymph. Blood flow in the veins. Circulation characteristics in different regions of the body - oral cavity and dental pulp, myocardium, brain, alimentary tract, lungs.	2
8.	Blood. Erythrocytes, hemoglobin, erythropoiesis. White blood cells. Immunity. Hemostasis. Blood types.	2
9.	Respiration. Mechanics of respiration. Lung volumes and capacities.	2
10.	Gas exchange Transport of O ₂ and CO ₂ . Regulation of respiration.	2
11.	Digestion. Motor function of the alimentary tract. Secretion of saliva. Gastric secretion	2
12.	Pancreatic secretion. Intestinal secretion. Digestion and absorption in the gastrointestinal tract.	2
13.	Renal functions. Glomerular filtration rate. Tubular functions. Resorption and secretion of organic substances.	2
14.	Electrolyte and water transport in renal tubules. Regulation of renal functions. Endocrine function of kidneys.	2
15.	Acid-base balance. Body fluids. Regulation of electrolyte and water balance.	2
SUMMER SEMESTER		
16.	Physiology of the neuron. Neuronal networks Reflex activity of the nervous system. Sensory systems. Receptors. Sensory information processing.	2
17.	Somatic sensory system.	2
18.	Gustatory and olfactory system functions.	2
19.	Audition. The vestibular system.	2
20.	Visual system.	2
21.	General characteristics of the system of regulation of motor activity. Spinal, brainstem, cerebellar and cortical mechanisms of motor control.	2
22.	Specifications of sensory and motor functions in the facial, maxillary and mandibular region.	2
23.	Reticular formation. Physiology of sleep.	2
24.	Autonomic nervous system. Hypothalamus. Stress reactions.	2
25.	Mechanisms of endocrine control. Pituitary gland. Hormones of the neurohypophysis. Adenohypophysis.	2
26.	Adrenal cortex. Thyroid gland.	2
27.	Endocrine function of the pancreas.	2
28.	Regulation of calcium and phosphate exchange.	2
29.	Reproductive system.	2
30.	Energy balance and temperature regulation.	2

- PRACTICAL LABORATORY TOPICS:

N9	TOPIC	Number of hours
1.	Winter semester Introduction. Transport across cellular membranes.	3
2.	Transmembrane potential. Electrochemical gradient. Excitable cells. Potential-gated and ligand-gated ion channels.	3
3.	Physiology of the peripheral nerve.	3
4.	Measurement of the conduction velocity of action potential propagation along the peripheral nerve in humans. Physiology of the synapse.	3
5.	Types of contraction in striated (skeletal) muscle.	3
6.	Muscle fatigue. Electromyography. Smooth muscle. Test with mcqs on excitable cells	3
7.	Cardiomechanogram. Conductive system of the heart. Premature beats. Regulation of cardiac performance.	3
8.	Auscultation of the acoustic events, which are generated during the cardiac cycle. Measurement of arterial pressure.	3
9.	Electrocardiography.	3
10.	Phase analysis of left ventricular systole. Measurement of pulse wave velocity.	3
11.	Functional tests for the cardiovascular system.	3
12.	Seminar on cardiovascular system.	3
13.	Preliminary examination on cardiovascular system . Oral examination and a mcqs test	3
14.	Daily nutritional regimen.	3
15.	Review of the practical topics during the winter semester	3
16.	Summer semester. Blood cell count. Hematocrit.	3
17.	Measurement of hemoglobin concentration. Erythrocyte indices. Blood types. Hemolysis. Blood coagulation.	3
18.	Lung volumes and capacities. Spirometry.	3
19.	Airway resistance in breathing. Flow/volume curves. Control of respiration.	3
20.	Measurement of gas exchange and energy expenditure. Basal metabolic rate	3
21.	Clearance methods for assessment of renal function	3
22.	Body fluids. Renal regulation of the volume and composition of body fluids	3
23.	Acid-basf, balance in the body. Preliminary examination oh renal physiology, body fluids and acid-base balance (written test)	3
24.	Visual acuity. Pupillary reflexes. Eye movements.	3
25.	Color vision. Visual field. Electroretinography.	3
26.	Auditory system. Somatosensory system.	3
27.	Preliminary examination oh sensory systems (written test and examination of practical skills).	3
28.	Physiology of the nervous system. Electroencephalography..	3
29.	Physiology of the endocrine system.	3
30.	Review of the practical topics during summer semester.	3