SYLLABUS FOR THE ORAL AND WRITTEN PART OF THE FINAL EXAMINATION OF PHYSIOLOGY – GENERAL MEDICINE

The syllabus provides more details to the questions for the oral part of the final examination of physiology. The written part of the final examination is also based on this syllabus.

General neurophysiology and physiology of the muscle
- Resting membrane potential – how is it generated, values for the nerve and muscle, distribution of ions in ICF and ECF, the effect of permeability of the cell membrane, the role of Na⁺-K⁺ pump
- Excitable and conductive membranes and their properties
- Stimulus and its qualities– adequate stimulus, strength and duration of a stimulus
- Receptor (generator) potential – characteristics, generation, spreading, spatial and temporal summation of stimuli
- Function of the receptors, classification, sensory modalities, adaptation of the receptors
- Action potential of the nerve and muscle – curve, values, phases, ion flows, duration of the AP
- Refractory periods of excitable tissues – definition, physiological importance
- The „all or nothing” principle, its application to 1 muscle (nerve) fibre and for muscle/peripheral nerve, compound action potential of a peripheral nerve
- Weiss-Hoorweg law of stimulation, Hoorweg-Weiss curve, definition of chronaxy and rheobase, du Bois-Reymond’s law and its physiological importance
- Types of nerve fibres, conduction of action potential on myelinated and unmyelinated nerve fibres, speed of conduction, degeneration and regeneration of nerve fibres
- Synapse – definition, types of synapses, structure, mechanism of synaptic transmission
- Excitatory and inhibitory postsynaptic potentials, mechanisms of activation of postsynaptic neurons, function of the ion channels, spatial and temporal summation
- Coding of the strength of the sensory stimuli at the level of receptors and at the level of a nerve fibre.
- Neuromuscular transmission – function of the motor end-plate, potential of the motor end-plate
- Motor unit, regulation of the strength of a muscle contraction, tetanus – complete, incomplete, curves
- Structure of the skeletal muscle, mechanism of contraction in the skeletal muscle, excitation-contraction coupling, work and fatigue of a skeletal muscle, causes of the muscle fatigue
- Classification of the skeletal muscles, types of muscle fibres and muscle contractions
- Physiology of the muscle spindle, alpha-gamma coactivation and its physiological importance
- Smooth muscle - classification, properties, excitation and contraction (contrasts to the skeletal muscle)
- Definition of the reflex and reflex arch, monosynaptic and polysynaptic reflexes – differences between both types

Physiology of the central nervous system
- Neurotransmitters and neuromodulators, their effects on the central brain functions (glutamate, GABA, ACH, NA, serotonine, dopamine)
- Function of the sensory division of the CNS, sensation and perception of a stimulus, transmission of the sensory information to the brain, function of thalamus, cortical sensory areas – sensory homunculus, unimodal and polymodal association areas
- Pain – mechanisms of sensation and types, pathways of transmission, the role of thalamus, mechanism of hypoalgaesia and the referred pain.
- Reticular activation system (RAS), its function in maintaining attention and sleep introduction.
- Sleep, stages of sleep, types of sleep and their physiological characteristics, biorhythms
- Electric activity of the brain, electroencephalogram - recording, types of EEG rhythms and their characteristics, generation of synchronized and desynchronized record, generation of the evoked potentials
- Functions of the motor division of the CNS, motor homunculus, classification of muscle movements, motor centres
- Motor pathways - pyramidal tract, extrapyramidal tracts, course, function, synaptic connections with alpha and gamma motor neurons in the spinal cord
- Regulation of the body posture and body movements - motor centres, muscle spindle (structure, function), alpha-gamma coactivation
- Functions of the spinal cord, basal ganglia and cerebellum in regulation of the body posture and body movements
- Hierarchical organization of the CNS, association areas of the brain cortex and their functions
- Speech – sensory/motor component, brain centres and speech disorders – aphasias
- Functional specialization of the cerebral hemispheres and sexual dimorphism in behaviour and specific cognitive functions, the role of hormones
- Memory, classification, physiological mechanisms, brain structures
- Association and non-association learning (habituation, sensitization, conditioning), neuronal and molecular mechanisms of sensory, short-term and long-term memory
- Emotions and their function – expression of emotions, modification of emotions by the brain cortex, limbic system, behaviour, brain structures – Papez circuit, fear and the function of amygdala, joy, reward – dopaminergic system
- Physiology of the autonomic nervous system, divisions, neurotransmitters, receptors, effects of stimulation of the ANS on the effector organs

**Physiology of the endocrine system and reproduction**
- Characteristics of the hormonal regulations, short-term and long-term stimuli for hormonal secretion, regulatory mechanisms for synthesis and secretion of hormones. Types of local and global action of hormones. Mechanism of the effects of hormones, second messengers. Links between endocrine and nervous regulation
- Hypothalamo-hypophyseal system – characteristics of the hormonal and nervous regulations, main types of feedback mechanisms of the hormonal regulation. Function of the hormones of hypothalamus and hypophysis.
- Regulation of the synthesis and secretion of oxytocine - main stimuli for its secretion, main effects. Regulation of the synthesis and secretion of vasopressin (ADH), main stimuli for its secretion, effects on individual organs and systems. Regulation of the synthesis and secretion of the growth hormone in different periods of life, stimuli for its secretion. Effects of somatotropin on organs, systems and the body as a whole. Regulation of the prolacin synthesis and secretion, stimuli for its secretion. Effects of prolactin. Melatonin – stimuli, secretion and effects.
- Regulation of the parathormone synthesis and secretion, stimuli for its secretion, effects on organs and systems. Functional links of parathormone and active vitamin D₃, effects of vitamin D₃.
- Regulation of the synthesis and secretion of hormones of the adrenal medulla, main stimuli for their secretion. Main effects of hormones of the adrenal medulla on organs and systems.
- Regulation of the synthesis and secretion of hormones of the adrenal cortex, main stimuli for their secretion. Main effects of hormones of the adrenal cortex on organs and systems.
- Regulation of the synthesis and secretion of hormones of the thyroid gland, stimuli for their secretion, effects on organs, systems and the body as a whole.
- Regulation of the synthesis and secretion of the male sex hormones, main stimuli for their secretion. Main effects of the male sex hormones in different periods of life.
- Regulation of the synthesis and secretion of the female sex hormones, main stimuli for their secretion. Main effects of the female sex hormones. Main functional and morphological changes during the menstrual cycle.
- Main functional and morphological changes in pregnancy and lactation.
- Regulation of the insulin and glucagon synthesis and secretion, their main effects on metabolism of nutrients and other functions. Main effects of somatostatin.
- Basic mechanisms of the complex adaptation to stress, types of stress and stressors.
Physiology of the cardiovascular system
- Physiological properties of myocardium: mechanism of the cardiac automacy and rhythmicity, transmembrane potential in the cells of the sinus node, function of the conduction system of the heart. Action potential of the working myocardium – curve, periods, ion flows, duration. Contractility of the heart and its changes in physiological situations. Mechanism of the cardiac excitability, its functions and clinical implications.
- Excitation-contraction coupling in the cardiac muscle
- Cardiac cycle – periods and their characteristics, values of the blood pressure in the cardiac cavities during the cardiac cycle. End-diastolic, systolic, end-systolic volume, ejection fraction. Cardiac output and its changes in physiological situations
- Heart sounds and their components, auscultation of the heart sounds, phonocardiography
- Main principles of the ECG recording, bipolar and unipolar leads, their location on the body surface. Basic shape of the ECG curve: description of individual waves and spikes, segments and intervals
- Heart rate and its changes in physiological situations, relationships with other parameters of circulation
- Energetics of the cardiac muscle in rest and in physical activity
- Frank-Starling autoregulation mechanism of the heart
- Primary cardiomotor centre and its importance for regulation of the cardiac function, afferentations to the cardiomotor centre from the sinus caroticus. Humoral factors (ions, hormones, etc.) in regulation of the cardiac function
- Blood distribution (volumes) in individual parts of peripheral circulation and in the cardiac cavities. Speed of the blood flow in individual types of vessels. Pressure gradients in different parts of the blood circulation.
- Blood pressure, its measurements, changes in physiological situations
- Arterial pulse and its qualities in different physiological situations
- Arterial haemodynamics. Haemodynamics in the veins: main factors that influence the venous blood return
- Mechanisms of hyperaemia: reactive and active
- Function of the microcirculation: blood and lymphatic capillaries. Process of transcapillary exchange of fluids, substances and gases in microcirculation: effective filtration and resorption pressures on the capillary membrane. Ratio of the filtered to the resorbed amount of liquids and substances
- Function of the lymphatic system: the lymph formation and flow, composition of the lymph and the interstitial fluid
- Main changes of the parameters of the blood circulation in physical activity and mental stress. Factors that cause these changes.
- Nervous regulation of the cardiovascular system, function of the vasomotor centre
- Humoral and hormonal regulation of the vessels under physiological circumstances
- Specifics of the coronary and the pulmonary circulation – renal circulation – hepatal circulation – skin circulation – cerebral circulation (differences in comparison to the circulation in other systems – the density and types of vessels, etc.). Circulation in the skeletal muscle in rest and in physical activity/mental stress
- Pressure and volume parameters of the pulmonary circulation – functional and nutritive. Effects of gravitation and respiration on the pulmonary circulation

Physiology of the senses
- Smell and taste – structure and function of the sensory receptors, adequate stimulus, elementary tastes and smells, sensory pathways, cortical centres
- Pain – receptors, stimuli, types of pain, referred pain, phantom pain, mechanisms of hypolgaesia
- Vision: refraction system of the eye – structure, function. Accommodation – mechanism and function, punctum proximum a remotum, ammetropias
- Retina – structure and function, receptors for vision, adequate stimulus, colour vision and its disorders, central and peripheral vision
- Binocular vision and 3D perception – mechanisms, visual field and scotomas, perimetry, visual pathway
- Sense of hearing – external, middle inner ear – structure and function. The organ of Corti – hair cells and their stimulation. Sound and its intensity, relations between threshold intensity and frequency of the sound waves, audiometry. Auditory pathway, cortical centre
- Sense of balance – organs of the static and dynamic balance and their function, vestibular pathway, nystagmus

**Body fluids, physiology of the kidneys and acid-base balance**
- Body fluids: classification, basic chemical composition – main solutes in individual compartments, basic mechanisms of water exchange between individual compartments, daily water balance and its consequences for homeostasis and body functions, osmosis
- Nephron – structure, basic parts and their characteristics, properties of individual types of cells of glomerulus and tubuli, permeability of individual parts for water, specifics of the renal circulation
- Basic requirements for the optimal function of kidneys: constant high blood flow and blood pressure in kidneys, total filtration surface and its physiological changes. Isotonicity of the renal cortex and a hypertonicity of the renal medulla
- Glomerular filter and its properties, type and size of the filtrable chemical substances, effective filtration pressure and its components
- Types of basic reabsorption and secretion processes and their description – in the proximal tubule, in the descending part of the loop of Henle, in the ascendental part of the loop of Henle, in the distal tubule, in the collecting ducts, % of the ultrafiltrate, that is here reabsorbed into the blood
- Basic mechanisms of the countercurrent multiplication system of the kidneys.
- Regulation of the mineral and water absorption in the distal tubule: function of the rennin-angiotensin-aldosterone system
- Regulation of water reabsorption in the renal collecting ducts: regulation of synthesis and secretion of the antidiuretic hormone and its effects
- Function of the urinary tract (from calyces to the urethra), micturition, urine – volume and composition – variations in different physiological situations
- Regulation of the acid-base balance, normal pH of the body fluids, – buffer systems in blood, function of the respiratory system and kidneys for the maintenance of the acid-base balance, disorders of the acid-base balance

**Blood physiology**
- Blood - composition, function. Physical and chemical properties og blood: specific gravity, viscosity, osmolarity. Homeostasis and its main parameters (isoionia, isohydria, isosmia, isotonia, isovolemia), importance of maintenance of homeostasis for the function of the body
- Haematocrit - definition, normal values in males and females and in newborns: causes of the differences in normal values, changes/abnormalities of the haematocrit in normal and some abnormal circumstances – causes of these changes
- Sedimentation rate of erythrocytes – definition, normal values, measurement, factors that influence the sedimentation rate. Abnormalities of the sedimentation rate and their main causes

- Erythrocytes – structure, size, function, normal count in males, females and newborns, causes of the differences in normal values. Polycythemia, its causes and consequences. Anaemia and its consequences. Erythrocyte haemolysis-definition, types, causes, consequences

- Haemoglobin – composition, types, main derivatives of haemoglobin, concentration in blood of males/females/newborns – causes of the difference in normal values

- Blood groups: ABO system, Rh system, compatibility, cross-matching test, blood transfusion

- Leukocytes – characteristics and functions, normal count and % of individual types, leukocytosis (normal, abnormal) - causes. The role of leukocytes in immunity – inborn and acquired immunity, active and passive immunization. Lymphocytes - humoral and cellular immunity


- Haemopoiesis and its main processes, main nutritional and morphological factors of haemopoiesis. Stimuli for erythropoiesis (erythropoietin, stimuli for its synthesis and secretion)

**Physiology of the respiratory system**

- Functions of the respiratory system, importance of breathing for the body. Functions of the upper and lower respiratory passageways, respiratory protective reflexes. Function of the ciliary epithelium in the respiratory passageways

- Mechanism of inspiration and expiration in rest and in increased ventilation. Function of the respiratory muscles – main and accessory

- Intrapleural and intrapulmonal pressure – its oscillations during the cardiac cycle, their values. Valsalva and Muller maneuver and values of the intrapleural pressures

- Lung volumes and capacities – their values and physiological variations. Lung compliance and its implications. Lung ventilation and its changes under physiological circumstances

- Dead space - definition, classification, function. Alveolar ventilation and its changes in different values of tidal volume

- Relaxation position of the chest, non-relaxation positions, breathing in non-relaxation positions. The curve of relaxation pressures of the chest and curves of maximal respiratory pressures

- Concentration of O₂ and CO₂ in the atmosphere/alveolar/expired air, partial pressure of gases

- Exchange of the respiratory gasses - alveolar-capillary barrier – its individual components. Diffusion capacity of the lungs

- Transport of O₂ in blood – individual forms and values, oxygen capacity of blood. Haemoglobin-oxygen association-dissociation curve, factors that influence the affinity of O₂ to haemoglobin. Transport of CO₂ in blood – its forms, their % and function. Association-dissociation curve of HGB for CO₂ in arterial and venous blood. Breathing and regulation of the acid-base balance. Compensation of metabolic alkalosis and metabolic acidosis by the respiratory system

- Function of respiratory centres. Afferentation to the respiratory centres, with permanent effect on breathing. Receptors involve in regulation of breathing – chemoreceptors, stretch receptors, proprioceptors

- Physiological and physical mechanisms of breathing under water in diving. Mechanisms of the decompression syndrome. Mechanisms and processes in respiration in high altitudes. Complex compensation of the short-term and long-term hypoxia in high altitudes

**Physiology of the gastrointestinal system**

- Functions of the gastrointestinal system

- Electrophysiological properties of the smooth muscles in GIT. Mechanisms of the GIT smooth muscle excitation and contraction. Nervous regulation of the smooth muscles in GIT. Humoral regulation of the function of the smooth muscles in GIT.
- Mechanical processing of food in the oral cavity. Swallowing of food, function of pharynx and oesophagus.
- Motor functions of the stomach: mixing of the food, gastric emptying, time of gastric emptying in relation to amount and composition of the consumed food, and processing in the oral cavity.
- Types of intestinal movements after food intake and in fasting, their function. Types of movements of the large intestine after food intake and in fasting, their function. Main processes in the large intestine. Defecation and its disorders.
- Causes of vomiting, symptoms of nausea, vomiting-sequence of events.
- Mechanisms of secretion of saliva, gastric and pancreatic juice. Regulation salivary secretion, chemical composition and functions of saliva.
- Regulation of secretion of the gastric juice, chemical composition of the gastric juice, function of individual components. Periods of secretion of the gastric juice.
- Regulation of secretion of the pancreatic juice, chemical composition of the pancreatic juice, function of individual components.
- Regulation of secretion of the intestinal juice (in small and large intestine), chemical composition of the intestinal juice and function of individual components.
- Functions of the liver. Function of the gallbladder, secretion of bile and its regulation. Chemical composition of the bile, function of the bile acids.
- Bacterial flora of the large intestine and their function, composition of the gastro-intestinal gases. Composition of the faeces.

Metabolism, nutrition, thermoregulation
- Types of energy balance and their consequences for the human body. Definition of the total energy expenditure and its components. Energy value of nutrients (in 1 g of the respective nutrient).
- Definition of the basal metabolic rate – activity of the systems in basal conditions. Values of the basal metabolic rate in males and females. Definition of the basal conditions. Factors that influence the basal metabolic rate in healthy individuals. Definition of the specific-dynamic effect of food, its values for individual nutrients.
- Efficiency of the physical work – definition. Oxygen deficit – definition, its causes, steady state in physical activity, oxygen deficit and oxygen debt.
- Methods of determination of the basal metabolic rate. Principle of the indirect calorimetry, procedure of the measurement. Energy equivalent, values and its association with the type of metabolism. Respiratory quotient, its values for individual nutrients and for the metabolic mixture. Definition of the metabolic mixture.
- Digestion and absorption of carbohydrates/fats/proteins. Digestion and absorption of minerals, vitamins and water.
- Basic metabolic pathways of metabolism of carbohydrates/fats/proteins (amino acids, peptides).
- Physiology of nutrition, main principles of healthy nutrition. Function of vitamins, minerals and trace elements in nutrition
- Vegetarian nutrition - risks and benefits, other alternative types of nutrition, fad diets and their risks.
- Basic factors of the food intake regulation. Definition of hunger and specific hunger.
- Definition of the body temperature, biorhythms of body temperature, normal values. Description of main reactions of thermoregulation in heat and cold
- Heat balance of the body, main physiological mechanisms of the heat production in the body.
- Main mechanisms of adaptation to cold, risks of the prolonged exposure to cold. Basic functional relationships of the thermoregulatory centres, their role in cold and hot environment.