

ORAL EXAM

Excitable tissues

1. Resting membrane potential of nerves
2. Voltage-gated sodium and potassium channels
3. Nerve and skeletal muscle action potential
4. An absolute and relative refractory period
5. Initiation and propagation of the action potential
6. Saltatory conduction
7. Roles of other ions during the action potential
8. The neuromuscular junction
9. Synthesis, secretion and removal of acetylcholine in the neuromuscular junction
10. Physiologic anatomy of skeletal muscle
11. General mechanism of muscle contraction
12. Excitation-contraction coupling in skeletal muscle
13. Sources of energy for muscle contraction
14. Fast and slow muscle fibers
15. Motor unit
16. Isometric and isotonic contraction
17. Muscle fatigue
18. Neuromuscular junctions of smooth muscle
19. Types of smooth muscle
20. Similarities and differences in contractions of skeletal and smooth muscle

The heart

1. Physiologic anatomy of cardiac muscle
2. Cardiac muscle as a syncytium ("Nothing or all" law)
3. Action potentials in cardiac muscle
4. The cardiac cycle, function of the atria as primer pumps
5. The cardiac cycle, function of the ventricles as pumps
6. Function of the valves
7. End-diastolic volume, end-systolic volume, and stroke volume output
8. Regulation of heart pumping, concepts of preload and afterload
9. Frank-Starling mechanism of the heart
10. Reflex control of heart rate (the Bainbridge reflex)
11. Control of the heart by the sympathetic and parasympathetic nerves
12. Effect of potassium and calcium ions on heart function
13. Effect of temperature on heart function
14. Conductive system of the heart, sinus (sinoatrial) node
15. Conductive system of the heart, atrioventricular node and Purkinje system
16. Extrasystoles
17. Cardiac output
18. Control of cardiac output by venous return
19. Heart sounds
20. Electrocardiogram

The Circulation

1. Functional parts of the circulation
2. Pressures in the various portions of the circulation
3. Vascular distensibility and compliance
4. Blood flow (laminar and turbulent flow)
5. Poiseuille's law
6. Arterial pressure (systolic and diastolic pressure)
7. Mean arterial pressure and pulse pressure
8. Veins and their functions
9. Structure of the microcirculation, flow of blood in the capillaries
10. Capillary fluid exchange ("Starling forces")
11. Lymphatic system
12. Acute control of local blood flow
13. Long-term blood flow regulation
14. Humoral control of the circulation
15. Nervous regulation of the circulation
16. The baroreceptor arterial pressure control system
17. Control of arterial pressure by the carotid and aortic chemoreceptors
18. Central nervous system ischemic response
19. Intermediate mechanisms for arterial pressure regulation (The Renin-Angiotensin System)
20. Renal-body fluid system for arterial pressure control

The kidneys

1. Physiologic anatomy of the kidneys and urine formation
2. Glomerular filtration
3. Renal blood flow
4. Physiologic control of glomerular filtration and renal blood flow
5. The tubuloglomerular feedback mechanism
6. Renal tubular reabsorption and secretion
7. Reabsorption and secretion along different parts of the nephron
8. Glomerulotubular balance
9. Hormonal control of tubular reabsorption
10. Use of clearance methods to quantify kidney function
11. Excretion of concentrated urine
12. The countercurrent mechanism
13. Excretion of dilute urine
14. The function of the kidney in the correction of hyperosmolarity
15. The function of the kidney in the correction of hypoosmolarity
16. Importance of thirst in controlling extracellular fluid osmolarity
17. Regulation of extracellular fluid potassium concentration and excretion
18. Regulation of extracellular fluid sodium concentration and excretion
19. Tubular load and transport maximum for substances that are actively reabsorbed
20. Renal control of acid-base balance

Respiratory system

1. Mechanics of pulmonary ventilation
2. Pressures that cause the movement of air and compliance of the lungs
3. Surfactant
4. Pulmonary volumes and capacities
5. Minute respiratory volume and rate of alveolar ventilation
6. Anatomic and physiologic dead space
7. Functions of the respiratory passageways
8. The partial pressure of oxygen and carbon dioxide in lungs, blood and tissues
9. Diffusion of gases through the respiratory membrane and diffusing capacity of the respiratory membrane
10. Factors that affect the rate of gas diffusion through the respiratory membrane
11. Transport of oxygen in the arterial blood
12. Oxygen-hemoglobin dissociation curve
13. Role of hemoglobin in maintaining nearly constant pO_2 in the tissues
14. Transport of carbon dioxide in the blood
15. The Bohr and Haldane effect
16. Neural regulation of respiration
17. Direct chemical control of respiratory center activity
18. Peripheral chemoreceptor system for control of respiratory activity
19. The Hering-Breuer inflation reflex
20. Respiratory regulation of acid-base balance

Blood Cells, Immunity, and Blood Clotting

1. Blood plasma, functional roles of the plasma proteins
2. Red blood cells (erythrocytes)
3. Production and maturation of red blood cells—requirement for vitamin B12 and folic acid
4. Erythrocyte sedimentation rate
5. Hemoglobin
6. Iron metabolism
7. Regulation of red blood cell production—role of erythropoietin
8. Leukocytes (white blood cells)
9. Neutrophils and macrophages defend against infections
10. General characteristics and roles of eosinophils and basophils
11. Roles of T and B lymphocytes
12. O-A-B blood types
13. Transfusion reactions resulting from mismatched blood types
14. Rh blood types
15. Platelets (thrombocytes)
16. Events in hemostasis
17. Mechanism of blood coagulation
18. Extrinsic and intrinsic pathways for initiating clotting
19. Fibrous organization or lysis of blood clots (plasmin)
20. Anticoagulants

Gastrointestinal Physiology and The Liver as an Organ

1. Enteric nervous system and autonomic control of the gastrointestinal tract
2. Gastrointestinal reflexes
3. Functional types of movements in the gastrointestinal tract
4. Hormonal control of gastrointestinal motility
5. Swallowing (deglutition)
6. Motor functions of the stomach
7. Regulation of stomach emptying
8. Secretion of saliva, regulation of salivary secretion
9. Gastric secretion
10. Phases and regulation of gastric secretion
11. Pancreatic secretion
12. Regulation of pancreatic secretion
13. Composition and roles of bile
14. Secretion of bile by the liver, function of bile salts
15. Secretions of the small and large intestine
16. Digestion and absorption of proteins
17. Digestion and absorption of fats
18. Digestion and absorption of carbohydrates
19. Absorption in the small and large intestine
20. Functions of the liver

Metabolism and thermoregulation

1. Protein metabolism
2. Lipid metabolism
3. Metabolism of carbohydrates
4. Glycogenesis, glycogenolysis and gluconeogenesis
5. Dietary balances, respiratory quotient
6. Neural centers for food intake regulation
7. Neurons and neurotransmitters in the hypothalamus that regulate feeding
8. Food intake regulation
9. Adenosine triphosphate as an "energy currency" in metabolism
10. Oxygen debt
11. Metabolic rate
12. Respiratory quotient, indirect calorimetry
13. Basal metabolic rate
14. Factors that influence basal metabolic rate
15. Body temperature regulation
16. The mechanisms by which heat is lost from the skin
17. Sweating and its regulation by the autonomic nervous system
18. Regulation of body temperature-role of the hypothalamus
19. Temperature-decreasing mechanisms when the body is too hot
20. Temperature-increasing mechanisms when the body is too cold

Endocrinology

1. Chemical structure, synthesis and regulation of secretion of hormones
2. Hormone receptors and mechanisms of action of secondary messengers
3. The role of the hypothalamus in the control of pituitary secretion
4. The anterior pituitary gland, growth hormone
5. Posterior pituitary gland
6. Synthesis and effects of the thyroid hormones
7. Regulation of thyroid hormone secretion
8. Functions of the mineralocorticoids - aldosterone
9. Regulation of aldosterone secretion
10. Functions of the glucocorticoids – cortisol
11. Regulation of cortisol secretion
12. The hormones of adrenal medulla – catecholamines
13. Insulin, metabolic effects and secretion control
14. Glucagon
15. Hormones involved in blood glucose regulation
16. Abnormalities in insulin secretion
17. Calcium and phosphate regulation in the plasma – parathormone and calcitonin
18. Testosterone
19. Female hormonal system
20. Monthly ovarian cycle

Central nervous system physiology

1. Organization of the nervous system
2. Synapse – types of synapses and mechanisms of transmission
3. Synaptic transmitters and receptors
4. Electrical events during neuronal excitation and inhibition
5. Transmission of signals in nerve tracts-spatial and temporal summation
6. Organization of the spinal cord for motor functions
7. The role of muscle spindles in muscle control
8. Golgi tendon reflex
9. Spinal cord transection and spinal shock
10. Brain stem functions
11. The function of the cerebellum and clinical abnormalities
12. The function of basal ganglia and clinical syndromes resulting from damage
13. Physiologic anatomy and functions of specific cortical areas of the cerebral cortex
14. Memory – classification and mechanisms
15. The role of the limbic system in the regulation of behavior and emotions
16. Functions of the hypothalamus
17. States of brain activity – sleep and types of sleep
18. General organization of the autonomic nervous system, physiologic antagonism and tone
19. "Alarm" or "stress" response of the sympathetic nervous system
20. Cerebrospinal fluid system

Sensory receptors

1. Receptors and receptor field, types of sensory receptors
2. Receptor potential and adaptation of receptors
3. Nerve fibers that transmit different types of signals and their physiologic classification
4. Classification, detection and transmission of tactile sensations
5. Transmission in the anterolateral pathway and dorsal column-medial lemniscal system
6. Pain, types of pain, pain receptors, transmission of pain, pain suppression ("analgesia") system
7. Thermal sensations
8. Mechanism of "accommodation" of the eye
9. Errors of refraction
10. Automatic regulation of retinal sensitivity-light and dark adaptation
11. Photoreceptors and color vision
12. Central neurophysiology of vision
13. The conductive part of the sense of hearing
14. The receptor part of the sense of hearing (organ of Corti)
15. Central auditory mechanisms
16. Vestibular apparatus
17. Sense of taste, primary sensations of taste, the threshold for taste, taste bud
18. Mechanism of stimulation of taste buds and transmission of taste signals
19. Stimulation of the olfactory cells and adaptation of olfactory sensations
20. Sense of smell, primary sensations of smell, the transmission of smell signals

PRACTICAL EXAM

Introduction and membrane transport

1. Physiological solutions
2. Simple diffusion (*PhysioEx*)
3. Active transport (*PhysioEx*)
4. Facilitated diffusion (*PhysioEx*)
5. Osmosis (*PhysioEx*)

Excitable tissues

1. The resting membrane potential (*PhysioEx*)
2. The action potential: conduction velocity (*PhysioEx*)
3. The action potential: importance of voltage-gated Na⁺ channels (*PhysioEx*)
4. The Action Potential: Coding for Stimulus Intensity (*PhysioEx*)
5. The effect of Stimulus Voltage on Skeletal Muscle Contraction (*PhysioEx*)
6. The Effect of Stimulus Frequency on Skeletal Muscle Contraction (*PhysioEx*)
7. Tetanus in Isolated Skeletal Muscle (*PhysioEx*)
8. Isotonic Contractions and the Load-Velocity Relationship (*PhysioEx*)

The heart

1. Stannius ligatures
2. Reflex stimulation of N.vagus (Goltz maneuver). Oculocardiac reflex
3. Examine the influence of N.vagus stimulation on heart activity (*PhysioEx*)
4. Examine the effects of epinephrine, acetylcholine (pilocarpine and atropine) and digitalis on heart activity (*PhysioEx*)
5. Examine the effect of temperature and change of extracellular concentration of K⁺ and Ca²⁺ on heart activity (*PhysioEx*)
6. Examine refractory period of the heart. Induce and record extrasystoles on frog heart (*PhysioEx*)
7. Auscultation of heart sounds
8. Analyze the electrocardiogram: determine the position of the heart, voltage and duration of electrocardiogram elements

Circulation

1. Studying the Effect of Blood Vessel Radius and Length on Blood Flow Rate (*PhysioEx*)
2. Studying the Effect of Blood Pressure and Blood Viscosity on Blood Flow Rate (*PhysioEx*)

3. Based on the Starling forces calculate the net pressure. Decide which end of the capillary bed is in question?
 - Capillary pressure = 32 mmHg
 - Interstitial pressure = 1 mmHg
 - Plasma colloid osmotic pressure = 28 mmHg
 - Interstitial colloid osmotic pressure = 3 mmHg
4. Indirect method for arterial blood pressure measurement
5. Characteristics of the arterial pulse
6. Evaluating functional cardiovascular system capability during physical exercise - Harvard step test and Astrand test

The kidney

1. The hormonal effects on reabsorption – ADH and aldosterone (*PhysioEx*)
2. Tubular reabsorption of glucose (*PhysioEx*)
3. Calculate the value of glomerular filtration through the clearance of inulin by using the following data:
 - a) plasma concentration of inulin is 0,003 g%
 - b) urine concentration of inulin is 0,5 g%
 - c) the volume of excreted urine is 0,75 ml/min.
4. Respiratory response to metabolic acidosis and alkalosis (*PhysioEx*)
5. Renal response to respiratory acidosis and alkalosis (*PhysioEx*)
6. Renal response to blood pressure changes (*PhysioEx*)
7. Functional examination of the kidney
8. Calculate tubular maximum for glucose reabsorption if glomerular filtration is normal, glycemia 280 mg% and every minute 32.5 mg of glucose is excreted through urine.
9. Calculate clearance of urea if diuresis is 1440 ml/24 h, concentration of urea in plasma is 6,2 mmol/l and concentration of urea in urine 510 mmol/l.
10. Calculate renal plasma flow and renal blood flow and fraction of filtration if hematocrit is 0,42, glomerular filtration is normal, concentration of PAH in serum 40 mmol/l, and excretion of PAH through urine 23,4 mmol/min.

Respiratory system

1. The role of diaphragm and intrapleural pressure in managing respiratory movements (Donders model)
2. Measuring respiratory volumes and calculating capacities (*PhysioEx*)
3. Comparative Spirometry (*PhysioEx*)
4. Effect of surfactant and intrapleural pressure on respiration (*PhysioEx*)
5. Determine the amount of oxygen that diffuses through the respiratory membrane for 5 minutes (from alveoli into the blood) under resting conditions. Oxygen pressure is 11 mm Hg, and diffusion capacity for oxygen under resting conditions is 21 ml/min/mmHg.

Hematology

1. Hematocrit determination (*PhysioEx*)
2. Determine the number of erythrocytes in a blood sample
3. Hemoglobin determination (*PhysioEx*)
4. Determine the coloring index of a person that has 3800 000 Er/mm³ blood and hemoglobin 12g%.
5. Erythrocyte Sedimentation Rate (*PhysioEx*)
6. Determine leukocyte formula in a blood sample
7. Determine the leukocyte count in blood a sample
8. Determine clotting time using capillary tube method
9. Determine blood type

Digestive system and the liver

1. Determine free HCl, bound HCl and whole acidity in gastric juice
2. Assessing Starch Digestion by Salivary Amylase (*PhysioEx*)
3. Assessing Pepsin Digestion of Protein (*PhysioEx*)
4. Assessing Lipase Digestion of Fat (*PhysioEx*)

Metabolism and Thermoregulation

1. Metabolism and Thyroid Hormone; Determining the Basal Metabolic Rates; The effect of TSH on Metabolic Rate; Determining the Effect of Propylthiouracil on Metabolic Rate (*PhysioEx*)
2. Calculate the value for RQ for non-proteins when 50% of energy consumption come from fats and 50% from carbohydrates.
3. Basal metabolism of a woman is 45 Kcal/m²/1h. Calculate the magnitude of the deviation from normal values in percents.
4. Compose daily nutritional plan for a person whose daily energy needs are 3000 Kcal.
5. Calculate the amount of released heat from the following data. Examinee is tall 172 cm and 72 kg heavy. His body surface area is 1,8 m². In 5 minutes he spends 1,405l O₂ and releases 1,165l CO₂. The amount of released heat express in Kcal/24h and m²body surface area.

RQ	0,70	0,74	0,78	0,82	0,86	0,90	0,94	0,98	1,00
Kcal	4,68	4,73	4,78	4,82	4,87	4,92	4,97	5,02	5,05

Endocrinology

1. Plasma Glucose, Insulin, and Diabetes Mellitus. Developing a Glucose Standard Curve (*PhysioEx*)
2. Hormone Replacement therapy: estrogen and calcitonin (*PhysioEx*)
3. Measuring Cortisol and Adenocorticotrophic Hormone (ACTH) (*PhysioEx*)

Physiology of the Central Nervous System

1. Spinal animal
2. Brown-Sequard syndrome
3. Examine reflex activity – myotatic reflexes
4. Decerebrated and thalamic animal
5. Electroencephalography
6. Chemical Synaptic Transmission and Neurotransmitter Release (*PhysioEx*)

Sensory receptors

1. Determine the tactile sensitivity of the skin using esthesiometer
2. Examine static and dynamic proprioception and cortical sensibility
3. Qualitative assessment of hearing using tuning fork
4. Examine excitability of the vestibular apparatus using rotation test – Barany rotational chair
5. Examine the eye sensitivity towards colors (color vision)
6. Determine the closest and the most distant point of clear vision using optotype and lenses
7. Determine visual acuity
8. Prove the existence of the blind spot using Mariott maneuver
9. Determine the field of vision
10. Examine the pupil reaction to light
11. Determine the sound direction using binaural hearing
12. Show the existence of different gustatory receptors on the tongue surface
13. Examine the eye movement
14. Examine the astigmatism
15. Effects of lesions of the optic pathway on the fields of vision