

CURRICULUM OF PHYSIOLOGY
GENERAL MEDICINE
ACADEMIC YEAR 2014/2015

Textbooks:

HP = Human Physiology (A.J. Vander, J.H. Sherman, D.S. Luciano), tenth (10) or eleventh (11) or twelfth (12) edition.

G = Review of Medical Physiology (William F. Ganong), eighteenth (18) or twenty second (22) edition.

MOODLE = <http://lms.lfp.cuni.cz/course/view.php?id=117>

BLOOD AND THE IMMUNE SYSTEM

MOODLE, Lectures. HP 10, 11, 12.

General Characteristics and Main Functions of the Blood. (MOODLE; HP 10 29-30; HP 11 26-27, 425; HP 12 28-29, 417). Blood volume. - The packed cell volume. - Blood and plasma viscosities. - The erythrocyte sedimentation rate (ESR). - Blood functions, blood buffers.

The Plasma. (MOODLE; HP 10 459-460; HP 11 425; HP 12 417). Plasma composition, plasma osmolality. - Plasma proteins, their functions. - Inorganic constituents of the plasma, their functions. - Organic constituents of the plasma.

Erythrocytes. (MOODLE; HP 10 460-461; HP 11 425-428; HP 12 417-420). RBC count, size and shape. - The RBC membrane. - The RBC energy production. - Hemolysis. - Fragility of RBC. - Hemoglobin concentration, composition, forms, oxygenation. - MCH, MCHC a MCV. - Anaemia, definition, types.

Erythropoiesis. (MOODLE; HP 10 461-463; HP 11 426-428; HP 12 418-420). Sites of RBCs production during prenatal and postnatal life. - Precursors of RBC. - Iron content in the body. Iron absorption, storage and transport. - Role of Vitamin B₁₂ and folic acid. - Erythropoietin.

Destruction of RBC. (MOODLE; HP 10 460; HP 11 426; HP12 418) RBCs life span. - Role of tissue macrophages. - Metabolism of the iron. - Bilirubin metabolism, concentration in plasma. Bile pigments. Entero-hepatic circulation.- Types of icterus, characteristic features. Diagnostic differences between free and conjugated bilirubin.

White Blood Cells (HP 10 463-465, 703; HP 11 428-429, 649; HP 12 420, 635). Classification. - Total white blood cell (WBC) count. - Differential WBC count. - Granulopoiesis. - Neutrophils. - Eosinophils. - Basophils. - Monocytes. - B and T lymphocytes.

Hemostasis. (MOODLE; HP 10 465-473; HP 11 431-437; HP 12 421-427). The vascular spasm. – Platelets: thrombopoiesis, count, size and shape. - Platelet functions: adhesion, aggregation. Formation of platelet plugs. - Hemocoagulation. - Clotting factors. - Three steps of blood coagulation. - Formation of the prothrombin activator: extrinsic and intrinsic pathways. - Fibrinolytic system. - Natural inhibitors of hemostasis. Antitrombin III. Heparin. - Drugs affecting hemostasis. Coumarin. - Role of vitamin K and heparin. - Disorders of coagulation.

Blood Groups. (MOODLE; HP 10 730-731; HP 11 672-673; HP 12 658-659). Agglutinogens and agglutinins. - ABO system. - Rhesus system. Hemolytic disease of the newborn. - Blood transfusion. - Blood typing. Cross-matching of the blood. - Transfusion reactions. - Autologous transfusion.

Immunity. (HP 10 701-734; HP 11 647-676; HP 12 632-663). Innate defense mechanisms. - Specific immunity. Cellular immunity. Humoral immunity. Immunoglobulins. - Immune responses. Antigen-Antibody reactions. - Complement. - Disorders of the immune mechanisms.

GENERAL PHYSIOLOGY

Lectures. HP 10, 11, 12.

Physiologic Regulation. - Internal environment of the multicellular organisms. - Homeostasis. - Control mechanisms of homeostasis. - Negative feedback loop, components, characteristic of action. Antagonistic effectors. - Positive feedback mechanism, characteristic. Examples. - Feedforward control and its strategy used to control systems in the body.

Communication. - Means of communication. - Direct communication via gap junction. - Autocrine and paracrine signaling via chemical messengers. - Nervous signaling. - Neuroendocrine signaling. - Hormonal signaling. - Tissue growth factors and their functions.

The Cell Membrane, Membrane Transport. - Structure of the cell membrane, major components. - Structure of phospholipids, their arrangement and function. - Function of cholesterol. - Membrane proteins, types and functions. - The role of glycocalyx. - Function of the cell membrane. - Membrane transport mechanisms. - Simple diffusion. - Facilitated diffusion via carrier proteins and ion channels. - Rate of diffusion. - Osmosis. - Osmotic pressure. - Molarity and molality. - Osmolality. Measurement of osmolality. - Tonicity. - Primary active transport. - Secondary active transport. Symport, antiport. - Types of endocytosis. - Exocytosis.

Electrogenesis on Cell Membrane. - Membrane potential. - Composition of the cytoplasm and the extracellular fluid. Diffusible and fixed ions. - Role of Na^+/K^+ pumps. - Electrical properties of cells. Permeability of the cell membrane to a particular ion. Equilibrium potential for a particular ion. Nernst equation. - Resting membrane potential, values and determinants. - Driving force for an ion movement. - Voltage shifts. - Categories of electrical events in membrane. - Excitable and inexcitable tissues. - Types of membrane channels.

Receptor and Synaptic Potential. - Location. - Membrane type. - Characteristic of initiating event. - Direction and size of potential change. Types of ion channels involved. - Mechanism of current spread. - Types of synapses. - Synaptic transmission. - Chemical synapse. - Mechanism of transmitter release. Quantum of a neurotransmitter. - Types of receptors and mechanisms of information transfer. - EPSP and IPSP. - Convergence and divergence. - Temporal and spatial summation.

Action Potential. - Cellular specialization to generate and transmit action potentials. Excitable tissues. - Initiation of the action potential. Threshold. - Characteristics of the action potential. Changes in sodium and potassium conductances associated with components of the action potential. Action potential gating mechanisms. - Role of the K^+/Na^+ pumps in the excitability. - Propagation and speed of the action potential. Nonmyelinated and myelinated nerves. - Refractory

periods. Absolute and relative refractory period. Refractory period and firing frequency.

Neurochemical Transmission. – Classes of neurotransmitters. – Cholinergic neurons. Cholinergic transmission. Acetylcholine synthesis, release, degradation, and modes of removal. Types, location and function of cholinergic receptors. – Adrenergic transmission. Catecholamines synthesis, release, modes of removal, and degradation. Types, location and functions of adrenoceptors. – Neuropeptides in the central and peripheral nervous system. - Excitatory and inhibitory amino acids. — Gases as neurotransmitters. – ATP and ADP as neuromodulators.

Signal transduction. - Types of external signals (first messengers). – Chemical nature of external signals. – Types of signaling on the cellular level. - Receptors that are ion channels.- Receptors coupled to G proteins. Structure of G protein and its cycling. Functions of α and $\beta\gamma$ subunits. Generation of a second messenger system. Signal amplification. The cyclic AMP as second messenger system. The phosphatidylinositol as second messenger system. Ion channels as second messenger system. - Catalytic receptors: receptor guanylyl cycle and tyrosin kinase, ligands and mechanisms of action. – Intracellular receptors and activation of genes. Pathways from genes to proteins.

Skeletal Muscles (HP 10 279 – 293, HP 11 255 – 266, HP 12 251 - 263). – Structure of the skeletal muscle. – Molecular mechanism of contraction. – Actin. Myosin. Troponin and tropomyosin. – Excitation-contraction coupling. – Sarcoplasmic reticulum. – Neuromuscular junction. – Motor unit. – Role of ACh. End-plate potential. – Acetylcholinesterase. – Effect of drugs on the neuromuscular junction.

Mechanical Properties of the Skeletal Muscles (HP 10 294 – 312, HP 11 266 – 283, HP 12 263 - 278). – Isometric and isotonic contractions. – Twitch contractions. – Summation. Incomplete and complete tetanic contractions. – Length-tension relation. – Load-velocity relation. – Skeletal muscle energy metabolism. – Muscle fatigue. – Slow and fast muscle fibers. – Control of muscle tension and shortening velocity. – Muscle adaptation to exercise. – Lever action of muscles and bones. – Skeletal-muscle disease.

Smooth Muscle (HP 10 312 – 321, HP 11 284 – 295, HP 12 279 - 285). – Structure of the smooth muscle. – Crossbridge activation. – Sources of cytosolic calcium. – Membrane activation. – Spontaneous electrical activity. – Nerves and hormones. – Types of smooth muscles. Single unit smooth muscle. Multiunit smooth muscle.

The Autonomic Nervous System (HP 10 196 – 204, HP 11 177 – 185, HP 12 175 -180).

CARDIOVASCULAR PHYSIOLOGY

General Properties of the Cardiovascular System. – Systemic and pulmonary circulations. Differences in the resistance, pressure gradients and blood flow. – The heart – anatomy, electrical pacemaker and conducting system, cardiac muscle, valves of the heart, coronary circulation, autonomic innervation of the heart.

Electrophysiology of Working Ventricular Cardiomyocytes. – Resting membrane potential and its determinants. Background currents. – Action potential – phases, duration, ionic channels, refractory period, relation to contraction. Plateau phase and its importance.

Conduction System of the Heart. – Anatomy, hierarchy, conduction velocities. – Electrophysiology of the pacemaker sinoatrial cells. Slow diastolic depolarization. Action potential – characteristic, ionic currents. – Characteristic of atrioventricular node. – Properties of Purkinje fibres.

Cardiac Muscle. – Structure of the cardiac muscle. – Structure of the cardiac sarcomere. Contractile proteins. Actin, myosin. Regulatory proteins. Troponin, tropomyosin. Titin. – Sarcolemma. T-tubules. Dihydropyridine receptors. Sodium-calcium exchanger. – Sarcoplasmic reticulum. Structure. Function. Ryanodine receptors. Calcium pump of sarcoplasmic reticulum. Phospholamban. – Excitation-contraction coupling. – Molecular mechanism of contraction. – Major differences between the cardiac and skeletal muscles.

Cardiac Contractility and its Regulation. – Contractile apparatus. – Excitation-contraction coupling. – Calcium cycling in cardiac myocytes. Calcium-induced calcium release. Calcium homeostasis during diastole. – Regulation of inotropism. – Autoregulation. Frank-Starling mechanism. – Catecholamines, sympathetic stimulation. Receptors. Second messenger. Target proteins in the cardiac myocyte. – Effect of the increased heart rate on the cardiac contractility. – Contractile effect of inhibition of Na-K-ATPase. – Acetylcholine. Receptors. Target proteins. – The role of IK(ATP) channels.

Cardiac Cycle. – Events during the cardiac cycle. Systole and diastole. – Individual subphases of the cardiac systole and diastole: timing, duration, pressure and volume changes in the heart compartments, role of the valves, importance of atrial contraction. – Relationship between electrical and mechanical events in the cardiac cycle. – Systemic and pulmonary circulation pressures during the cardiac cycle. – Heart sounds.

Electrocardiogram. – Origin of ECG. Intracellular and extracellular recording of the electrical activity of working ventricular cardiomyocyte. – ECG waves, intervals and segments. – Relationship of ECG curve to the sequence of electrical excitation of the heart. – Relationship between ECG curve and cardiac cycle. – Overview of ECG registration techniques – standard limb leads, augmented leads, chest leads. – Basic interpretation of the electrocardiogram: action, heart rate, rhythm, electrical axis, description of individual waves and intervals. – Construction of the electrical axis from the ECG by means of Einthoven's triangle.

Recording of the Cardiac Activity from the Body Surface. – Heart sounds. Phonocardiography. – Arterial pulse wave, registration, spreading velocity. Arterial sphygmography. – Pressure-volume changes in veins near the heart. Phlebography. – Relationship between pressure, volume, acoustic and electrical events in the cardiac cycle.

Cardiac Output. – Definition. – Cardiac volumes. End-systolic volume. Stroke volume. End-diastolic volume. – Ejection fraction. – Resting and maximal cardiac output. – Determination of cardiac output. Fick principle. – Determinants of the stroke volume. Preload. Afterload. Contractility. Duration of contraction. – Determinants of the heart rate. Positive and negative chronotropic effects. Heart rate as a function of duration of systole and diastole. Maximum heart rate. – Cardiac index. – Pressure-volume loops. Effects of preload, afterload and contractility.

The Vascular System: General Features. – General terms and definitions. Flow. Pressure. Resistance. Compliance. Velocity. – Relationship between flow, resistance and pressure gradient. – Relationship between blood flow velocity and total cross-sectional area. – Viscosity and its determinants. – Laminar and turbulent flow. Reynolds number. – Determinants of systemic vascular resistance. Resistances

in parallel and in series. – Vascular compliance. – Laplace law. Vascular wall tension. – Hagen-Poiseuille equation. – Bernoulli's principle. Effect on blood pressure in narrowed vessels. – Types of blood vessels. – Structure of vascular walls. – Function of the individual types of vessels. – Distribution of the blood volume in the cardiovascular system.

The Vascular System: Arteries. – Types and functions of arteries. – Structure of arterial wall. – Blood flow velocity in arteries. – Resistance and compliance of arteries. – Arterial pressure. Systolic pressure. Diastolic pressure. Pulse pressure. Mean arterial pressure. Changes with age. – Measurement of arterial pressure. Korotkoff sounds. – Pressures in the right and left circulations. – Pressure gradients in arteries. – Pulse wave and its spreading velocity. – Arterioles. Structure. Function.

The Vascular System: Microcirculation. – Design of microcirculation. – Three major types of capillaries. Structure of the capillary wall. Permeability. – Mechanisms of capillary exchange. – Diffusion. Fick's law of diffusion. – Bulk flow. Filtration and reabsorption. – Vesicular transport. – Hydrostatic and oncotic pressures in capillaries. Tissue (interstitial) hydrostatic and oncotic pressures. Net driving force. – The role of lymphatics. – Vesicular transport.

The Vascular System: Veins. – Major functions of veins. – Structure of veins. – Blood flow in veins. Mechanisms facilitating venous return. – Resistance and compliance of veins. – Effect of gravitational pressure on venous pressure. – Central venous pressure. Factors influencing central venous pressure.

The Lymphatic System. – Anatomy of the lymphatic system. Lymphatic capillaries. Lymphatic vessels and valves. Lymph nodes. – Formation of the lymph. – The lymph flow and functions. Factors facilitating the lymph flow. – Composition of the lymph.

Regulation of the Heart. – Chronotropy, inotropy, dromotropy, bathmotropy. – Intrinsic control. – Extrinsic control by the autonomic nervous system. – Cardiovascular centers. – Innervation of the heart. Parasympathetic pre- and postganglionic neurons, neurotransmitters, receptors, agonists and antagonists. – Sympathetic pre- and postganglionic neurons, neurotransmitters, receptors, agonists and antagonists. – The effects of autonomic neurotransmitters on heart rate, contractility, conduction and excitability. – Signal transduction. G proteins and cyclic AMP as a second messenger. – Peripheral cardiac neuronal interactions. Pre- and postsynaptic receptors.

Local Control of the Tissue Blood Flow. – Role of arterioles in regulation of tissue blood flow. – Myogenic autoregulation. – Metabolic autoregulation. Active hyperemia. Flow autoregulation. Reactive hyperemia. Response to injury. – Local humoral factors. Role of endothelial cells. Serotonin. Bradykinin. Nitric oxide. Histamine.

Extrinsic Control of the Tissue Blood Flow. – Innervation of vessels. Neurotransmitters. Receptors. – Hormones. Epinephrine. Vasopressin. Angiotensin II. Atrial natriuretic peptide. – Differences in norepinephrine and epinephrine effects on tissue blood flow.

Short-Term Regulation of Mean Arterial Pressure. – Neural control. – Arterial baroreflex. Location and innervation of baroreceptors. Pressure range for baroreceptors firing. Reflex arc. Functional responses to stimulation of baroreceptors. Adaptation of baroreceptors. – Peripheral chemoreceptors, location, innervation, stimuli, and role in regulation of arterial pressure. Respiratory and cardiovascular response to stimulation. – The CNS ischemic response. – Atrial pressure/volume reflex, receptors, stimuli, and reflex responses. – Venoconstriction.

Humoral Regulation of Mean Arterial Pressure. – Catecholamines. Origin, synthesis, degradation, cardiovascular effects. Comparison of the effects of intravenous infusion of epinephrine and norepinephrine on arterial blood pressure, peripheral resistance and cardiac output. – The renin-angiotensin-aldosterone system. Origin, function, converting enzyme. – Antidiuretic hormone. Origin, site of secretion, renal and cardiovascular effects. – Atrial natriuretic peptide. Origin, vascular and renal effects.

Long-Term Regulation of Blood Volume and Arterial Pressure. – The renal-body fluid feedback system. – Relationship between water and salt intake and output and mean arterial pressure. Mechanism by which extracellular fluid volume elevates arterial blood pressure. – Pressure diuresis and natriuresis, mechanism. – Renin-angiotensin-aldosterone system, components and activation. The principal effects of angiotensin II, mechanisms of water and salt retention.

Coronary Circulation and Cardiac Metabolism. – Functional anatomy of the coronary vessels. – Coronary blood flow at rest and during exercise. Pressure gradients in coronary circulation. – Relationship between oxygen consumption and coronary blood flow. Extraction of oxygen. – Regulation of coronary blood flow. Metabolic autoregulation. Effects of autonomic neural activity on coronary blood flow. – Energy sources for the heart contraction and their relative contribution to total uptake of oxygen. – The major metabolic processes of cardiac muscle to produce energy. – ATP as a fuel for the contraction process.

Fetal Circulation. – Structure and function of fetal circulation. Blood inflow and outflow. – Oxygen supply to upper part of the body. – Output of the right and left ventricle. – Changes in circulation after birth. HbF. – Differences between fetal and adult circulation.

RESPIRATION

HP 10, 11 or 12.

Organization of the Respiratory System (HP 10 478 - 481, HP 11 443 – 446, 12 435 - 438). - The upper airways. – Branching of the lower airways, conducting zone, respiratory zone. - Composition of the airway wall, function of the ciliated epithelial cells. – Pulmonary blood vessels. - The alveoli, alveolar wall, types of alveolar cells.

Ventilation and Lung Mechanics (HP 10 482 - 489, HP 11 446 – 453, 12 438 - 445). - Relation of the lungs and the chest wall, the visceral and parietal pleura, intrapleural fluid. - Boyle's law - Pulmonary pressures: alveolar pressure, intrapleural pressure, transpulmonary pressure. - Pneumothorax. - Inspiration, mechanisms enlarging the thorax, the diaphragm, inspiratory intercostal muscles. - Expiration, passive and active. - Lung compliance, its determinants, surface tension, surfactant.

Airway Resistance (HP 10 490 - 491, HP 11 453 – 454, 12 445 - 446). - Factors determining airway resistance, importance of airway radius. - Changes of airway resistance during the breathing cycle. - Lateral traction. Neuroendocrine factors affecting airway resistance, epinephrine, leukotriens. – Asthma, chronic obstructive pulmonary disease.

Static and Dynamic Ventilatory Parameters (practical exercise, seminars, HP 10 491 - 494, HP 11 454 – 455, 12 446 - 448). - Tidal volume, inspiratory and expiratory reserve volume, residual volume. – Functional residual capacity, vital

capacity, total lung capacity. – Forced expiration of vital capacity, performing the maneuver, forced vital capacity, forced expiratory volume in one second (FEV₁), forced expiratory flow between 25% and 75% FVC (FEF_{25-75%}). – Minute ventilation, maximal voluntary ventilation. - Techniques of measuring lung volumes and flow, BTPS correction.

Exchange of Gases in Alveoli and Tissues (HP 10 494 - 500, HP 11 456 – 462, 12 448 - 454). - Alveolar ventilation, the anatomic and alveolar dead space. – Whole body oxygen consumption and carbon dioxide production, respiratory quotient. - Partial pressures of gases, diffusion of gases in liquids. – Partial pressures of atmospheric and alveolar air. - Alveolar-blood gas exchange, partial pressures of gases in arterial blood. – Matching of ventilation and blood flow in alveoli, hypoxic vasoconstriction of pulmonary vessels. – Gas exchange in the tissues, partial pressures of gases in venous blood. - Hyperventilation, hypoventilation.

Transport of Oxygen in Blood (HP 10 500 - 505, HP 11 463 – 467, 12 454 - 458). - Oxygen content in arterial blood, forms of oxygen transport in the blood, dissolved oxygen in the blood. – Hemoglobin, its structure, site of oxygen binding. – Effect of pO₂ on hemoglobin saturation, the oxygen-hemoglobin dissociation curve, cooperativity of hemoglobin subunits. – Oxygen movement in the lungs and tissues, relationship between pO₂, dissolved oxygen and oxygen combined with hemoglobin. – Carbon monoxide and oxygen carriage. – Effects of blood pCO₂, pH, temperature, and 2,3-disphosphoglycerate on hemoglobin saturation.

Transport of Carbon Dioxide and Hydrogen Ions in Blood (HP 10 505 - 507, HP 11 467 – 469, 12 458 - 460). - Dissolved carbon dioxide in the blood. – Carbaminohemoglobin. - Conversion of carbon dioxide to bicarbonate, carbonic anhydrase, transport of bicarbonate across the erythrocyte membrane, equilibrium of the reaction in the tissues and in the lungs. – Hydrogen ions transport, binding of hydrogen ions to hemoglobin, respiratory disturbances of acid-base balance.

Neural Generation of Rhythmical Breathing (HP 10 507 - 508, HP 11 469 – 470, 12 460 - 461). Medullary inspiratory neurons. – Pontine respiratory neurons – Afferentation from the pulmonary stretch receptors, Hering - Breuer inflation reflex. – Drugs affecting medullary inspiratory neurons.

Chemical Control of Breathing (HP 10 508 - 514, HP 11 470 – 476, 12 461 - 466). - The peripheral chemoreceptors. – The central chemoreceptors. – Control by pO₂. – Control by pCO₂, arterial pCO₂ and the brain extracellular fluid H⁺ concentration. – Direct inhibitory effect of high blood pCO₂. - Respiratory adjustments to metabolic acid-base disturbances, metabolic acidosis, metabolic alkalosis. – Control of ventilation during exercise. – Other ventilatory responses.

Hypoxia (HP 10 514 - 516, HP 11 476 – 478, 12 466 - 468). - Definition. – Types of hypoxia, hypoxic hypoxia, anemic hypoxia, ischemic hypoxia, histotoxic hypoxia. – Causes of hypoxic hypoxia, hypoventilation, diffusion impairment, shunt, ventilation-perfusion inequality. – Emphysema. – Acclimatization to high altitude, mountain sickness. – Nonrespiratory functions of the lungs.

ALIMENTARY TRACT

HP 10 or 11 or 12.

Gastrointestinal Motility (HP 10 312-320, 588-593, 597-598, 603-605, HP 11 284-295, 540-543, 548-551, 555-557, HP 12 279-289, 528-530, 536-538, 542-544,

seminars). – Gastrointestinal smooth muscle, structure, basis of contraction. Differences between skeletal, smooth and cardiac muscle. – Enteric nervous system. Extrinsic innervation of the gut. – Peristalsis. Myenteric reflex. – General patterns of movement of the gut-mixing and propulsive movements. – Nervous and hormonal control of gastrointestinal motility.

Regulation of Gastrointestinal Processes (HP 10 588-590, HP 11 540-543, HP 12 528-530, seminars). – Neural regulation. Enteric nervous system, extrinsic innervation. Long and short reflexes and their role in the regulation of gastrointestinal processes. – Hormonal regulation. Secretion, cholecystokinin, gastrin, somatostatin, GIP, VIP-endocrine cell location, stimuli for hormone release, effects. – Phase of gastrointestinal control.

Mouth, Pharynx, and Oesophagus (HP 10 590-593, HP 11 543-545, HP 12 531-533, seminars). – Chewing. Swallowing – voluntary and involuntary phases. Swallowing centre. The role of myenteric nerve plexus in deglutition. – The saliva-pH, organic constituents, inorganic constituents, regulation of secretion. Secretory mechanisms - electrolyte secretion, protein secretion. – Oesophagus – function and innervation of lower oesophageal sphincter.

The Stomach (HP 10 593-598, HP 11 545-551, HP 12 533-538, seminars). - Function. - Anatomy. Gastric glands. - Hydrochloric acid secretion. Functions of HCl. The role of carbonic anhydrase. - Enzyme secretion, pH optima of secreted enzymes. - Intrinsic factor. - Control of gastric secretion - role of reflexes and gastrin. - Gastric motility. Role of pyloric sphincter in gastric emptying. Receptive relaxation. - Nervous and humoral control of gastric motility.

The Pancreas (HP 10 598-601, HP 11 551-554, HP 12 538-541, seminars). - Function and structure. - Composition of pancreatic juice - electrolytes, enzymes. Bicarbonate secretion in duct epithelial cells. - Nervous and hormonal control of pancreatic secretion. Role of cholecystokinin and secretin. - Mechanisms to prevent enzyme activation inside the gland.

The Small Intestine (HP 10 602-604, HP 11 554-556, HP 12 541-543, seminars). - Intestinal wall structure. Intestinal glands. - Intestinal juice - constituents, daily amount. - Absorptive capacity, enterocytes. - Electrical basis of small bowel contraction, patterns of movement. Migrating motor complex. - Regulation of intestinal motility.

Digestion and Absorption (HP 10 583-588, HP 11 528-540, HP 12 516-528, seminars). - Digestion and absorption in the mouth, the stomach, small and large intestines. - Mechanisms of absorption. - Digestion and absorption of carbohydrates. - Digestion and absorption of protein. - Digestion and absorption of fat. - Absorption of vitamins, ions, and water.

The Large Intestine (HP 8 583-584, HP 10 604-605, HP 11 556-557, HP 12 543-544, seminars). - Function, anatomy, innervation. - Colonic movements, haustrations, mass movements. - Defecation - anal sphincters, innervation. Defecation reflex. - Absorption in the colon. - Faeces - daily amount, composition.

The Liver and Bile (HP 10 601-602, 563-565, 579-581, HP 11 530-532, 553-554, HP 12 517-521, seminars). - Liver lobule. Perivenous and periportal zones. - Liver blood supply, blood flow. - Kupffer cells. - Metabolic functions of the liver. Carbohydrate metabolism. Fat metabolism. Protein metabolism. Detoxification. Storage. - Endocrine functions. - Bile. Composition. Bile acids. Bile pigments. - Control of bile secretion. - Control of gallbladder contraction.

METABOLISM AND TEMPERATURE REGULATION

HP 10 or 11 or 12.

Energy Balance (HP 10 619-621, HP 11 583-586, HP 12 569-571, seminars). - Biological work. - Total energy expenditure.- Metabolic rate. Basal metabolic rate. Basal conditions. Average values of BMR. - Direct calorimetry. - Indirect calorimetry. - Factors affecting the metabolic rate. - Total-body energy balance.

Nutrition (HP 10 640-645, HP 11 567-583, HP 12 555-567, seminars). - Energy requirements. - Protein requirements. - Fat requirements. - Carbohydrate requirements. - Mineral salts. - Vitamins. - Regulation of food intake. - Starvation. - Obesity.

Regulation of Body Temperature (HP 10 626-633, HP 11 590-598, HP 12 574-585, seminars). - Poikilotherms and homeotherms. - Body temperature - core temperature, shell temperature. - Heat loss - radiation, conduction, convection, evaporation. - Sweat glands - distribution, innervation, role of bradykinin. Temperature - regulating reflexes - central and peripheral thermoreceptors, thermoregulation centre. - Control of heat production - shivering and nonshivering thermogenesis. Control of heat loss - role of the skin. - Acclimatization to heat. Acclimatization to cold. - Fever. Hypothermia.

SPECIAL SENSES

HP 10, 11 or 12.

Sensory Physiology (HP10 211-223, HP11 192-202, HP12 187-197) – Sensory receptors. – Receptor potential. – Primary sensory coding. Stimulus type. Stimulus intensity. Stimulus location. Lateral inhibition. Central control of afferent information. – Ascending neural pathways. – Association cortex and perceptual processing. Factors affecting perception.

Somatic Sensation (HP10 224-229, 11 203-207, HP12 197-202). – Touch and pressure. – Sense of posture and movement. – Temperature. – Pain. – Neural pathways.

Vision (HP 10 229 - 238, HP 11 208-217, HP 12 202-212). – Light. Visible spectrum. - The principal structures of the eye. – The optics of vision. - Accommodation of the lens. Emmetropic eye. The changes in lens curvature during accommodation. Role of ciliary muscle. Near point. – Pupillary reflexes. Near response. Pupillary light reflex. Consensual light reflex. – Retinal image.– Defects in vision. Nearsightedness. Farsightedness. Astigmatism. Presbyopia. Use of corrective lenses. - Handling of the aqueous humor in the eye. Glaucoma - Organization of the retina. Types of neurons. – Receptors, rods and cones. – Types of photopigments. – The change in retinal in response to light. – Visual pathways. Visual field. - Color vision. The sensitivities of the photopigments. - Color blindness. – Eye movements.

Hearing (HP 10 238 - 244, HP 11 217 – 222, HP 12 212-217). – Sound. Sound waves. Sound frequency. – The sound transmission in the ear. - External and middle ear. - Function of the tympanic membrane and ossicles. – Inner ear. Cochlea. Scala

vestibuli and scala tympani. Cochlear duct. – Organ of Corti. Hair cells. – Electrical responses of hair cells. Genesis of action potentials in afferent nerve fibers. – Neural pathways in hearing. – Bone versus air conduction. – Tests with tuning fork.

Vestibular function (HP 10 244 - 247, HP 11 222 – 225, HP 12 218-220). – Semicircular canals. Organization of a cupula and ampulla. – Mechanisms leading to action potential firing in afferent neurons. - Utricle and saccule. Otolithic organ. Mechanism of its stimulation. – Neural pathways of vestibular apparatus. – Responses to rotational acceleration. Nystagmus. Responses to linear acceleration. – Orientation in space. – Vertigo. – Motion sickness. – Ménière's disease.

Smell (HP 10 248 - 249, HP 11 226 – 227, HP 12 220-221). – Olfactory epithelium. Its location and morphology. – Odorant receptors, mechanism of their stimulation. - Discrimination of different odors. – Olfactory neural pathways. Cortical projections. – Factors that influence olfactory discrimination.

Taste (HP 10 247 - 248, HP 11 224 – 226, HP 12 221-222). – Taste buds. Their location, structure and innervation. – Basic taste modalities. – Receptor stimulation. - Taste pathways.

CENTRAL NERVOUS SYSTEM

Lectures

Main Features of Structure and Function of the Central Nervous System. – Components of the central nervous system. – Components of the peripheral nervous system. – Input and output of the central and peripheral nervous system. – Subdivisions of the central nervous system. – The cerebrospinal fluid system. - The meninges and subarachnoid space of the brain and spinal cord. – The cerebral ventricles and the cerebrospinal fluid. – Production of the cerebrospinal fluid. – Composition of the cerebrospinal fluid. – Circulation and drainage of the cerebrospinal fluid. – The main functions of the cerebrospinal fluid.

The Movement and its Central Control. – Neural centers responsible for movement and their organization. – Lower motor neuron circuits and motor control. - Organization and function of the spinal cord motor neurons. Ventromedial and dorsolateral motor neuron pools. - Function of interneurons and propriospinal neurons. - The final common pathway. - The proximal - distal rule and an extensor – flexor rule. – The spinal nerves. – The cranial nerves. - Injury to peripheral motor neurons. The lower motor neuron syndrome. Peripheral paralysis and paresis. – Regeneration of the axons.

The Motor System of the Brain Stem and Cerebral Cortex. - The medial brain stem pathways, the origin, course, terminations, and function. - The lateral brain stem pathway, the origin, course, terminations, and function. – Motor areas in the cerebral cortex. Topographic maps of the body musculature in motor cortices. - Corticospinal and corticobulbar tracts, origin, course, terminations, and function. – Control of muscles of the head and face. – Cortical and subcortical inputs to the motor cortices. – Damage to central motor pathways. Upper motor neuron syndrome.

Motor Functions of the Spinal Cord. - The myotatic (stretch) reflex. - Muscle spindle, morphology. - Muscle spindle afferents. Primary and secondary endings. -

Basic reflex circuitry. – Reciprocal innervation. – Dynamic and static gamma motor neurons. Functional role of the gamma system, alpha-gamma coactivation. – The function of stretch reflexes. - The inverse myotatic reflex. – Golgi tendon organ, morphology. Afferent fibers and mechanisms of their activation. - Spinal connections, reflex response. – Functional importance of Ib afferents signaling. – Exteroceptive (flexor) reflex. Receptors, afferents, spinal connections, reflex response. Crossed extensor reflex. – Integration of the final common pathways. Recurrent inhibition. – Complete transection of the spinal cord. Spinal animal. – Partial transection of the spinal cord.

Locomotion. – Definition. – Neural mechanisms controlling walking. – Location of the central pattern generator. – Function of the central pattern generator. - Sensory inputs regulating stepping. – Supraspinal regulation of stepping. – Role of the cerebellum in locomotion.

Voluntary Movements. – Neural events leading to purposeful movements. - Regions of neocortex involved in performance of voluntary movements. – Somatotopic organization of motor cortices. - Cortical and subcortical projections. – Role of the posterior parietal cortex (PPC), functional connections. Damage to the PPC. – Role of the supplementary motor cortex (SMC), functional connections. Damage to the SMC. - Role of the premotor cortex (PC), functional connections. Damage to the PC. - Organization and function of the primary motor cortex. - Role of corticospinal neurons in the muscle control. - Symptoms caused by interruption of central motor pathways.

Functions of the Cerebellum. - The modulation of movement by the cerebellum. – Structure of the cerebellum. – Neurons and circuits within the cerebellum. -Projections to the cerebellum. - Projections from the cerebellum. - Functional organization of the cerebellum. – Vestibulocerebellum, input, output, and function. – Spinocerebellum, input, output, and function. Topographic organization. – Cerebrocerebellum, input, output, and function. - Consequences of cerebellar lesions.

Functions of the Basal Ganglia. - The modulation of movement by the basal ganglia. – The principle nuclei of the basal ganglia. - Projections to the basal ganglia. – Projections from the basal ganglia. – Circuits within the basal ganglia system. Neurotransmitters and types of synapses in different parts of the basal ganglia. – Mechanism of the basal ganglia function. – Manifestations of the basal ganglia disorders. Hypokinetic and hyperkinetic disorders.

Functions of the Hypothalamus. – Localization of the hypothalamus. – Role of the hypothalamus in basic homeostatic requirements. – Mechanisms used to regulate basic life processes. – The structure of the hypothalamus. Functional specialization of the hypothalamic nuclei. – Hypothalamic connections. Functions of hypothalamus. Relation to autonomic function. Relation to endocrine system. Relation to behavior concerned with the basic homeostatic requirements. Relation to food intake regulation.

Higher Cognitive Functions. - Higher order sensory and motor cortices. Localization and functional role. Agnosias. - Three association cortices. - Intracortical association pathways. - Prefrontal association area. The delayed spatial response. - The association areas of the limbic (orbitofrontal) cortex, affective and emotional behavior. A generalized arousal reaction. - The parietal-temporal-occipital areas of the dominant and nondominant hemispheres and higher sensory functions. Gerstmann's and neglect syndrome, constructional apraxia. - Asymmetry of the hemispheres, differences in hemispheric capabilities.

Emotions, Motivation and Affective Behavior. – Definition of emotions. – Physiological changes associated with emotions. – The limbic system. – Functional importance of the amygdala. The relationship between the amygdala and neocortex. – Cortical lateralization of emotional functions. - Motivation. Anatomic substrate of the reward and punishment. – Addiction. – Brain chemistry and behavior.

Natural Language, Disorders of Language and Other Localizable Disorders of Cognitive Function. - Primary language areas of the brain. Model for language. - Wernicke's aphasia. - Broca's aphasia. - Conduction aphasia. – Anomic aphasia. - Global aphasia. – Recognition of faces. Prosopagnosia.

Alert Behavior, Sleep, and the Electrical Activity of the Brain. – The reticular formation and the reticular activating system. – The thalamus and its division. – The dorsal thalamic nuclei. Inputs and outputs of the nonspecific projection nuclei, the specific sensory relay nuclei, the nuclei concerned with efferent control mechanisms, and the nuclei concerned with complex integrative functions. – The neocortical organization. – Evoked cortical potentials. – The electroencephalogram (EEG), source, recording. – Variations in the EEG during wakefulness. – Alpha rhythm, alpha block. – Beta, theta, and delta rhythm. – Sleep patterns. Slow-wave sleep without rapid eye movements (non-REM sleep). Sleep with rapid eye movements (REM sleep). – Distribution of sleep stages in a typical night. – Normal sleep cycles at various ages. – Mechanisms producing EEG arousal – Genesis of slow-wave sleep. – Genesis of REM sleep. – Sleep disorders. – Clinical uses of the EEG.

Learning. - Two major classes of learning. - Habituation. - Sensitization. - Classical conditioning. - Conditioned and unconditioned stimulus. - Conditioned and unconditioned response. - Appetitive and defensive conditioning. - Extinction. - Reinforcement. - Operant conditioning in comparison with classical conditioning. - Food aversion conditioning. - Conditioning as a therapeutic technique.

Memory. – Definition of memory. – Two main categories of memory. – Working memory. – The neural basis of memory. Important brain areas for some forms of memory. – Process of memory encoding. Long-term potentiation, long-term depression. Other models for memory encoding. – Synaptic neuronal plasticity. – Retrograde amnesia.

PHYSIOLOGY OF THE KIDNEY

Physiological Anatomy of the Kidney. Overview of renal functions. - Structure of the kidney. Cortex. Medulla. – Nephron-functional unit of the kidney. Cortical and juxtamedullary nephrons. – Anatomy of the nephron. Glomerulus. Tubule. – Bowman's capsule. Proximal tubule. Loop of Henle. Distal tubule. Collecting duct. – Kidney blood vessels. Afferent and efferent arterioles. Peritubular capillary network. Vasa recta. Juxtaglomerular apparatus. - Principles of urine formation.

Glomerular Filtration. Glomerular filtration membrane. - Net filtration pressure. – Glomerular filtrate. Composition. Glomerular filtration rate. – Clearance. Definition. Calculation. Inulin clearance. Creatinine clearance. PAH clearance. – Renal plasma flow. Filtration fraction. – Physiological control of glomerular filtration and renal blood flow. Nervous regulation. Humoral regulation. Autoregulation. Tubuloglomerular feedback. Myogenic autoregulation.

Tubular Reabsorption. Mechanisms of transport. – Transport maximum, threshold substances. Reabsorption of glucose. Renal threshold. – Active transport. Primary active transport. Transport of sodium. Secondary active transport.

Pinocytosis. - Passive transport. Osmosis. Transport of chloride, urea and creatinine. – Transport in proximal tubule. Transport in loop of Henle. Transport in distal tubule and collecting duct. - Tubular secretion. – Regulation of tubular reabsorption. Glomerulotubular balance. Peritubular capillary and renal interstitial fluid physical forces. Pressure natriuresis and pressure diuresis. Hormonal control of reabsorption. Sympathetic nervous system activation.

Excretion of Water. Reabsorption of water in tubular segments. – Excreting excess water by forming a dilute urine. – Conserving water by excreting a concentrated urine. Obligatory urine volume. Osmotic stratification of renal medulla. Countercurrent multiplier system (loop of Henle). Role of distal tubule and collecting duct. Contribution of urea. Recirculation of urea. Countercurrent exchange system (vasa recta). - Mechanism of water reabsorption. Role of antidiuretic hormone (ADH). Diabetes insipidus. – Water diuresis. Osmotic diuresis.

Excretion of Sodium, Chloride, Potassium and Other Ions. Reabsorption of sodium in tubular segments. Mechanisms of sodium reabsorption. Reabsorption of sodium in late distal tubule and in collecting duct. Role of aldosterone. – Excretion of potassium. Reabsorption of potassium. Secretion of potassium. Principal cells. Intercalated cells. Regulation of potassium secretion. – Excretion of chloride. – Excretion of calcium. Regulation of calcium reabsorption. – Excretion of phosphate. - Excretion of magnesium.

Regulation of Renal Functions. Autoregulation mechanisms. Tubuloglomerular feedback. Glomerulotubular balance. – Regulation of sodium excretion. Sodium balance. Regulation of glomerular filtration. Role of baroreceptors. Regulation of tubular reabsorption. Aldosterone. Renin. Angiotensin II. Atrial natriuretic factor. – Regulation of potassium excretion. Aldosterone. – Regulation of water excretion. ADH. Regulation of ADH secretion. Osmoreceptors. - Thirst. Stimuli for thirst. Thirst center.

Acid-Base Balance and Kidney. Plasmatic pH. Acidosis, alkalosis. Sources of hydrogen ions. - Acid-base buffer systems. Bicarbonate buffer system. – The role of kidney in the acid-base regulation. Secretion of hydrogen ions. Filtration and reabsorption of bicarbonate ions. Generation of new bicarbonate ions. – Renal response to acidosis. Tubular buffers. The role of ammonium ion and ammonia. Renal response to alkalosis. – Respiratory acidosis and alkalosis. Metabolic acidosis and alkalosis.

Micturition. Ureter Ureterorenal reflex. – Bladder. Detrusor muscle. Innervation of the bladder. Internal sphincter. External sphincter. – Micturition reflex. - Supraspinal control of micturition.

ENDOCRINOLOGY

Principles of Endocrinology. – Neuroendocrine interactions. – Endocrine glands and endocrine tissues. - Processes that hormones regulate. – Definition of hormones. – Chemical classification of hormones and their synthesis. – Mechanism of hormone secretion. - Regulation of hormone secretion. Negative feedback loop. Positive feedback loop. Cyclic variations of hormones secretion. – Transport of hormones in the circulation and their half-lives. – Hormone receptors and signal transduction processes. - G protein-linked hormone receptors. The functional activity of G protein. The cyclic AMP second messenger system. The phosphatidylinositol

second messenger system. Enzyme-linked hormone receptors. - Intracellular hormone receptors and activation of genes. – Hormone receptor regulation.

Hypothalamus and Anterior Pituitary. - The hypothalamopituitary axis. Embryology of the pituitary gland. – Blood supply of the hypothalamopituitary axis. - Endocrine cells of the anterior pituitary. - Anterior pituitary hormones. Trophic hormones, hormones with direct effects on non-endocrine target tissues. - Releasing and inhibitory hormones of the hypothalamus. - Regulation of growth and body mass. - Growth hormone (GH), structure, secretory patterns and control. Actions of GHRH, somatostatin, ghrelin and IGF-1. – Acute effects of GH. - Plasma levels of GH as a function of age. – Long-term effects of GH through IGF-1 on the growth of somatic tissues, mechanisms. – Other hormones promoting growth. – Abnormalities of GH secretion. – Prolactin (PRL). – Synthesis and chemistry. – Plasma levels of PRL throughout the life and control of its secretion. – Mamotrophic and lactogenic effects of PRL. – Suckling and its effect on PRL secretion. - Abnormalities in PRL secretion.

Hypothalamus and Posterior Pituitary. - Hormones of the posterior pituitary. – Chemistry, synthesis, transport, storage and secretion of antidiuretic hormone (ADH) and oxytocin. - Signals generating stimuli for ADH (AVP) secretion. - The major actions of ADH. Target cells, intracellular mechanism. - Other functions of ADH. – Integrated action of AVP with other hormones regulating blood volume and pressure. - Syndrome of inappropriate hypersecretion of ADH. - Diabetes insipidus. – Oxytocin. Target cells, intracellular mechanism. - Signals generating stimuli for oxytocin secretion. – Effect of oxytocin in the pregnant uterus. – Oxytocin and milk ejection. Suckling reflex.

Thyroid Gland. - Functional anatomy of the thyroid gland. – Synthesis, storage and secretion of the thyroid hormones (TH). Role of thyroglobulin. - Transport of TH by the blood. – Peripheral metabolism of TH. – TH receptors and action of TH on target cells. – Role of TH in normal body growth and development of CNS. - Effect on basal metabolic rate. - Effect on the cardiovascular system. - Effect on respiration - Effect on the GIT. – Effect on the nervous system. - Effect on other endocrine glands. - Effects on carbohydrate, lipid and protein metabolism. - Regulation of TH secretion and synthesis. The hypothalamopituitary - thyroid axis. TRH, TSH, and TH relationships. - TSH receptor, structure, and cellular mechanism. Effects of TSH on follicular cells. – TRH receptor, cellular effects and function. - Abnormalities in TH synthesis and secretion. Hypothyroidism. Dietary iodide and the synthesis of TH. Hyperthyroidism.

Adrenal Cortex – Glucocorticoids. - Functional anatomy of the adrenal gland. - Hormones of the adrenal cortex. - Starting material and pathway for the synthesis of adrenal steroids, metabolism, and excretion. - Transport of glucocorticoids in blood. – Metabolic actions of cortisol, principal target tissues. Other effects of cortisol: skin, bone, cardiovascular system, immune system, CNS, kidney, fetus. - Mechanism of cortisol action at cellular level. – Regulation of glucocorticoids secretion. Role of CRH and ACTH. Action of CRH on the corticotrops. Effect of ACTH on the adrenocortical cells.. - Rhythm of ACTH and cortisol secretion. – Synthesis and secretion of ACTH, proopiomelanocortin processing and effects of its products. - Gonadocorticoids. – Abnormalities of adrenocortical secretion. Addison disease, Cushing syndrome, and adrenogenital syndrome.

Adrenal Cortex – Mineralocorticoids. – Adrenal steroids with mineralocorticoid activity. - Synthesis of aldosterone. - Transport of aldosterone in the blood. - Target cells and cellular mechanism of aldosterone action. - Effect of aldosterone in tubular epithelium of the kidney, on extracellular fluid volume, and blood pressure. -

Regulation of aldosterone secretion. Renin-angiotensin system, plasma potassium and sodium levels, ACTH. - Abnormalities of mineralocorticoid secretion. Addison disease and Conn syndrome. Adrenogenital syndrome.

Adrenal Medulla. - Catecholamines, synthesis and storage. Control of catecholamine synthesis. - Mechanism of the secretion and degradation of catecholamines. - The origin of norepinephrine and epinephrine in the plasma. - Types of adrenergic receptors, target cells, and cellular mechanisms. - The CNS-epinephrine-axis. The sympathoadrenal system. - The fight or flight response. - Metabolic effects of catecholamines in the liver, skeletal muscle, and adipose tissue. Abnormalities in the secretion of catecholamines. Pheochromocytoma.

Endocrine Pancreas. - Islets of Langerhans, beta, alpha, delta, and PP cells. Synthesis and secretion of hormones. - Insulin chemistry and synthesis. - Neural and humoral factors of insulin secretion. - Insulin receptor and mechanism of cellular action. - Effects of insulin on carbohydrate, lipid, and protein metabolism in the liver, muscle, and adipose tissue. - Glucagon, synthesis and secretion. - Glucagon and insulin secretion. - Signal transduction of glucagon. - Effect of glucagon on glucose and fat metabolism in the liver. - Extrahepatic function of glucagon. - Control of glucagon secretion. - Secretion of somatostatin. - Effects of somatostatin, amylin, and pancreatic polypeptide. - Importance of blood glucose level regulation. - Abnormalities in the secretion of insulin. Insulin-dependent and non-insulin-dependent diabetes.

Hormonal Control of Calcium and Phosphate Metabolism, Physiology of Bone. Role of calcium and phosphate in the body. - Distribution of calcium and phosphate in the body and their principal forms in the blood. - Calcium and phosphate handling by the GIT, kidneys, and bone. - Bone physiology. Basic structure of bone. Cells of bone and their functions. Bone formation and resorption. - Regulation of plasma calcium concentration. Parathyroid hormone production, cellular effect, and the primary actions of the hormone. - Regulation of calcitonin production and primary actions of the hormone. - The pathways involved in the production of hormonally active metabolites of vitamin D and their action. - Abnormalities of bone metabolism. Osteoporosis. rickets, osteomalacia.

Male Reproduction. - Male reproductive system. - Puberty in the male. Secondary sex characteristics. - Determination of genetic sex. Spermatogenesis. Spermogenesis. - Hormonal control of sexual maturation. Role of the hypothalamus and anterior pituitary in puberty. - Endocrine regulation of male reproductive system. - Male sexual response and its regulation.

Female Reproduction. - Female reproductive system. - Puberty in the female. Secondary sex characteristics. - Oogenesis. - The ovarian cycle. Follicle maturation. Ovulation. Formation of corpus luteum. Hormonal control of ovarian function. The plasma levels of FSH, LH, estrogen, and progesterone during a typical ovarian cycle. - Uterine changes in the menstrual cycle, main phases and their regulation. - Female sexual responses.

Pregnancy and Lactation. - Transport of the secondary oocyte. - Transport of sperm. Capacitation. Fertilization. Block of polyspermy. - Sex determination. - Development and implantation of the blastocyst. Maintenance of the endometrium. - Development of the placenta as an endocrine gland. - Parturition. Three stages of labor. The initiation of parturition. Factors associated with parturition. - Lactation. Preparation of the breasts for lactation. Role of prolactin. - Milk and colostrum. - Production of milk. - Milk ejection reflex.

PRACTICAL EXERCISE

Hematology

1. Hematocrit determination
2. Determination of MCH, MCHC and MCV
3. Fragility of red blood cells in hypotonic saline
4. Blood typing
5. Cross-matching of blood
6. Sedimentation rate
7. Quick's protrombin time

General physiology, central and peripheral nervous systems

8. Determination of plasma volume
9. Somatic reflexes
10. Cerebellar functions
11. Visceral reflexes
12. Examination of the pupils
13. Electroencephalogram
14. Assessment of the visual memory
15. Short-term memory testing

Sense organs

16. Visual acuity
17. Accommodation in the human eye
18. Astigmatism
19. Optokinetic nystagmus
20. Blind spot experiment (Mariot's experiment)
21. Visual fields of the eye
22. Hearing tests

Circulation and respiration

23. Blood pressure
24. Model of elastic and inelastic artery
25. ECG
26. Demonstration of negative intrapleural pressure in rat
27. Spirometry - static values
28. Spirometry - dynamic values

Metabolism, endocrinology, kidney and GIT

29. Biological pregnancy tests
30. Action of bile salts on fats in vitro
31. Digestion of protein by pepsin
32. Basal metabolic rate
33. Creatinine clearance. Glomerular filtration. Tubular reabsorption
34. Evaluation of tubular functions
35. Glucose tolerance tests
36. Evaluation of the gastric secretion after the stimulation