CURRICULUM OF PHYSIOLOGY

DENTAL MEDICINE

ACADEMIC YEAR 2014/2015

Textbooks:

HP = Human Physiology (A.J. Vander, J.H. Sherman, D.S. Luciano), tenth (10), eleventh (11) or twelfth (12) edition.
MOODLE http://lms.lfp.cuni.cz/course/view.php?id=118

BLOOD AND THE IMMUNE SYSTEM

General Characteristics and Main Functions of the Blood. (MOODLE). Blood volume. - The packed cell volume. - Blood and plasma viscosities. - The erythrocyte sedimentation rate (ESR). - Blood functions, blood buffers.

The Plasma. (MOODLE;). Plasma composition. - Inorganic constituents of the plasma, their functions. - Organic constituents of the plasma. Plasma proteins, their functions.

Erythrocytes. (MOODLE). RBC count, size and shape. - The RBC membrane. - Hemolysis. - Hemoglobin concentration, composition, forms, oxygenation. - MCH, MCHC a MCV. - Anaemia, definition, types.

Erythropoiesis. (MOODLE). 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 B_{12} and folic acid. - Erythropoietin.

Destruction of RBC. (MOODLE) RBCs life span. - Role of tissue macrophages. - Metabolism of the iron. - Bilirubin metabolism, concentration in plasma. Entero-hepatic circulation. - Types of icterus, characteristic features.

White Blood Cells (handouts). Classification. - Total white blood cell (WBC) count. - Differential WBC count. - Neutrophils. - Eosinophils. - Basophils. - Monocytes. - B and T lymphocytes.

Hemostasis. (MOODLE). 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.

Blood Groups. (MOODLE). Agglutinogens and agglutinins. - ABO system. - Rhesus system. Hemolytic disease of the newborn. - Blood typing. - Cross-matching of the blood. Blood transfusion.

Immunity. (handouts). 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. - Extracellular and intracellular homeostasis. – Control mechanisms of homeostasis. - Feedback control. - Elements of negative feedback loop. Examples. - Positive feedback. Examples.

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. – Functions of the cell membrane. – Composition of the extracellular and intracellular fluid. – Membrane transport mechanisms. Simple diffusion. Facilitated diffusion. – Rate of diffusion. – Movement of water across the cell membrane. - Osmotic pressure. – Osmolarity and osmolality. - Osmolality and tonicity. - Primary active transport. - Secondary active transport. - Movement of macromolecules across the cell membrane.

Electrogenesis on Cell Membrane. - Composition of the cytoplasm and the extracellular fluid. - An unequal distribution of charges across the membrane. Diffusible and fixed ions. - Role of Na^+/K^+ pumps. - Permeability of the cell membrane. - Electrical properties of cells. - Equilibrium potential for a particular ion. - Nernst equation. - Resting membrane potential and its determinants. - Driving force for an ion movement. - Restoration of the membrane potential following depolarization or hyperpolarization. - Categories of electrical events in membrane. - Excitable and non-excitable tissue.

Graded potentials and action potentials (HP 10 164–175, HP 11 149–159, HP 12 147-156). Characteristics of the action potential. – Depolarization. – Hyperpolarization. – Repolarization. – Overshoot. – Decremental current. – Excitable membrane. – Ionic basis of the action potential. – Mechanism of ion-channel changes. Threshold. Threshold, sub-threshold and suprathreshold stimuli. – All-or none behavior. – Absolute and relative refractory period. Refractory period and firing frequency. – Propagation of the action potential. Nonmyelinated and myelinated nerves. – Initiation of the action potential.

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. – Types of receptors and mechanisms of information transfer. – EPSP and IPSP.

Synapses (HP 10 176–191, HP 11 159–173, HP 12 156-169). – Divergence and convergence. – Excitatory and inhibitory synapses. – Synaptic cleft. – Activation of the postsynaptic cells. Temporal and spatial summations. – Presynaptic inhibition and facilitation. – Effect of drugs on synapses. – Neurotransmitters.

Neurochemical Transmission (HP 10 183–191, HP 11 166-173, HP 12 163-169). – Classes of neurotransmitters. – Cholinergic transmission. Mediator synthesis, release, degradation, and modes of removal. Types, location and function of cholinergic receptors. – Adrenergic transmission. Mediators synthesis, release, modes of removal, and degradation. Types, location, and functions of

adrenoreceptors. – Excitatory and inhibitory amino acids. – Neuropeptides. – Gases as neurotransmitters.

Neural tissue (HP 10 151-158, HP 11 137–143, HP 12 135-142). – Neurons. Cell body. Dendrites. Initial segment. Myelin. Schwann cell. Axon transport. – Afferent and efferent neurons. Interneurons. – Neural growth and regeneration.

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.

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.

Autonomic nervous system (HP 10 196–204, HP 11 177–185, HP 12 175-180).

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 (HP10 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 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 (HP10 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.

PHYSIOLOGY OF RESPIRATION

Physiological anatomy of respiratory system. External and internal respiration. Overview of functions of respiratory system. – Alveoli. – Airways. Conducting zone. Respiratory zone. Respiratory unit. Structure and innervation of airways. – Relation of lungs, pleura and chest wall.

Pulmonary ventilation and lung mechanics**.** Pulmonary ventilation. Mechanism of air flow between lungs and atmosphere. – Intrapleural pressure. – Respiratory cycle. Inspiration. Inspiratory muscles. Expiration. Expiratory muscles. – Alveolar and intrapleural pressures during respiratory cycle. – Compliance of lungs and of chest. Alveolar surface tension. Surfactant. – Airway resistance. Respiratory work.

Lung volumes and capacities**.** Spirometry. Lung volumes. Lung capacities. – Dynamic ventilatory parameters derived from forced expiration of vital capacity. Minute ventilation and maximal voluntary ventilation. Breathing reserve. – Anatomic and physiologic dead space. Alveolar ventilation. Influence of respiration frequency and of tidal volume on alveolar ventilation.

Pulmonary circulation. Functional circulation. Nutritional circulation. Flow, pressure and volume in pulmonary circulation. Capillary pressure and its functional importance. – Influence of gravity on pulmonary perfusion and ventilation. Ventilation-perfusion ratio. Ventilation-perfusion ratio and shunt. Ventilation-perfusion ratio and dead space. – Regulation of pulmonary blood flow. Extrinsic and local regulation.

Exchange of gases in alveoli and tissues**.** Partial pressure. Composition of alveolar air. Partial pressures of O_2 and CO_2 in the body. – Respiratory membrane. Diffusion of respiratory gases through respiratory membrane. Diffusing capacity of respiratory membrane. – Gas exchange in the tissues.

Transport of gases in the blood**.** Transport of O_2 in the blood. Hemoglobin as O_2 transporter. Oxygen-hemoglobin dissociation curve. Saturation of hemoglobin with O_2 in arterial and venous blood. – Factors influencing the oxygen-hemoglobin dissociation curve. Influence of pH. Influence of temperature. Importance of 2,3-bisphosphoglycerate. – Transport of CO_2 in the blood. Mechanisms of the transport of CO_2 in the arterial and venous blood. Haldane effect and its importance.

Regulation of respiration**.** Mechanisms of the regulation of respiration. – Nervous regulation. Automaticity of respiration. Voluntary control of respiration. – Respiratory center. Dorsal group. Ventral group. Pneumotaxic center and its importance. Importance of vagus afferentation. Efferent output of respiratory center. – Nonchemical control of respiration. Receptors in airways and lungs. Slowly adapting receptors. Functional importance. Rapidly adapting receptors. Coughing.

Chemical regulation of respiration**.** Central chemoreceptors. Action of CO_2 and H^+ on central chemoreceptors. – Peripheral chemoreceptors. Carotid bodies. Aortic bodies. Innervation. Blood supply of peripheral chemoreceptors. Structure of peripheral chemoreceptors. Influence of hypoxia on peripheral chemoreceptors. – Ventilatory response to CO_2. Ventilatory response to changes in acid-base balance. Ventilatory response to O_2 deficiency.

Adaptation of respiration**.** Exercise. Mechanisms of increased entry of O_2 from alveolar air into blood. Oxygen debt and its removal. Mechanisms of increased

extraction of O_2 in tissues. Causes of increased ventilation. – Influence of high barometric pressure on respiration.

Hypoxia and hypercapnia**.** Hypoxia. Classification and manifestations. Cyanosis. – Hypoxic hypoxia in high altitude. Mountain sickness. Acclimatization. Hypoxic hypoxia at respiratory diseases. – Anemic hypoxia. Poisoning with CO. – Stagnant hypoxia. Histotoxic hypoxia. – Hypercapnia. Hypocapnia.

CARDIOVASCULAR PHYSIOLOGY

General Properties of the Cardiovascular System (lectures). – Systemic and pulmonary circulations. – The heart – anatomy, electrical pacemaker and conducting system, cardiac muscle, valves of the heart, coronary circulation, autonomic innervation of the heart.

Electrical Activity of the Heart (lectures). – Electrophysiology of the cardiac cells. – The intrinsic pacemaker activity. – Sequence of electrical excitation of the heart. – The action potentials of the cardiac cells – two major types. Ionic basis, phases, refractoriness. – The effects of norepinephrine and acetylcholine on the pacemaker activity, conduction velocity and contractility.

Cardiac Muscle (lectures). – Structure of the cardiac muscle. – Structure of the cardiac sarcomere. Contractile proteins. Actin, myosin. Regulatory proteins. Troponin, tropomyosin. – Sarcoplasmic reticulum. – Molecular mechanism of contraction. – Excitation-contraction coupling. – Regulation of contractility. – Major differences between the cardiac and skeletal muscles.

Electrocardiogram (lectures). – Origin of ECG. – Overview of ECG registration techniques – standard limb leads, augmented leads, chest leads. – ECG waves, intervals and segments. – Relationship of ECG curve to the sequence of electrical excitation of the heart. – Basic interpretation of the electrocardiogram: action, heart rate, rhythm, electrical axis, description of individual phases and intervals.

Cardiac Cycle (lectures). – Events in the cardiac cycle. Systole and diastole. – Individual phases of the cardiac systole and diastole: timing, duration, pressure and volume changes in the heart compartments, role of the valves, importance of atrial contraction. – Systemic and pulmonary circulation pressures during the cardiac cycle. – Heart sounds.

Cardiac Output (lectures). – Definitions of the cardiac volumes. End-systolic volume. Stroke volume. End-diastolic volume. – Definition of the cardiac output, normal values under resting conditions and during physical exercise. – Ejection work of the ventricle. Pressure-volume loops. – Ejection fraction.

Regulation of the Cardiac Output (lectures). – Regulation of the heart rate. Positive and negative chronotropic effects. – Regulation of the stroke volume. Preload (Frank-Starling relationship). Afterload. Heart rate. Sympathetic stimulation. Cardiac glycosides.

The Vascular System: General Features (lectures). – General terms and definitions. Flow. Pressure. Resistance. Compliance. Velocity. Viscosity. – Laminar and turbulent flow. – 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 (lectures). – 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. – Measurement of arterial pressure. Korotkoff sounds. – Pressures in the right and left circulations.

The Vascular System: Arterioles (lectures). – Structure, innervation, vasomotion and major functions of arterioles. – Regulation of arteriolar blood flow. – Intrinsic control. Myogenic contraction. – Local control. Active hyperemia. Flow autoregulation. Reactive hyperemia. Response to injury. – Extrinsic control. Sympathetic nerves. Hormones. – Substances secreted by endothelial cells.

The Vascular System: Microcirculation (lectures). – Design of microcirculation. – Three major types of capillaries. – Mechanisms of capillary exchange. – 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.

The Vascular System: Veins (lectures). – 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 (lectures). – Anatomy of the lymphatic system. Lymphatic capillaries. Lymphatic vessels and valves. Lymph nodes. – Formation of the lymph. – The lymph flow and functions. – Composition of the lymph.

Regulation of the Cardiovascular System (lectures). – General design. Local control (myogenic and metabolic regulation). Central (extrinsic) control (nervous and hormonal regulation of the heart and circulation). – Regulation of the cardiac output (control of the heart rate, stroke volume). – Regulation of the tissue blood flow (myogenic and metabolic control, endothelium, sympathetic nerves). – Regulation of the arterial pressure. Nervous (short-term), hormonal and long-term regulation of the arterial pressure. Baroreceptors in the carotid sinus and aortic arch. Peripheral and central chemoreceptors. The renin-angiotensin-aldosterone system. Catecholamines. Antidiuretic hormone. The role of kidneys in the regulation of blood pressure.

PHYSIOLOGY OF THE KIDNEY

Physiologic 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. Peritubullar capillary network. Vasa recta. Juxtaglomerular apparatus.

Glomerular Filtration. Glomerular membrane. - Glomerular filtrate. Composition. – Net filtration pressure. – Glomerular filtration rate. – Clearance. Definition. Calculation. Inulin clearance. Creatinine clearance. PAH clearance. – Renal plasma flow. Filtration fraction.

Tubular Reabsorption. Mechanisms of transport. Active transport. Passive transport. Secondary active transport. – Threshol substances. Transport maximum. Renal threshold. Reabsorption of glucose. —- Tubular secretion.

Excretion of Water. Osmolality and quantity of urine. – Mechanism of water reabsorption – Reabsorption of water in different segments of tubule. –Osmotic stratification of medulla. Countercurrent multiplier system. Countercurrent exchange system. Role of urea. –

Regulation of water excretion. Regulation of glomerular filtration. Role of antidiuretic hormone (ADH). Regulation of ADH production. Diabetes insipidus. – Water diuresis. Osmotic diuresis. – Thirst.

Excretion of Sodium, Chloride and Potassium. Reabsorption of sodium in different tubule segments. – Mechanisms of sodium reabsorption. – Reabsorption of sodium in late distal tubule and in collecting duct. Role of aldosterone. – Reabsorption of potassium. Secretion of potassium. – Reabsorption of chloride. – Reabsorption of calcium.

Regulation of Renal Functions. Glomerulotubular balance. Tubuloglomerular feedback. Juxtaglomerular apparatus and its function. – Autoregulation of renal blood flow. – 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 calcium excretion.

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

Acid-Base Balance and Kidney. Plasmatic pH. Acidosis, alkalosis. - Sources of hydrogen ions. Acid-base buffers. Bicarbonate buffer system. – Secretion of hydrogen ions and reabsorption of bicarbonate ions in kidney. – Renal response to acidosis and alkalosis. Secretion of ammonium ion. – Respiratory acidosis and alkalosis. Metabolic acidosis and alkalosis.

SPECIAL SENSES

Lectures, HP 10, 11 or 12.

The Somatic Sensation (lecture). – Aspects of a stimulus. – Types of sensory receptors. - Sensory transduction. - Mechanoreceptors specialized for tactile sensation. Rapidly and slowly adapting receptors. – Punctate localization of skin sensation. Receptive field and two-point discrimination threshold. Regional differences in receptive field size. - Mechanoreceptors specialized for proprioception. – Somatic sensory afferents for low threshold mechanoreceptors. – Segmental innervation: dermatomal map. – Central pathway for tactile information: The dorsal column – medial lemniscus system. - Central pathway for tactile information from the face: The trigeminothalamic system. – The somatic sensory components of the thalamus. – Primary somatic sensory cortex. Somatotopic organization. – Higher-order cortical representations.

Nociception and Thermoception (lecture). – Types of nociceptors and thermoceptors. - Somatic sensory afferents for nociceptive and thermoceptive signals. – Transduction of nociceptive and thermoceptive signals. – The perception of pain. First and second pain. – Hyperalgesia and sensitization. – Referred pain, Head´s zones. - Central pathways for nociception and thermoception: The spinothalamic (anterolateral) tract. Pain and temperature pathway for the face. – The nociceptive components of the thalamus and somatic sensory cortex. - Parallel pain pathways for the sensory discrimination of pain and for the affective and motivational aspects of pain.

Tooth and Pain (lecture). – Structure of the tooth, composition of its components. – Blood supply of the tooth. – Innervation of the tooth and its density. - Tooth pulp pain. - Transmission of stimulus across dentin. Hydrodynamic theory. - Pulpar nociceptors and their sensory afferents. – Central pathways for tooth nociception: The trigeminothalamic system. Parallel pain pathways for the sensory discrimination of pain and for the affective and motivational aspects of pain. information: The dorsal column – medial lemniscus system. - Central pathway for tactile information from the face: The trigeminothalamic system. – The somatic sensory components of the thalamus. – Primary somatic sensory cortex. Somatotopic organization. – Higher-order cortical representations. - Modulation of pain transmission. Periaquaductal gray pain modulation.

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. Emetropic 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 rympani. 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. Otholitic 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

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.

ENDOCRINOLOGY

Vander's Human Physiology 11 or 12

General endocrinology (HP 11 315-328, HP 12 311-324). Functions of the endocrine system. – Hormone. Characteristics. – Overview of endocrine glands and of hormones. – Chemical structure of hormones. Steroid hormones. Derivatives of the amino acid tyrosine. Peptides and proteins. – Synthesis and secretion of hormones: Peptides and proteins. Derivatives of the amino acid tyrosine. Steroid hormones. – Control of hormone secretion. Negative feedback. – Transport of hormones in the blood. – Removal of hormones from the plasma. – Mechanisms of hormonal action. Receptors. Mechanism of action of peptides and catecholamines. Second messenger (cAMP). Mechanism of action of steroid hormones. Mechanism of action of thyroid hormones.

Hypophysis. Neurohypophysis (HP11 330-336, 510-512, 634-6, HP12 325-331, 499-501, 621-623). Morphology. Anterior pituitary, posterior pituitary and pars intermedia. – Hypothalamus-hypophysis system. Hypothalamus-neurohypophysis system. Hypothalamus-adenohypophysis system. Hypophysiotropic hormones. – Hormones of the posterior pituitary gland. Vasopressin (ADH). Receptors and effects. Regulation of vasopressin secretion. Defects in vasopressin secretion. Hypersecretion. Diabetes insipidus. – Oxytocin. Milk ejection. Effects on the uterus.

Adenohypophysis (HP11 330-336, 350, HP12 325-331, 344). Anterior pituitary hormones. – Growth hormone. Mechanism of action. Effects on growth. Insulin-like growth factor I (IGF-I). Metabolic effects: protein metabolism, fat metabolism, glucose metabolism. – Control of growth hormone secretion. GHRH and somatostatin. Diurnal rhythm and stimuli increasing the secretion. – Defects in secretion of growth hormone. Giantism. Dwarfism. Acromegaly.

Thyroid gland (HP11 323-5, 337-341, 584-85, HP12 318-321, 332-336, 569-570). Structure. Hormones. – Synthesis of thyroid hormones. Iodine. Thyroglobulin. Mechanism of synthesis. Secretion of T3 and T4. Conversion of T4 into T3. – Effects of thyroid hormones. Metabolic effects. Effects on growth. – Regulation of secretion. TSH and TRH. Negative feedback. – Hypothyroidism. Iodine-deficient goiter. Cretinism. Hyperthyroidism.

Adrenal medulla (HP11 182, 317-318, HP12 178, 313-314). Morphology of the adrenal gland. Medulla. Cortex. – Hormones of adrenal medulla. Secretion. Effects of epinephrine and norepinephrine. Receptors. Circulatory effects. Metabolic effects. Activation of the sympathetic system during stress.

Adrenal cortex (HP11 318, 321, 342-3, 350, 507-9, 513-14, 576-7, HP12 314, 317-318, 336-339, 344, 497-498, 502-503, 565-566). Hormones of adrenal cortex. Mineralocorticoids. Glucocorticoids. Androgens. Synthesis of the corticoid hormones. Zona glomerulosa, fasciculata and reticularis. Enzymatic differences between cortical layers. - Effects of aldosterone. Renal regulation of potassium and sodium. Control of aldosterone secretion by potassium and agiotensin II. – Effects of cortisol. Metabolic effects. Effects on growth. Functions of cortisol in stress. - Regulation of cortisol secretion. CRH and ACTH. – Effects of androgens. Androgens in women.

Endocrine functions of pancreas. Glucagon (HP11 318, 571-572, 575-80, HP12 314, 560-561, 564-566). Islets of Langerhans. Cell types and hormones produced. – Glucagon. Effects of glucagon. Glycogenolysis. Gluconeogenesis. – Control of glucagon secretion. Influence of plasma glucose. Influence of sympathetic stimulation. Influence of exercise.

Endocrine functions of pancreas. Insulin (HP11 318, 349, 571-574, 578, HP12 314, 343, 560-564, 581-583). Metabolic effects of insulin. Effects in muscle cells. Effects in adipose-tissue cells. Effects in liver cells. – Mechanisms of insulin actions. - Control of insulin secretion. Plasma glucose. Amino acids. Hormones. Autonomic nervous system. – Diabetes mellitus. Types of diabetes. Main mechanisms. Manifestations. Diabetic ketoacidosis. Chronic abnormalities. – Effects of insulin on growth.

Calcium and bone physiology (HP11 352-356, HP12 345-348). Overview of calcium functions in the body. Hypocalcemic tetany. – Bone. Bone functions. - Bone structure. Osteoid. Minerals. Bone cells and their function. Osteoblasts. Osteocytes. Osteoclasts. – Bone growth. Epiphyseal growth plate. Epiphyseal closure. – Calcium handling in kidneys. Calcium handling in gastrointestinal tract.

Hormonal control of calcium homeostasis (HP11 352-6, HP12 345-348). Parathyroid hormone. Parathyroid gland. Control of parathyroid hormone secretion. Effects of parathyroid hormone in bone, in kidneys, in gastrointestinal tract and in plasma. – Vitamin D. Processing of vitamin D in skin, liver and kidneys. 1,25-dihydroxyvitamin D3. Effect of 1,25-dihydroxyvitamin D3 in the intestine. Regulation of secretion. – Calcitonin. Site of secretion. Effects. – Metabolic bone disease. Rickets. Osteomalacia. Osteoporosis.

Male reproduction system (HP11 605-613, HP12 593-602). Anatomy. Testes. Seminiferous tubules. Leydig cells. Epididymis. Vas deferens. Seminal vesicles. Prostate gland. – Semen. Composition. - Spermatogenesis. Stages of sperm development. Sertoli cells. – Spermatozoa. Head. Midpiece. Tail. – Erection. Vascular changes. Reflex center. Afferent pathway. Efferent pathway. – Ejaculation. Two phases of ejaculation. Emission. Efferent neurons.

Hormonal control of male reproductive functions (HP11 605-613, HP12 593-602). Hypothalamic control (GnRH). Pituitary control. FSH. LH. Action on Sertoli cells. Action on Leydig cells. Negative feedback. Inhibin. – Testosterone. Dihydrotestosterone. - Effects of testosterone on spermatogenesis. Negative-feedback effects on hypothalamus and pituitary gland. Effects on reproductive organs. Effects on secondary sex characteristics and growth. Effects on behavior.

Female reproduction system (HP11 615-644, HP12 603-631). Menstrual cycle. Menstruation. Ovarial cycle. Follicular phase. Development of follicle. Structure of a mature follicle. Ovulation. Luteal phase. Corpus luteum. – Oogenesis. Oogonium. Primary oocyte. Secondary oocyte. - Uterine cycle. Menstrual phase. Proliferative phase. Secretory phase. Mechanism of the cyclic changes. Estrogens. Progesteron.

Ovarian hormones (HP11 615-644, HP12 603-631). Sites of secretion of ovarian hormones. Granulosa and theca cells. Corpus luteum. Estrogen. Progesteron. – Time course of secretion of ovarian hormones during menstrual cycle. – Multiple effects of estrogen. Multiple effects of progesteron.

Control of ovarian function (HP11 615-644, HP12 603-631). Hypothalamus. GnRH. Hypophysis. FSH. LH. - Feedback regulation. Negative feedback. Positive feedback. – Mutual relationships of hypothalamus (GnRH), hypophysis (FSH, LH) and ovarian (estrogen, progesteron) hormones in the time course of the menstrual cycle: follicular phase, ovulation (LH surge), luteal phase, degeneration of corpus luteum.

Pregnancy (HP11 615-644, HP12 603-631). Egg transport. Sperm transport. Capacitation. – Fertilization. Acrosome reaction. Block to polyspermy. Zygote. Cleavage. – Blastocyst. Trophoblast. Inner cell mass. Implantation. – Hormones during pregnancy. Corpus luteum. Placenta. Chorionic gonadotropin and somatomammotropin. Estrogen. Progesteron. – Parturition. Mechanisms of parturition. Effects of estrogen. Oxytocin receptors. Prostaglandins. Effects of oxytocin. – Lactation. Breast development before and during pregnancy. Start of lactation with the delivery. Prolactin. Milk ejection reflex. Oxytocin. Lactation and ovulation.

CENTRAL NERVOUS SYSTEM

Lectures, HP 10, 11 or 12

Main Features of Structure and Function of the Central Nervous System.– Cellular components of the nervous system. Neurons. Neuroglial cells. Neural circuits. - The organization of the human 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 and their main functions.

The Movement and its Central Control. – Neural centers responsible for movement. – Lower motor neuron circuits and motor control. - Organization and function of the spinal cord motor neurons. Ventromedial and dorsolateral 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 of peripheral motor neurons. The lower motor neuron syndrom. Peripheral paresis and paralysis. – Regeneration of the axons.

Motor Function of the Spinal Cord. -The myotatic (stretch) reflex. - Muscle spindle, morphology. Muscle spindle afferents. - Basic reflex circuitry. – Reciprocal innervation. – Muscle spindle efferents. Effect of gamma innervation, alpha-gamma coactivation. – The function of stretch reflexes. - The inverse myotatic reflex. – Golgi tendon organ, morphology. - Afferent fibres of Golgi tendon organ and mechanisms of their activation. Spinal connections, reflex response. – Functional importance of Ib afferents signaling. – Exteroceptive (flexor, flexion) reflex. Receptors, afferents, spinal connections, reflex response. – Crossed extensor, extension reflex. – Integration of the final common pathways. – Complete and partial transection of the spinal cord.

The Motor System of the Brain Stem and Cerebral Cortex. – Lower and upper motor neurons of the brainstem. - 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. - 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. – Control of the motor hierarchy by the cerebellum and basal ganglia. - Lesions to the corticospinal system. Upper motor neuron syndrom.

Function of the Cerebellum. - The modulation of movement by the cerebellum. – Major components of the cerebellum. Connections between the cerebellum and other parts of the nervous system. - Projections to the cerebellum. Somatotopic maps of the body surface in the cerebellum. – Projections from the cerebellum. – Neurons and circuits within the cerebellum. – Cerebellar circuitry and the coordination of ongoing movement. - Consequences of cerebellar lesions.

Function 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. Neutrotransmitters 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.

Cerebrospinal Fluid System. - The meninges of the brain and spinal cord. – The cerebral ventricles and the cerebrospinal fluid. Production and composition. – Circulation and drainage of the cerebrospinal fluid. – The main functions of the cerebrospinal fluid.

The State of Conciousness (HP 10 255-263, HP 11 233 – 237, HP 12 229–233). - The electroencephalogram, source, recording. – Variations in the EEG during wakefullness. Alpha rhythm, alpha block. Beta, 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 – Clinical uses of the EEG.

Learning and Memory (HP 10 269-271, HP 11 245 – 247, HP 12 241–243). – 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.

Cerebral Dominance and Language (HP 10 272-274, HP 11 247 – 249, HP 12 243–245). Primary language areas of the brain. Model for language. - Wernicke´s aphasia. - Broca´s aphasia. -

PRACTICAL EXERCISE

Hematology

1. Hematocrit determination
2. Determination of MCH, MCHC and MCV
3. Blood typing
4. Cross-matching of blood
5. Sedimentation rate
6. Quick´s protrombin time

General physiology, central and peripheral nervous systems

7. Determination of plasma volume
8. Somatic reflexes
9. Visceral reflexes
10. Examination of the pupils
11. Assesment of the visual memory
12. Short-term memory testing

Sense organs

13. Visual acuity
14. Accommodation in the human eye
15. Astigmatism
16. Optokinetic nystagmus
17. Blind spot experiment (Mariot´s experiment)
18. Hearing tests

Circulation and respiration

19. Blood pressure
20. Model of elastic and inelastic artery
21. ECG

22. Spirometry - static values

Metabolism, endocrinology, kidney and GIT

23. Action of bile salts on fats in vitro
24. Digestion of protein by pepsin
25. Basal metabolic rate
26. Creatinine clearance. Glomerular filtration. Tubular reabsorption
27. Oral glucose tolerance test