CURRICULUM OF PHYSIOLOGY

DENTAL MEDICINE

ACADEMIC YEAR 2023/2024

Textbooks:
Vander´s Human Physiology (E. Widmaier, H. Raff, K.Strang)
MOODLE: http://lms.lfp.cuni.cz/course/view.php?id=118

GENERAL PHYSIOLOGY

Lectures and seminars.

Membrane Transport. – Membrane transport mechanisms. – Simple diffusion. Membrane channel. Facilitated diffusion. Rate of diffusion. – Osmosis. Osmotic pressure. – Molarity and molality. Osmolarity and osmolality. – Primary active transport. - Secondary active transport. – Exocytosis. - Endocytosis.

Membrane electrogenesis – Membrane potential. – Equilibrium potential. Nernst equitation. – Resting membrane potential. – Membrane current, membrane permeability, driving potential. – Excitable tissues. – Graded potential. Propagation of graded potential. – Action potential, origin, ionic mechanism. Absolute and relative refractory period. Action potential propagation in unmyelinated and myelinated fibers. – Differences between action and graded potential. – Classification of nerve fibers.

Skeletal Muscles. – Structure of the skeletal muscle. Sarcomere. Thick and thin filaments. – Molecular mechanism of contraction. – Excitation-contraction coupling. – Frequency-tension relation. – Types of muscle fibers. – Metabolism of skeletal muscle. Muscle fatigue. Neuromuscular junction. – Motor unit. – Structure of neuromuscular junction. Acetylcholine. Cholinergic receptor. – Mechanism of transmission. End-plate potential. –Effect of drugs on the neuromuscular junction.

Smooth Muscle. – Types of smooth muscle. – Structure of the smooth muscle. – Mechanism of contraction. Cross-bridge cycling. Sources of calcium – Electrical activity. Spike potential. Action potential with plateau phase. Pacemaker potential. – Control of contraction. Nervous regulation, Hormonal regulation. Local factors.

Physiological Regulation. – Internal environment of the body. – Homeostasis. – Homeostatic mechanisms. – Control mechanisms of homeostasis. Negative feedback. Positive feedback. Feedforward control.

Body fluids. – Composition of human body. – Total body water. – Extracellular fluid. Plasma. Interstitial fluid. Transcellular fluid. – Intracellular fluid. – Factors determining volume of total body water. – Indicator-dilution method. Indicators. Calculated volumes.

Cell. – Cell and its organelles. – Cell membrane. Lipid. Proteins. – Nucleus and nucleolus. – Ribosomes. – Endoplasmic reticulum. – Golgi apparatus. – Mitochondrion. – Lysosomes. – Peroxisomes. – Cytoskeleton.

Intercellular Communication. – Gap junction. - Autocrine and paracrine signalling. – Endocrine signalling. – Nervous signalling. – Synapse-definition. – Structure and mechanism of electrical synapse. – Structure and mechanism of chemical synapse. Removal of neurotransmitters. – Postsynaptic potential. Excitatory and inhibitory postsynaptic potentials. Summation. – Neuronal and synaptic interactions.

Neurotransmitters. Typical neurotransmitters in the human nervous system. – Agonist and antagonist. – Catecholamines; sources, synthesis, receptors, degradation. – Acetylcholine; sources, synthesis, receptors, degradation. – Principal roles of histamine and serotonin. – Excitatory and inhibitory aminoacids. – Other neurotransmitters.

Receptors. – Receptors for chemical messengers and their properties. Down-regulation. Up-regulation. Internalization. Desensitization. – Signal transduction pathways of water-soluble messengers. – G-protein coupled receptors. – Second messengers. Adenylyl cyclase and cAMP. Diacylglycerol and inositol triphosphate. Calcium. Arachidonic acid and eicosanoids. Guanylyl cyclase and cGMP. Channel coupled receptors. – Catalytic receptors. – Signal transduction pathways of lipid-soluble messengers.

PHYSIOLOGY OF BLOOD AND THE IMMUNE SYSTEM

MOODLE, handouts

General characteristics and main functions of the blood. (MOODLE) Blood functions. - Blood volume. – Hematocrit. – Blood and plasma viscosities. – The erythrocyte sedimentation rate. Factors affecting erythrocytes sedimentation rate.

Plasma. (MOODLE) Plasma volume and composition. – Inorganic constituents of the plasma, their concentrations and functions. – Organic constituents of the plasma. Plasma proteins, their concentrations and functions. Plasma lipids.

Erythrocytes. (MOODLE) Erythrocytes count, size and shape. – MCH, MCHC a MCV. – Hemoglobin concentration, structure, types, and forms. – Energy metabolism.

Erythropoiesis. (MOODLE) Sites of erythrocytes' production. – Reticulocytes. – Iron metabolism. – Role of Vitamin B_{12} and folic acid. – Hormonal regulation of erythropoiesis.

Destruction of erythrocytes. (MOODLE) Erythrocytes' life span. – The site and mechanism of red blood cell destruction. Hemoglobin destruction. – Bilirubin metabolism, concentration in plasma. Entero-hepatic circulation. – Icterus. Physiological neonatal jaundice. – Hemolysis.

Blood groups. (MOODLE, seminar) Agglutinogens and agglutinins. Agglutination. – ABO system. – Rhesus system. – Blood typing. – Cross-matching of the blood.

Thrombocytes. (MOODLE) Production, lifetime and count. - Structure of thrombocytes. Platelet's granules. - Thrombocyte's functions. - The role of platelets in the organization and regulation of physiological hemostasis. Formation of the platelet plugs.

Hemostasis. (MOODLE) Basic processes of hemostasis. - Vascular spasm. – Fate of blood clot. Fibrinolytic system. – Prevention of blood clotting in the vascular system. – Quick's test.

Hemocoagulation. (MOODLE) Clotting factors. Role of vitamin K. – Hemocoagulation cascade. – Cell based model of coagulation. – Clot retraction. – Blood serum and its composition.

White blood cells. (MOODLE) Classification. – Total white blood cell (WBC) count. – Differential WBC count. – Production of WBCs. – Individual types of leukocytes and their functions.

Nonspecific immune defenses. (lecture) Functions of immunity system. Innate defense mechanisms. – Phagocytosis. Macrophage system. - Opsonization. – Complement.

Specific immune defenses. (lecture) Functions of immunity system. Cellular and humoral components of acquired immunity. – T-cells and their functions. – B-cells. Immunoglobulins, their structure, types and functions. – Primary and secondary immune response.

SPECIAL SENSES

Lectures, seminars.

General physiology of senses. Sensory receptors, their morphology and classification. – Adequate stimulus. Receptor potential. – Primary sensory coding. - Basic processes of sensation. - Receptor adaptation. Lateral inhibition. - Brain cortex and perceptual processing. Factors affecting perception.

Somatosensory system. Types of somatosensory receptors. – Skin and muscle mechanoreceptors, their morphology and function. – Threshold pressure. - Two-point discrimination. Receptive field. – Thermoception and thermoreceptors. – Thermoception in the orofacial region. – Ascending neural pathways. Afferent fibers. - Segmental innervation: dermatomal map. – Neural pathways involved in transmission of somatosensory information. – Primary somatic sensory cortex. Somatotopic organization.

Pain. Function, classification and etiology of pain. – Pain stimulus. - Types of nociceptors. - Conduction of information about pain. Fast and slow pain. – Visceral pain. Referred pain. Head´s zones. - Central pathways for nociception. – Modulation of pain transmission.

Tooth and pain. Innervation of the tooth, its density and plasticity. - Pulpal nociceptors and their sensory afferents. – Tooth pulp pain. - Transmission of stimulus across dentin. Hydrodynamic theory. - Central pathways for tooth nociception.

Taste. Function of taste. Basic taste modalities. – Taste buds, their location, structure and innervation. – Receptor stimulation. - Taste pathways. – Factors influencing taste sensation. - Taste abnormalities.

Smell. Function of smell. - Olfactory epithelium, location and morphology. – Odorant receptors, mechanism of their stimulation. - Discrimination of different odors. – Olfactory neural pathways. – Factors that influence olfactory discrimination.

Hearing. Sound. Acoustics. – The sound transmission in the ear. - External and middle ear. Function of the tympanic membrane and ossicles. – Inner ear. Organ of Corti. - Hair cells and their activation. – Auditory pathway. – Bone versus air conduction.

Vestibular function. Semicircular canals. Organization and function of an ampulla. – Structure and function of utricle and saccule. Otholitic organ. - Mechanism of vestibular apparatus stimulation. – Mechanisms of transformation of mechanical energy into action potential firing in afferent neurons. - Neural pathways of vestibular apparatus. – Physiological nystagmus.

Optics of the eye. Light. Visible spectrum. - The principal structures of the eye. – The optics of vision. – Optical power. - Accommodation of the lens. Near and far point. Range of accommodation. – Defects in vision. Use of corrective lenses. – Pupillary function.

Retina and phototransduction. Visual pathway. Organization of the retina. Retinal cell types. – Photoreceptors. – The change in retina in response to light. – Light and dark adaptation. - Color vision. The sensitivities of the photopigments. - Color blindness. – Visual pathway. – Eye movements.

NERVOUS SYSTEM

Lectures, teaching material on MOODLE

Main features of structure and function of the nervous system. Cellular components of the nervous system. Neurons. Relations between neurons. Regulation of impulse transmission. - Neuroglial cells in the central and peripheral nervous system, their types and functions. - The organization of the nervous system. – Components of the peripheral nervous system. - Components of the central nervous system. – Subdivisions of the central nervous system and their main functions. – Basic functional unit of the nervous system.

Cerebrospinal fluid. Production, composition and functions. – Circulation and drainage of the cerebrospinal fluid. – Blood-brain barrier mechanisms. Morphology and functions. - Circumventricular organs. – Metabolism of the central nervous system.

State of consciousness. Consciousness system. Ascending reticular activating system. - The electroencephalogram, source, recording and assessment. – Sleep patterns. Sleep phases. – Distribution of sleep stages in a typical night. – Normal sleep cycles at various ages. – Sleep and wake alternation.

Higher cognitive functions. Cognition. - Higher order sensory and motor cortices. Localization and functional role. – Symbolic cortical functions. Agnosias. Apraxia. – Asymmetry of the hemispheres, differences in hemispheric capabilities. - Primary language areas of the brain. Model for language. - Aphasias.

Emotions and motivation. Definition of emotions. – Components of emotions. - Physiological changes associated with emotions. – Regions of brain involved in emotions. – Motivation. – Instinct. - Fixed action patterns. Comparison of fixed activity pattern and unconditional reflex. - Drives. – Inherited determinants of human behavior. - Addiction.

Learning and memory. Classes of learning. - Habituation. - Sensitization. - Classical conditioning. – Extinction and reinforcement of conditioned reflex. -Operant conditioning. Operant conditioning in comparison with classical conditioning. - Definition of memory. – Stages of memory. - Categories of memory. – The neural basis of memory. Brain areas involved in memory. – Learning pyramid. – Amnesia.

Functions of the hypothalamus. Structure of the hypothalamus. - Role of the hypothalamus in homeostasis. – Relation to autonomic function. - Relation to endocrine system. - Relation to food intake regulation.

Autonomic nervous system. Structure and localization. – Sympathetic and parasympathetic division. – Mediators and receptors of the autonomic nervous system. – Functions of the autonomic nervous system.

Motor neurons. Classes of movement. – Organization of motor nervous system. - Motor neurons of the spinal cord. Types, organization and functions. - Function of propriospinal neurons. - Motor neurons of the cranial nerves. - The ventromedial system pathways, the origin, course, terminations, and function. - The dorsolateral system pathways, the origin, course, terminations, and function.

Motor functions of the spinal cord and brain stem. The myotatic (stretch) reflex. Basic reflex circuitry. - Muscle spindle, morphology and mechanisms of its activation. Effect of alpha-gamma coactivation. – Reciprocal innervation. – The function of stretch reflexes. - The inverse myotatic reflex. Basic reflex circuitry. – Golgi tendon organ, morphology and mechanisms of its activation. – Motor function of the brain stem. - Definition, function and regulation of the muscle tone.

Posture and locomotion. Functions and mechanisms of adjustments. – Posture-regulating system of the central nervous system. - Postural reflexes. Their centers and types. – Balance. Cerebellar influence to balance. - Locomotion. The central pattern generator, location and function. - Supraspinal regulation of stepping. – Exteroceptive reflexes. Receptors, afferents, spinal connections, reflex response.

Function of the cerebellum. Functional organization of the cerebellum. – Vestibulocerebellum, input, output, and functions. – Spinocerebellum, input, output, and functions. – Cerebrocerebellum, input, output, and functions. - Consequences of cerebellar lesions.

Function of the basal ganglia. The principal nuclei of the basal ganglia. - Basal ganglia projections. – Circuits within the basal ganglia system. – Mechanism of the basal ganglia function. – Manifestations of the basal ganglia disorders.

Voluntary movement. Processes leading to purposeful movement. - Regions of neocortex involved in performance of voluntary movements, their roles and functional connections. - Role of the primary motor cortex, localization, organization and function. – Injury to the somatic motor system.

ENDOCRINOLOGY

Lectures or Vander's Human Physiology

General endocrinology. 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. 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. 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. 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. 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 - glucocorticoids. Hormones of adrenal cortex. Synthesis of the steroid hormones. Zona glomerulosa, fasciculata and reticularis. Enzymatic differences between cortical layers. Androgens - Effects of cortisol. Metabolic effects. Functions of cortisol in stress. - Regulation of cortisol secretion. CRH and ACTH. – Effects of androgens. Regulation of androgen secretion. Impaired secretion: Addison disease. Cushing disease. Adrenogenital syndrome.

Adrenal cortex – mineralocorticoids- Synthesis of mineralocorticoid in zona glomerulosa. Transport in the plasma and metabolism. Effects of aldosterone. Renal regulation of potassium and sodium. Control of aldosterone secretion by potassium and angiotensin II. –. Defects in secretion of mineralocorticoids.

Endocrine functions of pancreas.. Islets of Langerhans. Cell types and hormones produced. 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. – Effects of insulin on growth. – Glucagon. Effects of glucagon. Glycogenolysis. Gluconeogenesis. – Control of glucagon secretion. Influence of plasma glucose. Influence of sympathetic stimulation. Influence of exercise.

Hormonal control of calcium homeostasis and bone physiology. Overview of calcium and phosphate metabolism. Bone structure. - Bone cells and their function.– Bone growth and renewal. Vitamin D. Synthesis of 1,25-dihydroxycholecalciferol in skin, liver and kidney. 1,25-dihydroxycholecalciferol - mechanism of action, effects and regulation of secretion. Deficit of vitamin D. Rickets. Osteomalacia. –Parathyroid hormone. Parathyroid gland. Synthesis of PTH. Effects of PTH in bone, in kidneys, in gastrointestinal tract and in plasma.

Control of parathyroid hormone secretion. Deficit and excess of PTH. –Calcitonin. Site of secretion. Effects. Regulation.

Male reproduction system. Anatomy. Testes. Seminiferous tubules. Leydig cells. Epididymis. Vas deferens. Seminal vesicles. Prostate gland. –- Spermatogenesis. Stages of sperm development. Sertoli cells. – Spermatozoa. Head. Midpiece. Tail. - Erection. Vascular changes. Reflex center. Afferent pathway. Efferent pathway. – Ejaculation. Afferent and efferent pathways. – Semen. Composition.– Testosterone. Dihydrotestosterone. Structure and synthesis. - Effects of testosterone, mechanism of the effect. – Regulation of testis functions. – Abnormal functions of testis during development and in adulthood. Androgen overproduction.

Female reproduction system . Menstruation cycle. Menstruation. Ovarian cycle. Follicular phase. Development of follicle. Structure of a mature follicle. Ovulation. Luteal phase. Corpus luteum. – Oogenesis. Primary oocyte. Secondary oocyte. - Uterine cycle. Proliferative phase. Secretory phase. Arteries of endometrium. Menstruation. Ovulation. Basal temperature.

Ovarian hormones . Estrogens. Synthesis. Sites of secretion of ovarian hormones: Granulosa and theca cells. Corpus luteum. Multiple effects of estrogen. - Progesterone. Structure. Multiple effects of progesterone. – Time course of secretion of ovarian hormones during menstrual cycle. Hypothalamus. GnRH. Hypophysis. FSH. LH. - Feedback regulation. Negative feedback. Positive feedback. – Mutual relationships of hypothalamus (GnRH), hypophysis (FSH, LH) and ovarian (estrogen, progesterone) hormones in the time course of the menstrual cycle: follicular phase, ovulation (LH surge), luteal phase, degeneration of corpus luteum. – Defects of ovarian functions. Menstruation abnormalities.

Pregnancy. Fertilization and implantation. Acrosomal reaction. Block to polyspermy. Zygote. Blastocyst. Trophoblast. – Hormones during pregnancy. Corpus luteum. Placenta. Chorionic gonadotropin and somatomammotropin. – 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.

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.

ALIMENTARY TRACT

Vander´s Human Physiology and seminars

Gastrointestinal Motility – 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. – Neural regulation. Enteric nervous system, extrinsic innervation. Long and short reflexes and their role in the regulation of gastrointestinal processes. – Hormonal regulation. Secretin, cholecystokinin, gastrin, somatostatin, GIP. – Phases of gastrointestinal control.

Mouth, Pharynx, and Oesophagus – 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 - 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 - 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 - 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 - 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 - 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 - 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

Metabolism (Seminar) – Metabolism. Anabolic reactions. Catabolic reactions. – Chemical energy consumption. – Principle of calorimetry. Direct calorimetry. Indirect calorimetry. – Metabolic rate. Basal metabolic rate (BMR). Basal conditions. Average values of BMR. – Factors affecting the metabolic rate.

Regulation of Body Temperature (Seminar) – Poikilotherms and homeotherms. – Body temperature – core temperature, shell temperature. – Heat transport. – Heat loss - radiation, conduction, convection, evaporation – perspiration, sweating and its regulation. – Central and peripheral thermoreceptors. – Thermoregulation centre. – Temperature decreasing mechanisms. – Temperature increasing mechanisms. – Thermoregulation during physical exercise. – Temperature regulation in new-borns. – Temperature adaptation. – Fever. Hyperthermia. Hypothermia.

RESPIRATION

Lectures and seminars

Physiological Anatomy of Respiratory System. Functions of respiratory system. – Respiratory function. External and internal respiration. – Non-respiratory functions. – Structure of airways. Conducting zone. Respiratory zone. – Innervation of airways. – Relation of lungs, pleura and chest wall.

Pulmonary Ventilation and Lung Mechanics. Pulmonary ventilation. – Pressures. Intrapleural, intraalveolar a transpulmonary pressures. – Respiratory cycle. Pressure gradient. – Inspiration. Inspiratory muscles. – Expiration. Expiratory muscles. – Alveolar and intrapleural pressures during respiratory cycle. – Compliance of lungs and of thorax. – Alveolar surface tension. Surfactant. – Resistance of respiratory system. Airways resistance. Respiratory work.

Lung Volumes and Capacities (seminars). Spirometry. – Static parameters. Lung volumes. Lung capacities. – Dynamic parameters derived from forced expiration of vital capacity. – BTPS correction. – Anatomical and physiological dead space. – Pulmonary ventilation. – 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. Composition of atmospheric and alveolar air. – Partial pressure. Partial pressures of gases in the body. – Respiratory membrane. – Diffusion of respiratory gases through respiratory membrane. Solubility and molecular weight of respiratory gases. Pressure gradient. Diffusion surface. Diffusing path. – Gas exchange in the tissues.

Transport of oxygen. Dissolved O_2. – Hemoglobin as O_2 transporter. – Saturation of hemoglobin with O_2 in arterial and venous blood. – Oxygen-hemoglobin dissociation curve. – Factors influencing the oxygen-hemoglobin dissociation curve. Influence of pH. Influence of temperature. Influence and importance of 2, 3–bisphosphoglycerate.

Transport of Carbon Dioxide. Diffusion of CO_2 from cells into capillaries' blood. – Forms of the transport of CO_2 in the blood. – Amount of CO_2 in arterial and venous blood. – CO_2 dissociation curve. Haldane effect and its importance.

Nervous and Nonchemical Regulation of Respiration. Nervous regulation of respiration. – Automaticity of respiration. Voluntary control of respiration. – Respiratory center. Dorsal group. Ventral group. – Pneumotaxic center. – Vagus afferentation. Receptors in airways and lungs. – Efferent output of respiratory center. – Nonchemical regulation of respiration. Slowly adapting receptors. 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. Structure of peripheral chemoreceptors. Blood supply of peripheral chemoreceptors. – Ventilatory response to CO_2. – Ventilatory response to changes in acid-base balance. – Ventilatory response to O_2 deficiency.

PHYSIOLOGY OF THE KIDNEY

Lectures and seminar

Physiological Anatomy of the Kidney. Overview of the renal functions. Anatomy of the renal system. – Anatomy of the kidney. Cortex. Medulla. – Nephron. Structure of the nephron. Glomerulus. Bowman´s capsule and tubular system. Proximal tubule, Loop of Henle. Distal tubule. Collecting duct. Distal nephron. – Types of nephrons. Cortical and juxtamedullary nephrons. – Renal blood supply. Renal artery and vein. Afferent and efferent arterioles. Capillary network: glomerulus and peritubular capillary network. Vasa recta. Portal arrangement of blood vessels in the kidneys. – Juxtaglomerular apparatus and its function. – Principles of urine formation.

Glomerular Filtration. Glomerular filtration membrane. – Net filtration pressure – Glomerular filtrate. Composition. – Glomerular filtration rate. – Clearance. Definition. Calculation. – Clearance of inulin and creatinine. Comparison, advantages and disadvantages. – Clearance of paraaminohippuric acid (PAH). Renal plasma and blood flow. Filtration fraction. – Physiological control of glomerular filtration and renal blood flow. Nervous and humoral regulation. Autoregulation. Myogenic autoregulation. Tubuloglomerular feedback.

Tubular Reabsorption and Secretion. Tubular processes. – Types of transport. Paracellular and transcellular transport. – Active and passive transport. – Primary active transport. – Secondary active transport. – Passive transport. Transport of water, chloride and urea. – Transport in proximal tubule, in the loop of Henle, in distal tubule and collecting duct. – Threshold substances. Transport maximum. Renal threshold. Glucose reabsorption. – Tubular secretion. Tubular secretion of creatinine, paraaminohippuric acid and foreign chemicals. – Pressure natriuresis and pressure diuresis. – Regulation of tubular reabsorption. Glomerulotubular balance.

Excretion of Water. Aquaporin. – Osmolality and quantity of urine. – Mechanism of water reabsorption. Water reabsorption in different segments of tubule. – Osmotic stratification of renal medulla. – Countercurrent exchange (multiplier) system. Role of loop of Henle and role

of distal tubule and collecting duct. – Recirculation of urea. Transport of urea in different segments of tubule. – Role of antidiuretic hormone (ADH). Regulation of ADH production. Diabetes insipidus. – Water diuresis. Osmotic diuresis. – Thirst. Thirst center. Stimuli to thirst.

Excretion of Ions. Excretion of sodium. Sodium balance. Mechanism and the amount of reabsorbed sodium in different tubule segments. Renin-angiotensin system-aldosterone system. – Atrial natriuretic peptide. – Excretion of potassium. Reabsorption and secretion of potassium. – Excretion of chloride. Reabsorption of chloride.

Micturition. Urinary tract. Renal calyxes and renal pelvis. – Ureter. Urinary spindle. – Urinary bladder. Detrusor muscle. Urine bladder innervation. – Internal and external sphincter. – Micturition reflex. – Supraspinal control of micturition. – Composition or urine. Daily production of urine and it's changes.

Acid-Base Balance and Kidney. Plasmatic pH. Definition of acid and base. Acidosis and alkalosis. – Sources of hydrogen ions. – Acid-base buffer systems. Bicarbonate buffer system. – Secretion of hydrogen ions. – Filtration and reabsorption of bicarbonate ions in kidney. Generation of new bicarbonate. – pH disorders. Respiratory acidosis and alkalosis. Metabolic acidosis and alkalosis. Renal response to acidosis. Renal response to alkalosis.

PRACTICAL EXERCISE

Hematology

1. Hematocrit determination
2. Determination of MCH, MCHC and MCV
3. Blood typing – AB0 and Rh systems
4. Bed-side test
5. Sedimentation rate
6. Quick´s prothrombin time

General physiology, central and peripheral nervous systems

7. Determination of plasma volume
8. Somatic reflexes
9. Visceral reflexes
10. Cerebellar functions

Sense organs

11. Visual acuity
12. Astigmatism
13. Optokinetic nystagmus
14. Blind spot experiment (Mariott)
15. Color Vision
16. Hearing tests

Circulation and respiration

17. Blood pressure
18. Heart sounds
19. ECG
20. Spirometry - static values
21. Spirometry - dynamic values

Metabolism, endocrinology, kidney and GIT

22. Basal metabolic rate
23. Creatinine clearance. Glomerular filtration. Tubular reabsorption