

# Thematic plan HISTOLOGY

## (General Medicine, Dentistry)

### II semester

#### **LECTURES**

1. Subject and goals of Histology. Cell. Tissue classification.
2. Embryology I.
3. Embryology II.
4. Epithelial tissue.
5. Connective tissue I.
6. Connective tissue II.
7. Muscle tissue.
8. Nerve tissue.

#### **SEMINARS**

##### **1. Introduction to Histology**

Subject and goals of Histology.

Microscopy, structure of the light microscope. Rules and skills to work with a light microscope.

Types of light microscopy (bright-field, dark-field, phase contrast, polarizing, fluorescence, confocal microscopy. Types of electron microscopy: scanning and transmission electron microscopy).

##### **2. Methods of study in Histology**

Preparing tissues for Microscopy (material obtain, fixation, dehydration, clearing, infiltration, embedding, sectioning, mounting, removal of paraffin, rehydratation, staining).

Peculiarities of material preparation for electron microscopy. Frozen sections.

##### **3. Cell I**

General structure of the cell. Cell membrane, structure and function (Membrane permeability, Signal transduction, Endocytosis, phagocytosis). Cytoplasm. Mitochondria. Ribosome. Polyribosome. Endoplasmic reticulum: smooth and rough. Golgi complex. Phagosomes. Lysosomes. Peroxisomes. Cytoskeleton (microtubules, microfilaments, intermediate filaments).

##### **4. Cell II**

Nucleus (structure, nuclear envelope, chromatin, nucleolus, nucleoplasm. Cell functions, cellular differentiation. Intercellular communication. Mitosis. Cell cycle. Cell death (necrosis, apoptosis).

##### **5. Embryology I**

The structure of gametes. Spermatogenesis and oogenesis. Meiosis. Main steps of fertilization. Acrosome and cortical reactions, their importance. Forming of fertilization envelope, polyspermy blockade. Zygote formation.

## **6. Embryology II**

Morula. Blastocyst. Trophoblast (syncytiotrophoblast, cytotrophoblast). Inner cell mass (epiblast, hypoblast). Implantation. Gastrulation: ectoderm, endoderm, mesoderm and their derivatives. Extraembryonic germ layers and its derivatives. Neurulation. Mesenchyme and its role in tissue formation. Chorion. Decidual reaction. Placenta, its structure, function, steps in placenta development. Placental barrier.

### **Quiz 1 (topics 1-6)**

## **7. Tissue classification. Epithelial tissue.**

Tissue classification and general characteristics. Epithelial tissue, classification, general features. Polarity, apical surface specialization. Apical pole: cilia, flagella, microvilli, stereocilia. Lateral pole: compact (closing) contacts the adhesive contacts (girdle desmosomes), desmosomes, hemidesmosomes, gap junctions (nexus). Basal pole: the basement membrane.

Glandular epithelium: general characteristics, types. Various modes of secretion: merocrine, apocrine, holocrine.

## **8. Connective tissue I**

*General features of connective tissue.* Functions.

*Connective tissue cells:* fibroblast, fibrocyte, mast cells, macrophages, plasma cells. Intercellular matrix (collagen, reticular and elastic fibers). Ground substance (proteoglycans, glycoproteins). Components of connective tissue (fibers, ground substance, cells).

*Connective tissue types:* loose connective tissue, dense connective tissue (regular, irregular), reticular, mucous and adipose (white and brown) connective tissue.

## **9. Connective tissue II**

*General features of cartilage.* Structure of chondroblasts, chondrocytes; structure and function of intercellular matrix. Structure and functions of perichondrium. Types of cartilage (hyaline, elastic, fibrocartilage). Intervertebral discs.

*General features of bone.* Bone cells (osteoblasts, osteocytes, osteoclasts). Bone matrix: fibers, ground substance, inorganic and organic components. Periosteum and endosteum, their importance for the growth, nutrition and regeneration of bone tissue.

Types of bone: primary and secondary bone tissue.

Intramembranous ossification and enchondral. Bone growth in length and thickness.

The regeneration of bone tissue. Metabolic bone value. Connections of the bones, the continuous and discontinuous (joints ) , their structure.

## **10. Muscle tissue**

General features of muscle tissue. Types of muscle. Function.

**Skeletal muscle:** Sarcolemma, sarcoplasm, basal membrane. Sarcomere, its structure. Structure and function of skeletal muscles triad. Synapse. The mechanism of contraction and the role of calcium ions. Organization of skeletal muscles: endomysium, perimysium, epimysium, fascia, tendon.

The concept of fast and slow muscle fibers and muscles.

Histogenesis and regeneration of skeletal muscle, satellite cells.

**Cardiac muscle.** Cardiomyocytes : ultrastructure, T-system, types of cardiomyocytes. Structure of cardiomyocytes: intercalated disks. Innervation and mechanism of contraction. Histogenesis and regeneration.

**Smooth muscle.** Smooth muscle cells structure. Innervation and mechanism of contraction. Histogenesis and regeneration.

## **11. Nervous tissue**

General features of nerve tissue: structural components; neurons and supporting cells. Embryonic development of nerve tissue.

Neurons: classification of neuron types by configuration of cell processes, cell size, function, neurotransmitter released. Neuron cell body, dendrites, axon, their structure and function.

Supporting cells: embryonic origins, classification. Macroglia (astrocytes, oligodendrocytes, ependymal cells) and microglia, structure and function. Blood-brain barrier, its structure and function. Supporting cells of the peripheral nervous system: Schwann cells, satellite cells, structure and function.

Ganglia, types and their functions.

Nerve fibers (axons), their structure and types. Formation of the myelin. Features of signal transmission by myelinated and unmyelinated axons. Peripheral nerves. Sheaths of peripheral nerve.

Synapse. Types of synapses. Structure of chemical synapses (pre- and postsynaptic membranes, synaptic cleft, neurosecretory vesicles, their structure). Regeneration of nerve tissue.

## **12. Skin and its derivatives**

Skin: embryonic origins, tissue types, general features. Types of skin. Distinguishing features of epidermis in different types of skin, its cell types. Layers of dermis, characteristics of tissues. Hypodermis. Blood supply and innervation of the skin.

Skin receptors: free nerve endings, Merkel's, Meissner's, Pacinian corpuscles, Krause's end-bulbs. Their structure and function.

Skin derivatives. Structure of sebaceous and sweat glands, mammary glands; cell types, types of secretion and its regulation. Structure of hair follicle and hair. Nails.

Proprioceptors. Muscle spindle and Golgi tendon organ: structure, functions.

### **13. Work with the slides.**

## **Quiz 2 (topics 7-13)**

# **III semester**

## **LECTURES**

9. Digestive system
10. Respiratory system
11. Urinary system
12. Genital system I
13. Genital system II
14. Endocrine system I
15. Endocrine system II
- 16 Cardio-vascular system
17. Peripheral blood. Hematopoiesis
18. Immune system

## **SEMINARS**

**1. Digestive system I.** Embryogenesis of digestive system organs. General features of Digestive tract, structure of the wall (mucosa, submucosa, muscularis externa, serosa and adventitia).

Oral cavity: walls, tongue (histological structure and function).

Chemoreceptors. The organ of taste. The structure and cellular composition of taste buds. Histophysiology of the organ of taste.

Teeth: classification, tooth structure. The structure of dentin, enamel, cement. Teeth development.

Esophagus: general features of the wall in different parts.

Stomach: general features. Cells of gastric mucosa: structure and function, regional differences.

Features of the structure of the wall of the pharynx and esophagus.

*The stomach:* general characteristics. Epithelial cells of the stomach: mucocytes, undifferentiated cells, cervical cells, parietal cells, main cells, enteroendocrine

cells, their structure and functions. Differences in the structure of the stomach wall in different sections (cardia, fundus and body, pyloric section).

## **2. Digestive system II**

*Small intestine:* general characteristics. Features of the structure of the mucous: villi, glands (crypts of Lieberkühn). Enterocytes (microvilli, brush border) and M-cells, goblet cells, Paneth cells, enteroendocrine cells, undifferentiated cells (structure and function). Differences in the structure of the wall of the duodenum, jejunum, ileum.

*The large intestine:* general characteristics. Features of the structure of the wall in different departments. Appendix. Rectum. The anal canal.

Peritoneum.

## **3. Digestive system III**

General characteristics of the glands associated with the digestive system (embryonic development, exocrine and endocrine functions, serous and mucous secretory sections, acinus, lobule, lobe). Excretory ducts: interlobular, intralobular (interlobular, striated).

*Salivary glands:* general characteristics and function. Salivary gland cell types: serous, mucosal, myoepithelial. Cellular composition and structural features of the parotid, submandibular and sublingual salivary glands. Saliva production, the influence of duct epithelium and innervation on this process.

*Pancreas:* general characteristics and functions. Acini cells, centroacinar cells, their structure and function. Overview of the islets and hormone-producing cells of the pancreas.

*Liver:* general characteristics and functions. Blood supply (hepatic artery, portal vein, liver sinusoids, central vein, hepatic veins). Cell types: epithelial cells (hepatocytes, cholangiocytes), sinusoid cells (endothelium, hepatic stellate cells, hepatic stellate macrophages (Kupffer cells), liver-associated lymphocytes), their structure and functions. Disse space. Structural and functional units of the liver (classical lobule, portal lobule, acinus). Regeneration of the liver.

*Biliary tract:* bile ducts, cholangioli (Hering's tubules), bile duct, hepatic ducts, cystic duct, common bile duct.

*Gallbladder,* structural features of the wall, function. Composition and function of bile.

## **4. Respiratory system**

General characteristics of the respiratory system. Sources of Embryonic development.

*Olfactory organ.* General characteristics. Sources of development. The structure and cellular composition of the olfactory lining (supporting olfactory, basal cells). Olfactory bulb, cellular composition. Histophysiology of the olfactory organ.

*Respiratory epithelium:* cellular composition (ciliated cells, goblet cells, brush cells, basal cells, endocrinocytes — structure and function). Features of the wall structure in different parts of the airways (nasal cavity, nasopharynx, larynx, trachea, bronchial tree, bronchioles, terminal bronchioles).

*Respiratory portion:* respiratory bronchiole, alveolar duct, alveolar sac, alveoli. Acinus is a structural and functional unit of the respiratory part of the lung. Type I and II alveolocytes. Alveolar macrophages. Surfactant. Regeneration of the alveolar lining. Aero-blood barrier and its importance in gas exchange. The effects of autonomic innervation on the bronchi.

*Pleura.*

## **5. Urinary system**

General characteristics of the urinary system (kidneys, urinary tract). Sources of embryonic development.

*General structure of the kidney.* Nephron is a structural and functional unit of the kidney. Divisions of the nephron (renal corpuscle, proximal convoluted tubule, loop of Henle, distal convoluted tubule), their structure and function.

*Histophysiology of the nephrons.* Filtration barrier. Filtration, reabsorption, secretion mechanisms. The role of nephron tubules and collecting ducts in urine concentration. Significance of aldosterone and vasopressin in urine formation. Types of nephrons. Blood supply to the kidneys, cortical and juxtamedullary nephrons.

*Juxtaglomerular complex.* The renin-angiotensin system in the regulation of blood pressure and renal function.

*The structure of the urinary tract wall:* calyx-pelvic system, ureter, bladder.

General plan of the structure of the urinary tract. Features of the structure of the female and male urethra.

## **6. Male reproductive system**

General structure of the male reproductive system, the functions of its various parts (testicle, epididymis, vas deferens, seminal vesicles, prostate gland, bulbourethral glands, external genital organs). Sources of embryonic development.

*General characteristics of the histological structure of the testicle.* The structure of the convoluted seminiferous tubules. *Spermatogenic epithelium* (spermatology, primary and secondary spermatocytes, spermatids, spermatozoa). Sertoli cells and Leydig cells, structure and function. Endocrine function of the testicle. Hemato-testicular barrier. Spermatogenesis, meiosis. Sperm maturation. The structure of a mature sperm.

Histophysiology of the rectus tubules, rete testis, and testicular efferent tubules. The epididymis. The vas deferens. The ejaculatory duct.

The histological structure of the prostate, seminal vesicles, bulbourethral glands and their functions. Age-related changes.

Penis: histological structure, function, blood supply and innervation.

## **7. Female reproductive system**

The general structure of the female reproductive system, the functions of its various parts (ovaries, fallopian tubes, uterus, vagina, external genital organs, mammary glands). Sources of embryonic development of the female reproductive system.

*Ovaries:* cortex and medulla.

The structure of *ovarian follicles*: primordial, growing (primary, secondary, tertiary), mature (Graaf's vesicle), corpus luteum and atretic bodies. The structure of the follicular membrane, the function of its cells.

The origin and maturation of the ovocyte. Gonocytes. Meiosis. Ovocytes of the I and II order, polar bodies. The ovarian cycle and its regulation. Endocrine function of the ovary, the role of sex hormones, hormones of the hypothalamus and pituitary gland. Corpus luteum (menstrual, pregnancy), white body.

*Fallopian tubes:* wall structure in various parts, function.

*Uterus:* general characteristics. Features of the structure of the uterine wall in various parts. Basal and functional layers of the mucosa, features of blood supply.

*The menstrual cycle and its hormonal regulation.* The endometrium in different phases of the menstrual cycle.

*The structure and function of the vagina.* General characteristics of the histological structure of the external genital organs.

*The structure and function of the mammary gland.* The development of the mammary glands and their changes during the ovarian-menstrual cycle, during pregnancy and lactation. Milk composition. Regulation of lactation, the role of prolactin and oxytocin in maintaining lactation.

## **8. Endocrine system I**

General characteristics of the endocrine system. Hormones and their classification. *Neuroendocrine cells of the hypothalamus*, the concept of liberins and statins. Sources of development of the pituitary gland. Cellular composition and structure of various lobes of the pituitary gland (adenohypophysis (distal part, tuberos part, intermediate part), neurohypophysis - the cellular composition, hormones produced and their functions). The concept of tropic hormones. Hormones of the neurohypophysis and their synthesis in the hypothalamus.

*Hypothalamic-pituitary system*: structure, vascularization. Hypothalamic-pituitary regulation of hormone synthesis and its mechanisms.

*Epiphysis*. The structure, the hormones produced and their function, age-related changes.

## **9. Endocrine system II**

*Adrenal glands*: sources of development, structure. Cortical substance, medulla, their structure, cellular composition, hormones and their function. Features of the blood supply.

*Pancreas*: islets of Langerhans. Cellular composition, hormones produced and their function. Regulation of blood sugar levels, hyper- and hypoglycemia.

*Thyroid gland*: sources of development, general morpho-functional characteristics. Follicle structure. Synthesis, storage and release of thyroid hormones. Functions of thyroid hormones. Hypo- and hyperthyroidism.

Parafollicular cells of the thyroid gland, their structure, produced hormones and their function.

*Parathyroid glands*: development, structure, main cells, parathyroid hormone and its function. Regulation of blood calcium levels: the role of vitamin D, bone tissue, calcitonin and parathyroid hormone. Hypo- and hypercalcemia.

*Single hormone-producing cells (diffuse neuroendocrine system)*.

## **Control 3 (topics 1-9)**

## **10. Cardiovascular system**

General characteristics: cardiovascular and lymphatic systems. General of the walls of blood and lymphatic vessels.

*Arteries*: classification (elastic, muscle type, arterioles, metarterioles), wall structure. Carotid and aortic bodies: structure and function. Carotid sinus, structure and function.

*Capillaries*: endothelial cells, pericytes, their structure and function. Capillary types: continuous, fenestrated, sinusoidal. Capillary permeability, transport of substances through the capillary wall.

*Veins and venules*: classification, wall structure, function.

*Arteriovenular anastomoses*, structure and function.

*Portal vascular systems* (liver, kidney, pituitary gland), structure, functional significance.

Features of the structure of lymphatic vessels (capillaries, vessels, trunks, ducts).

Blood supply and innervation of blood vessels.

*Heart*: general plan of structure and function. The structure of the heart wall.

Endocardium. Myocardium of the atria and ventricles. Epicardium, structural features.

Conductive system of the heart. Endocrine function of the heart

(atriopetine). Embryonic sources of development of the heart and blood vessels.

## **11. Blood**

*Blood and lymph*, their main functions. Plasma: composition, function of plasma components.

*Form elements of blood and lymph*. The basophilia, acidophilia, neutrophilia.

*Erythrocytes*: structure and function in health and disease (anisocytosis, reticulocytosis, nuclear fragmentation), hemoglobin, its types.

*Leukocytes*. Agranulocytes: lymphocytes, their types (B-lymphocytes, T-lymphocytes, T-killers, T-helpers, T-suppressors, natural killer cells), structure and functions; central lymphoid organs (thymus, red bone marrow); monocytes, structure and function. Macrophages. Granulocytes: neutrophils, eosinophils, basophils, their structure and function.

*Platelets*. Megakaryocytes. Structure and function. Factors and mechanisms of blood coagulation.

*Hematopoiesis*: history of the discovery of stem cells, the concept of stem cells,

hematopoietic stem cell, unipotent stem cell. Stages of hematopoiesis in

ontogenesis. Red bone marrow, structure and function. Erythropoiesis,

granulocytopoiesis, lymphopoiesis, monocytopoiesis, thrombocytopoiesis.

Regulation of hematopoiesis, colony-stimulating factors.

Hemogram and leukocyte formula. Age and sex characteristics of blood.

Physiological regeneration of blood and lymph, factors regulating them.

## **12. Immune system. Immunity**

*The general structure* of the lymphatic system, its components, their structure and functions: lymphocytes, aggregates of lymphocytes, lymph nodes, spleen, thymus, red bone marrow.

*Immunocompetent cells*: B-lymphocytes, plasma cells, T-lymphocytes, T-killers, T-helpers, T-suppressors, natural killer cells (NK-cells). Effector cells and memory

cells. Major histocompatibility complex, human leukocyte antigens. Macrophages. Antigen presenting cells. Reticular cells. Clonal expansion of lymphocytes. Antigens and antibodies. Antigenic determinants, epitopes. The structure of an antibody (immunoglobulin) molecule, types of antibodies, mechanisms of action. *Types of immune response, humoral and cellular immunity*. Interaction of cells in the immune response. Primary and secondary immune response. Differentiation of T-lymphocytes in the thymus.

### **13. Organ of vision**

*The structure of the eye*: fibrous, vascular and retinal membranes. The structure of the anterior and posterior chambers of the eye, cornea, iris, lens, vitreous body.

*Retina*: layers, cellular composition. The structure of photoreceptors, associative neurons and ganglion cells. Yellow and blind spots. The optic nerve. Conjunctiva, eyelids, glands, lacrimal apparatus. Sources of embryonic development of the eye.

### **14. Organs of hearing and balance**

The organ of hearing and balance: general morpho-functional characteristics. Outer ear. Middle ear. Inner ear. Bony and membranous labyrinths.

*The vestibular part of the membranous labyrinth*: elliptical and spherical sacs and semicircular canals, their receptor sections: the structure and cellular composition of the spot and ampullar crests. Innervation. Histophysiology of the vestibular labyrinth.

*The cochlear part of the membranous labyrinth*: the structure of the cochlear canal, the structure and cellular composition of the spiral organ, its innervation.

Histophysiology of sound perception. Age-related changes.

Sources of embryonic development of the organ of hearing and balance.

### **15. Practical skills training**

Working with the slides on topics 1-14.

### **Control 4 (topics 10-14)**