

## Histology with Cytophysiology

### Educational subject description sheet

#### Basic information

<b>Department</b> Faculty of Medicine  <b>Field of study</b> Medical Program  <b>Study level</b> long-cycle master's degree program  <b>Study form</b> full-time  <b>Education profile</b> general academic  <b>Disciplines</b> Medical science  <b>Subject related to scientific research</b> Yes		<b>Didactic cycle</b> 2016/17  <b>Realization year</b> 2016/17  <b>Lecture languages</b> English  <b>Block</b> obligatory for passing in the course of studies  <b>Mandatory</b> obligatory  <b>Examination</b> examination  <b>Standard group</b> A. Morphological education
<b>Subject coordinator</b>	Grzegorz Lis	
<b>Lecturer</b>	Grzegorz Lis, Ewa Jasek-Gajda, Grażyna Pyka-Fościak, Małgorzata Jasińska, Bożena Wójcik	

<b>Period</b> Semester 1	<b>Examination</b> -	<b>Number of ECTS points</b> 0.0
	<b>Activities and hours</b> lecture: 28, laboratory: 36	
<b>Period</b> Semester 2	<b>Examination</b> examination	<b>Number of ECTS points</b> 11.0
	<b>Activities and hours</b> laboratory: 28, lecture: 28	

## Goals

C1	To provide students with the knowledge concerning the microscopic and submicroscopic structure and its relations to functions of cells, tissues and organs.
C2	To familiarize students with the morphological features related to functional specialization of cells, tissues, organs.
C3	To provide students with the skills allowing them to identify different cells, tissues and organs in the light and electron microscope.

## Subject's learning outcomes

Code	Outcomes in terms of	Effects	Examination methods
<b>Knowledge - Student knows and understands:</b>			
W1	anatomical, histological and embryological denominations in Polish and English	A.W1	practical examination, multiple choice test
W2	basic cellular structures and their functional specializations	A.W4	practical examination, multiple choice test
W3	microarchitecture of tissues, extracellular matrix and organs	A.W5	practical examination, multiple choice test
<b>Skills - Student can:</b>			
U1	operate an optical microscope, including the use of immersion	A.U1	practical examination
U2	recognize histological structures corresponding to organs, tissues, cells and cellular structures in optical or electron microscopy images, describe and interpret their structure and relations between structure and function	A.U2	practical examination
U3	use anatomical, histological and embryological denominations in speech and writing	A.U5	practical examination, multiple choice test
<b>Social competences - Student is ready to:</b>			
K1	use objective sources of information	O.K7	multiple choice test
K2	formulate conclusions from own measurements or observations	O.K8	practical examination, multiple choice test

## Calculation of ECTS points

### Semester 1

Activity form	Activity hours*
lecture	24
laboratory	36
preparation for classes	80

preparation for colloquium	20
participation in examination	2
<b>Student workload</b>	<b>Hours</b> 162
<b>Workload involving teacher</b>	<b>Hours</b> 60
<b>Practical workload</b>	<b>Hours</b> 36

\* hour means 45 minutes

## Semester 2

Activity form	Activity hours*
laboratory	28
lecture	20
preparation for classes	40
preparation for examination	77
participation in examination	3
<b>Student workload</b>	<b>Hours</b> 168
<b>Workload involving teacher</b>	<b>Hours</b> 50
<b>Practical workload</b>	<b>Hours</b> 28

\* hour means 45 minutes

## Study content

No.	Course content	Subject's learning outcomes	Activities
1.	Introduction to histology. Light and electron microscopy. Magnification and resolving power. Preparation of the tissues for light and electron microscopy. Basic histological methods. Principles of histochemistry, enzyme histochemistry, immunohistochemistry and hybridization techniques.	W1, U1, K1, K2	laboratory

2.	The cell - The biological membranes. Transport across the membranes. The cell membrane, glycocalyx, adhesion molecules. The cell nucleus. The nucleolus. The nuclear envelope and communication between the nucleus and the cytoplasm. Structure and function of ribosomes, the translation process. The endoplasmic reticulum (smooth and rough). The Golgi apparatus. Exo- and endocytosis, including receptor-mediated endocytosis. Lysosomes. Proteasomes. Mitochondria. Genetic apparatus and biogenesis of mitochondria. Peroxisomes. The cytoskeleton and its involvement in the motility of cells. Cell death: necrosis and apoptosis.	W1, W2, U1, U2, U3, K1, K2	laboratory, lecture
3.	The epithelial tissue. Definition and components of a tissue. General characteristics and functions of epithelia. Classification and characteristics of different types of epithelia. Introduction to stem cells and renewal of the epithelia. Epithelial cell polarity. Free surface of the epithelial cells and its structures: microvilli and cilia, mechanism of ciliary movement. The basolateral surface: cell-cell and cell-matrix junctions, their structure and functions. Basal lamina. Glands: morphological and functional classification.	W1, W2, W3, U1, U2, U3, K1, K2	laboratory, lecture
4.	The connective tissue proper. Chemical and structural characteristics of the extracellular substance: matrix and fibers. Stages of collagen fiber production. Mesenchymal stem cells. Origin, structure and function of the connective tissue cells: fibroblasts, plasma cells, mast cells and macrophage family. General classification of connective tissue. Characteristics of connective tissue proper types. The comparative characteristics of white and brown adipose tissue.	W1, W2, W3, U1, U2, U3, K1, K2	laboratory, lecture
5.	Cartilage and bone. Cartilage: characteristics of the extracellular substance, chondral territories, nourishment of cartilage. Types of cartilage and their mechanical properties. Bone: organic and inorganic components of the extracellular substance. Bone cells: osteoprogenitor cells, osteoblasts, osteocytes, osteoclasts. The bone lamella, organization of cancellous and compact (Haversian) bone. Intramembraneous and endochondral ossification. Growth and remodelling of the bone. Principles of biomineralization. The joint.	W1, W2, W3, U1, U2, U3, K1, K2	laboratory, lecture
6.	Blood and hemopoiesis. Blood plasma. Blood cells, their counts, characteristics and functional adaptations. Erythrocyte and its cell membrane. Comparative characteristics of granulocytes and agranulocytes. The role of granulocytes in the defense mechanisms: neutrophils and bacteria-killing system, eosinophils, basophils. Lymphocytes – general characteristics. Monocytes and their functions. Blood platelets. The structure of hemopoietic bone marrow: the vascular and hemopoietic compartments. Hemopoiesis: stem cells, progenitor cells, the main hemopoietic lineages (erythroblastic, myeloblastic, megakaryocytic). Factors controlling the hemopoiesis.	W1, W2, W3, U1, U2, U3, K1, K2	laboratory, lecture

7.	The muscle tissue. The contractile apparatus. Classification of the muscle tissue. Characteristics of smooth, skeletal and cardiac muscle cells/fibres. Structural and biochemical basis of smooth and striated muscle contraction. Sarcomere, its structure, contractile, regulatory and accessory proteins. The role of T-tubules and sarcoplasmic reticulum in excitation-contraction coupling. Motor end plate. Satellite cells. The organization of smooth muscle layer, skeletal muscle, and cardiac muscle including the conduction system. Muscle spindle and Golgi tendon organ. The nonmuscle contractile cells.	W1, W2, W3, U1, U2, U3, K1, K2	laboratory, lecture
8.	The nerve tissue. Definition of the neuron and its structural characteristics. Classification of neurons. Neural stem cells. Types of nerve fibers. Structural and chemical basis of neural conduction: resting and action potentials, the role of ion channels and myelin sheath. Structure and types of synaptic junctions, neurotransmitters, the synaptic transmission. Paracrine transmission. Types and functions of neuroglial cells. Organization of peripheral nerve and dorsal root ganglion. Central nervous system: composition of white and grey matter, microscopic organization of the spinal cord, cerebral and cerebellar cortex. The blood-brain barrier. Meninges and choroid plexus.	W1, W2, W3, U1, U2, U3, K1, K2	laboratory, lecture
9.	The vascular system. Components of the vascular wall. Endothelium – structural characteristics and functions. Mechanisms of transendothelial transport of substances and migration of leukocytes. Endothelial progenitor cells. The structure and types of capillaries. Precapillaries (metaarterioles) and postcapillary venules. Regulation of blood flow in capillary bed. Layers of the vascular wall, comparative characteristics of arteries and veins. Arterioles and arteries (muscular and elastic). The veins and their structural variability. Arteriovenous anastomoses. Carotid and aortic bodies, carotid sinus. The heart wall layers.	W1, W2, W3, U1, U2, U3, K1, K2	laboratory, lecture
10.	The lymphatic system. The innate immunity: pattern recognition receptors, NK cells. The adaptive immunity: cells involved in the immune reactions - antigen presenting cells, T- and B-lymphocytes and their subpopulations, characteristics and cooperation. Humoral and cell-mediated immune response. The lymphoid tissue and its organization. The lymphoid node. Structure and function of the lymph node. Spleen - organization and functions of white and red pulp, the splenic circulation. Thymus: general organization, epithelioreticular cell system and its role in the differentiation and maturation of T lymphocytes. Mucosa-associated lymphoid tissue: the tonsils.	W1, W2, W3, U1, U2, U3, K1, K2	laboratory, lecture
11.	The integument. Layers of the integument. Epidermis: keratinocytes and the keratinization process, melanocytes, Langerhans and Merkel cells and their functions. Organization of dermis and hypodermis. Eccrine and apocrine sweat glands and sebaceous glands: structure, function and mode of secretion. The hair follicle and its appendages. Epidermal stem cells. Vascularization and innervation of the skin, types of encapsulated mechanoreceptors and their function. Comparative characteristics of thick and thin skin.	W1, W2, W3, U1, U2, U3, K1, K2	laboratory, lecture

12.	The alimentary system - Oral cavity and salivary glands. Definition and general characteristics of mucosa. Regional differentiation of oral mucosa. The tongue: lingual papillae, taste buds, mechanism of taste perception. Tooth: structure of the mineralized parts, dental pulp and periodontal membrane. The major and minor salivary glands: the secretory portions of serous and mucous type, structure and function of excretory ducts. Comparative characteristics of major salivary glands. General organization of the alimentary canal, characteristics of the wall layers. The esophagus. The wall of stomach: surface lining epithelium and its protective function, characteristics of the gastric glands and their cellular composition. The intestines and their adaptations to function (intestinal epithelium, villi and crypts), segmental differences in the wall structure. The gut-associated lymphoid tissue. Innervation of the alimentary canal. The enteroendocrine cells.	W1, W2, W3, U1, U2, U3, K1, K2	laboratory, lecture
13.	Large glands of the alimentary system. The pancreas - organization of the exocrine part, characteristics of the secretory pancreatic cell, acini and ducts. General organization of the liver, types of hepatic lobules. Structural and functional characteristics of the hepatocyte and its polarity. The hepatic sinusoids and associated cells. The hepatic circulation. Intra- and extrahepatic bile ducts.	W1, W2, W3, U1, U2, U3, K1, K2	laboratory, lecture
14.	The respiratory system. The airways - characteristics of the mucosa, the airway epithelium and its cell types, the mucociliary cleaning mechanism. Nasal mucosa: the respiratory and the olfactory regions. Olfactory epithelium: cell types and functions. Pharynx and larynx. The structure of trachea, bronchi and bronchioles. General organization of the lungs. The pulmonary alveoli: types and functions of pneumocytes, air-blood barrier, the surfactant and its role. The alveolar macrophages.	W1, W2, W3, U1, U2, U3, K1, K2	laboratory, lecture
15.	The endocrine system. General characteristics of endocrine glands. The pituitary gland: adeno- and neurohypophysis. The functional interrelations between hypothalamus and the pituitary, the role of the vascular system. Morphological and functional classification of cells in adenohypophysis, structure and function of pars nervosa. General organization of thyroid gland. The thyroid follicle: its cells and stages of thyroid hormone production. The C-cells. Adrenal cortex, its layers and hormones. The ultrastructural features of steroidogenic cells. Adrenal medulla: chromaffin cells and production of catecholamines. The pancreatic islets: ultrastructural and functional characteristics of their cells. The parathyroid glands - cell types and function. The pineal gland. The system of disseminated neuroendocrine cells (DNES, APUD). Molecular mechanisms of chemical signaling. Types of chemical signals and principles of chemical signaling. Receptor types. Membrane receptors. Signal transduction involving G-proteins, second messengers and their action. Enzyme-linked membrane receptors. Intracellular receptors and the mechanisms of cell response.	W1, W2, W3, U1, U2, U3, K1, K2	laboratory, lecture

16.	<p>The female reproductive system. The ovary - ovarian follicles and their successive developmental stages. The structure of the Graafian follicle. Follicular atresia. Formation, structure and function of corpus luteum, luteolysis and corpus albicans. Endocrine cells of the ovary. The oviduct: layers of the wall, characteristics of epithelium. The structure of uterine wall, changes of endometrium in the course of the menstrual cycle. The uterine cervix and vagina. Exfoliative cytology of cervical smears. Accessory organs of the female reproductive system. General organization of placenta. Formation, development and maturation of placental villi, characteristics of the placental barrier. The syncytiotrophoblast and its function. Decidua and basal plate: decidual cells, extravillous cytotrophoblast and its role. The histological structure of fetal membranes and umbilical cord. Cord blood as a source of stem cells. The mammary gland - general organization and changes related to development and functional status. Structure of secretory portion (alveolus), the secretory cell and mechanisms of milk secretion. The excretory ducts.</p>	W1, W2, W3, U1, U2, U3, K1, K2	laboratory, lecture
17.	<p>The male reproductive system. The testis - general structure. The seminiferous tubule and its tunica propria. The seminiferous epithelium, spermatogenesis. Structure of the mature spermatozoon. Sertoli cells and their functions, the blood-testis barrier. The interstitial tissue: Leydig cells, testicular macrophages. The excretory passages: tubuli recti, rete testis, epididymis and vas deferens. Structure and function of associated glands: prostate, seminal vesicles and bulbourethral glands.</p>	W1, W2, W3, U1, U2, U3, K1, K2	laboratory, lecture
18.	<p>The urinary system. The kidney: cortex and medulla. Nephron and the localization of its segments in the renal parenchyma. The renal corpuscle and filtration barrier, mechanism of ultrafiltration. Structural and functional characteristics of the successive segments of the nephron. The collecting tubule and its role in urine condensation. The juxtaglomerular apparatus: its components and their function. Renal blood vessels. The excretory passages: ureter and urinary bladder. Adaptation of the urinary bladder to the filling/voiding cycle.</p>	W1, W2, W3, U1, U2, U3, K1, K2	laboratory, lecture
19.	<p>The organ of vision. General organization of the eyeball and its layers. The sclera and cornea. The choroid and structures responsible for accommodation and adaptation: ciliary body and iris. Production and circulation of the aqueous humor. The lens. The retina: layers, characteristics of cones and rods, molecular basis of photoreception. Macula lutea and optic disk. The eyelid: conjunctiva, tarsal plate, glands. The lacrimal gland.</p>	W1, W2, W3, U1, U2, U3, K1, K2	laboratory, lecture

20.	The organ of hearing and balance. External ear: auricle and external auditory meatus, tympanic membrane. Middle ear: tympanic cavity, auditory ossicles, auditory tube, cavities of the mastoid process. Inner ear: bony and membranous labyrinth. Saccule and utricle, semicircular ducts, endolymphatic duct and sac, cochlear duct. Structure and function of sensory structures: maculae, cristae and the organ of Corti. Characteristics of hair cells and supporting cells, morphological and molecular basis of hearing and balance.	W1, W2, W3, U3, K1, K2	lecture
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## Course advanced

### Semester 1

#### Teaching methods:

classes / practicals, lecture

Activities	Examination methods	Credit conditions
lecture	multiple choice test	Passing mini-quizes (MCQ) concerning all subjects (approx. 9 questions in each). The mid-term MCQ exam (80 questions, 60% pass level), covering the material concerning the cell and the tissues (Cell & Tissues exam). A student who fails the exam will be allowed to retake it in about two weeks time. The final theoretical exam (MCQ, 100 questions, 60% pass level), covering the material concerning histology of systems and organs.
laboratory	practical examination, multiple choice test	The practical (laboratory) exam: Identification of cells/tissues/organs and their specific structures in 13 microscopic slides and 2 electron micrographs. This part is evaluated on the pass/fail basis, pass level 9 pts. 2. the theoretical part (MCQ, 100 questions, 60% pass level), covering the material concerning histology of systems and organs. Passed lab mini-tests.

### Semester 2

#### Teaching methods:

classes / practicals, lecture

Activities	Examination methods	Credit conditions
laboratory	practical examination, multiple choice test	Basic knowledge during labs (minitests). Theory included to mid-term and final exams. The practical (laboratory) exam: Identification of cells/tissues/organs and their specific structures in 13 microscopic slides and 2 electron micrographs. This part is evaluated on the pass/fail basis, pass level 9 pts.
lecture	multiple choice test	Passing the theoretical part of the final exam (MCQ, 100 questions, 60% pass level), covering the material concerning histology of systems and organs..



**Additional info**

Requirements to get the credit and to be allowed to take the final exam: Completed labs and lectures and passed the Cell & Tissues exam. Students who fail the Cell & Tissues retake will have to retake it once more, before the final exam.

**Entry requirements**

none

**Literature****Obligatory**

1. Mescher: Junqueira's Basic Histology: Text and Atlas. 14th ed., 2015 or later

**Optional**

1. Gartner: Textbook of Histology. 4th ed. 2012 Elsevier or later

## Standard effects

Code	Content
A.U1	operate an optical microscope, including the use of immersion
A.U2	recognize histological structures corresponding to organs, tissues, cells and cellular structures in optical or electron microscopy images, describe and interpret their structure and relations between structure and function
A.U5	use anatomical, histological and embryological denominations in speech and writing
A.W1	anatomical, histological and embryological denominations in Polish and English
A.W4	basic cellular structures and their functional specializations
A.W5	microarchitecture of tissues, extracellular matrix and organs
O.K7	use objective sources of information
O.K8	formulate conclusions from own measurements or observations