

Semmelweis University
Department of Anatomy, Histology and Embryology
2020/2021

Faculty of Medicine
2nd year / 1st semester

MICROSCOPIC ANATOMY HANDBOOK



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Microscopic Anatomy and Embryology II

TEACHING DEPARTMENT:

SEMMELEI UNIVERSITY

Department of Anatomy, Histology and Embryology

Budapest, Tűzoltó utca 58.

H-1094 Budapest

<http://semmelweis.hu/anatomia>

LEARNING OBJECTIVES

Histology - Demonstration of the fine structure of cells and tissues composing the organs of the human body specifically to provide the future clinicians/medical doctors with a valid body of information describing the microscopical elements of clinically significant morphological structures (including cell biology, general histology and the histology of organs).

Embryology – the subject demonstrates the steps of the formation of a new human being together with the stages of intrauterine development, including the clinically relevant aspects of the development of organ systems. Teaching is done in the form of lectures and histology laboratory practical classes

Competences acquired by completion of the course:

Understanding the microscopical composition of the human body together with the understanding of human development in order to draw parallels with macroscopical anatomy. Clear understanding of histological structure and function. Ability to identify basic structural elements within the tissue specimen. Identification of general directions/landmarks within digitized tissue slides.

LECTURES: First semester: 2 x 45 min; second semester: 2 x 45 min.

PRACTICAL CLASSES: First semester: 3 x 45 min; second semester: 2 x 45 min.

ECTS CREDITS: Altogether 9 (first semester: 5; second semester: 4).

MIDTERM TESTS: Written (in the Moodle system)

ACCEPTANCE OF THE SEMESTER:

Active participation in laboratory sessions is obligatory for every student. Students should attend at least 75% of the scheduled hours to gain a signature proving the validity of the semester. Absences are therefore limited in **25%**. Attendance will be recorded in the classes.

TYPE OF EXAMS: oral and written

First semester: semifinal examination (oral), second semester: final exam (oral and written)

The final examination consists of written and oral (practical and theoretical) parts

1. Written pretest (e-learning module – access to SeKA account is obligatory)
2. Oral examination (identification of structures on digitized histological slides) including relevant theoretical questions from the fields of Histology and Embryology

COURSE DESCRIPTION

Microscopic Anatomy and Embryology II.

Lectures and histology classes

Subject matter: Histology of the lymphatic system, together with the histology and developmental aspects of the central and peripheral nervous systems, endocrine organs and organs of special senses, including the skin.

Credits: 4

Prerequisites: Cell sciences, Microscopic Anatomy I.

Academic Year 2021/2022

EM II. Microscopic Anatomy and Embryology II.

Weeks	Lectures (Mondays 14.00-15.40 EM 1-10 Lenhossék, EM 11-20 Huzella)	Lecturer Lenhossék	Lecturer Huzella	Histology laboratory <i>Tuesdays EM 1-6 12.00-13.30 and EM 7-12 14.00- 15.30 Wednesdays EM 13-17 10.00-11.30 Fridays EM 18-19 8.00-9.30</i>
Week 1 09. 6-10.	1. Cellular components of lymphatic tissue. Thymus, tonsils, MALT 2. Structure and circulation of lymph nodes and spleen	1 Puskár 2 Puskár	1 Nagy 2 Nagy	Thymus, tonsils 43a, 43c, 47, 42a, 42b, 46, 48
Week 2 09. 13-17.	3. Microscopy of the CNS – fine structure of the spinal cord (spinal reflexes, receptors, effectors, monosynaptic/proprioceptive reflexes 4. Microscopy of the CNS – Nociceptive (withdrawal) and autonomic reflex arcs	3 Kozsurek 4 Puskár	3 Horváth 4 Vereczki	Lymph node, spleen 40, 45, 1a, 1b
Week 3 09. 20-24.	5. Microscopy of the CNS – Nerve tissue. Fine structure of the cerebral cortex 6. Microscopy of the CNS – Diencephalon, thalamic nuclei	5 Pálfi 6 Dobolyi?	5 Tóth Zs 6 Vereczki	Histology of the peripheral nervous system 88, 67, 53, 79, 75, 6, 151b, 33b
Week 4 09.27 - 10. 1.	7. Microscopy of the CNS – Sensory systems, epicritical and protopathic sensibilities 8. Microscopy of the CNS – Motor systems, pyramidal tract	7 Ádám 8 Hanics	7 Csáki 8 Katz	Histology of the central nervous system 101, 22, 111, 80, 96, 16, 20
Week 5 10. 4-8.	9. Microscopy of the CNS – Brainstem nuclei and pathways. Brainstem monoaminergic systems 10. Microscopy of the CNS – Structure and connections of the basal ganglia.	9 Kálmán 10 Ádám	9 Dóra 10 Horváth	Midterm test 1 (Histology slides of weeks 1-4) Microscopy of the CNS – consultation 1.
Week 6 10. 11-15.	11. Microscopy of the CNS – Microscopy of the cerebellum, pathways 12. Microscopy of the CNS – Limbic system	11 Dobolyi 12 Kocsis	11 Ádám 12 Dobolyi	Microscopy of the CNS – consultation 2.
Week 7 10. 18-22.	13. Microscopy of the CNS – Hypothalamus, the hypothalamo-hypophysial system 14. Microscopy of the CNS – Endocrine organs (pineal, thyroid, parathyroids, adrenal glands)	13 Tóth Zs 14 Barna	13 Minkó 14 Katz	Microscopy of the CNS – consultation 3. No classes on Friday
Week 8 10. 25-29.	15. Development of the neural tube. Cranio-caudal and dorso-ventral differentiation 16. Differentiation of the brain vesicles	15 Kálmán 16 Kálmán	15 Csáki 16 Nagy	Microscopy of the CNS – consultation 4. Development of the CNS
Week 9 11. 1-5. Nov. 1 National Holiday	17. Formation and derivatives of the neural crest and placode ectoderm 18. Development of the skull	17 Nagy 18 Székely ONLINE ELŐADÁSOK		Midterm test 2 Microscopy of the CNS, Development of the nervous system Endocrine system 1. Hypothalamus, pituitary gland 14, 105a
Week 10 11. 8-12.	19. Development of the vertebral column, limb development 20. Skin and appendages. Mammary gland	19 Nemeskéri 20 Kocsis	19 Nagy 20 Székely	Endocrine system 2. Thyroid, parathyroid and adrenal glands, pineal body, endocrine cells 102, 104, 32, 70, 44, 97
Week 11 11.15-19.	21. Fibrous and vascular coats of the eyeball. Lens, chambers of the eye, vitreous body, accommodation 22. Inner coat of the eyeball, retina	21 Tóth Zs 22 Kozsurek	21 Szél 22 Szél	Histology of palm skin, scalp skin. Mammary gland 59, 153, 11, 107, 93 Palpebra 39
Week 12 11. 22-26	23. Optic nerve, visual pathway, visual reflexes. Development of the eye 24. External ear, middle ear - tympanic cavity, tympanic membrane, auditory ossicles	23 Ádám 24 Pálfi	23 Lendvai 24 Katz	Histology of the organ of vision: eye bulb, retina, lacrimal gland 29, 30, 113
Week 13 11.29-12.3.	25. Bony and membranous labyrinth. Vestibular system 26. Spiral organ of Corti. Auditory pathway. Development of the organ of hearing	25 Hanics 26 Nemeskéri		Histology of the organ of hearing cochlea, macula 36, 4
Week 14 12. 6-10.	27. Microscopy of the CNS – Olfactory and gustatory systems 28. Drugs of abuse, opiates and receptor mediated actions in the CNS	27 Kocsis 28 Wenger		Revision

List of slides

Weeks	Histology laboratory <i>Tuesdays EM 1-6 12.00-13.30 and EM 7-12 14.00- 15.30</i> <i>Wednesdays EM 13-17 10.00-11.30 Fridays EM 18-19 8.00-9.30</i>
Week 1 09. 6-10.	Lymphatic system 1 43.a Thymus (HE) 43. c Thymus 47. Palatine tonsil (HE) 42.a Palatine tonsil (CD20 immunocytochemistry) 42.b Palatine tonsil (CD3 immunocytochemistry) 46. Lingual tonsil (HE) 48. Pharyngeal tonsil (HE)
Week 2 09. 13-17.	Lymphatic system 2 Lymph node, spleen 40. Lymph node (rat, semithin, toluidine blue) 45. Spleen (human, HE) 1.a Spleen (CD20 immunocytochemistry) 1.b Spleen (CD3 immunocytochemistry)
Week 3 09. 20-24.	Histology of the peripheral nervous system 88. Peripheral nerve (sciatic nerve, HE) 67. Autonomic ganglion (celiac ganglion, Bielschowsky's impregnation) 53. Autonomic ganglion (submandibular gland, HE) 75. Motor end plate (cholinesterase enzyme histochemistry) 79. Spinal cord + dorsal root ganglion (Luxol Fast blue + cresyl violet) 6. (Vater-)Pacinian corpuscle (plantar skin, HE) 151b, 33.b
Week 4 09.27 - 10. 1.	Histology of the central nervous system 101. Spinal cord (Luxol Fast blue + cresyl violet) 111. Cortex cerebri (Bodian) 22. Cortex cerebri (pre- and postcentral gyri, Nissl) 80. Cerebellar cortex (HE) 96. Cerebellar cortex (neurofilament immunocytochemistry) 20. Hippocampus + choroidal plexus (Nissl) 16. Mesencephalon (Luxol fast blue + cresyl violet)
Week 5 10. 4-8.	Midterm test 1 (Histology slides of weeks 1-4) Microscopy of the CNS – consultation 1.
Week 6 10. 11-15.	Microscopy of the CNS – consultation 2.
Week 7 10. 18-22.	Microscopy of the CNS – consultation 3. No classes on Friday
Week 8 10. 25-29.	Microscopy of the CNS – consultation 4. Development of the CNS
Week 9 11. 1-5. Nov. 1 National Holiday	Midterm test 2 Microscopy of the CNS, development of the nervous system Endocrine system 1. 14. Hypothalamus (Chrom haematoxylin floxin/ GÖMÖRI) 105. Pituitary gland (Chrom haematoxylin floxin/GÖMÖRI)
Week 10 11. 8-12.	Endocrine system 2. 44. Pineal body (HE) 102. Thyroid gland (HE) 104. Parathyroid gland (HE) 32. Suprarenal gland (HE) 70. Endocrine pancreas/ islands of Langerhans (HE) 97. Corpus luteum (HE)
Week 11 11.15-19.	Histology of palm skin, scalp skin. Mammary gland 59. Palm skin (HE) 153. Glomus organ, nail (HE) 11. Scalp skin (HE) 107. Mamma lactans (HE) 93. Mamma non lactans (HE) Histology of the organ of vision 1 39. Eyelid (HE)
Week 12 11. 22-26	Histology of the organ of vision 2 29. Eye bulb (HE) 30. Retina (semithin, toluidine blue) 113. Lacrimal gland (HE)
Week 13 11.29-12.3.	Histology of the organ of hearing 36. Cochlea / organ of Corti (semithin, toluidine blue) 4. Macula (semithin, toluidine blue)
Week 14 12. 6-10.	Revision

SUBJECT MATTER OF THE PRESENT SEMESTER

I. Histology of lymphatic organs

II. Neurohistology

- a) Histology of neurons and supporting elements
- b) Fine structure of peripheral nerves
- c) Receptors and effectors, interneuronal synapses
- d) Histology of the brain and spinal cord

II. Development of the locomotor system

- a) Membranous and cartilaginous neurocranium and viscerocranium
- b) Development of the limbs and vertebral column
- c) Development of the muscular system

III. Development of the nervous system and organs of special senses

- a) Development and primary differentiation of the neural tube
- b) Development of the peripheral nervous system (neural crest, placodes)
- c) Development of the organ of vision
- d) Development of the organ of hearing&equilibrium

V. Microscopy of the central nervous system

- a) Microscopic anatomy of brain and spinal cord
- b) Nuclei and tracts of brain and spinal cord
- c) Microscopy of the autonomic nervous system, tracts

III. Organs of special senses (histology and embryology)

- a) Organ of vision, visual pathways
- b) Organ of hearing and equilibrium, auditory pathways, vestibular system
- c) Organ of smell, olfactory pathways
- d) Organ of taste, gustatory pathways
- e) Skin and appendages

IV. Endocrine organs (histology and embryology)

- a) Hypothalamo-hypophysial system
- b) Endocrine glands and cells

Midterm test I. Written midterm (Moodle)
Topic: Histology of the lymphatic system, histology of the nervous system
Date: 5th week

Midterm test II. Written (Moodle)
Topic: Microscopy and development of the central nervous system.
Date: 9th week

Final examination

- Topics:** Subject matter of the two semesters
1. Written pretest
 2. Oral examination (2 digitized tissue slides, including theoretical relevances).

EM II ANNOUNCEMENTS

Evaluation is made using a five-grade scale (1-5).

Signing of the lecture book: active participation in histology lab sessions is obligatory. Students should attend at least 75% of the scheduled hours, including the obligatory midterm examination, to gain a signature proving the validity of the semester. Absences are therefore limited in **25%**.

Mid-term examinations: During the semester, both practical and theoretical knowledge will regularly be evaluated. There are two written (Moodle) midterm tests during the semester. Attendance at these midterms is obligatory. Students absent from the test should reattend at a given timepoint or their semester will not be accepted.

Exemptions/bonus marks - if the average of the two midterm marks is at least 4.00, students may earn a „*bonus mark*” to be counted with the examination marks at the final examination. Bonus marks are calculated as follows: good (4) - if the midterm results equal to 4+4 or 3+5; excellent (5)- if the midterm results equal to 4+5 or 5+5.

Please note that only marks from the first, official, attempt are counted in, marks earned at the retake midterm are not considered. Furthermore, the result of the first attempt cannot be improved by taking the retake midterm.

FINAL EXAMINATION

Topics: Subject matter of the two semesters

Written pretest (moodle)

Composition: 30% Histology, 40% Microscopy of the nervous system, 30% Embryology

Oral examination (identification of structures on 2 digitized tissue slides, as well as theoretical relevances from the subject matter of the two semesters (see the Topic list).

Students may request an oral examination to replace the written theoretical part for the 2nd or 3rd retakes of the final examination. The request will have to be submitted in writing with the Course Director 48 hours prior to the date of the final examination.

WORK / ENVIRONMENTAL PROTOCOL AND INFECTION CONTROL

GENERAL RULES

1. Please keep a **1.5 -2 m social distance** towards everybody.
2. Do not touch, or come into close contact with, other people (e.g., no handshakes).
3. Frequently wash your hands using soap and warm water.
4. Sanitise your hand frequently.
5. Do not touch your face or eye.
6. It is **STRICTLY FORBIDDEN** to smoke/vape, consume food, drinks or chewing gum **anywhere** on the premises of the department (including lecture halls, dissection rooms, histology laboratories or on the hallways, staircases).
7. No smoking/vaping or the consumption of alcoholic beverages is allowed in the yard.
8. Use paper tissues in case you cough or sneeze and dispose of them immediately in the designated bins.

SPECIFIC RULES CONCERNING THE HISTOLOGY LABORATORIES

1. Use hand sanitizers upon entering.
2. You may clean the surfaces with sanitizing towels before you start using them.
3. Food and drinks are **strictly forbidden** on the premises of the department.

FIRE SAFETY PROTOCOL

Please make sure to adhere to the rules of fire safety regulation with full compliance, paying special attention to the following:

1. The use of naked light or smoking is **STRICTLY PROHIBITED** on the premises of the Department, including the building and the yard.
2. In case of fire, a loud fire alarm signal is to ring throughout the building. In case of a fire drill, the building must be left organized, with the guidance of the teacher/instructor of the group, using the exits as quick as possible. Escape routes are illustrated on every floor.
3. The use of elevators is **STRICTLY PROHIBITED** during a fire drill.
4. Every lecture room has 3 accessible entrances/exits. Students usually enter and leave through the lower single entrance under normal circumstances. When necessary, i.e. in case of fire, the upper 2 doors could also be opened using the keys kept in the fire cassettes next to the doors.
5. All fire cases or signs/ suspicion of a possible fire should be reported to the teacher of the group.
6. No electrical devices should be plugged in a connector/socket different from the designated ones. Only electrical devices in an intact and perfect condition should be used.

LIST OF TEXTBOOKS

Langmann's Medical Embryology, 13th Edition by TW Sadler, Wolters Kluwer, ISBN 9781469897806, 2014

Histology: A Text and Atlas: With Correlated Cell and Molecular Biology; 7th Edition by MH Ross and W Pawlina ; Wolters Kluwer 2015, ISBN 9781451187427

Wheater's Functional Histology, A Text and Colour Atlas, 6th Edition by B Young, G O'Dowd and P Woodford Churchill Livingstone, Edinburgh, 2013, ISBN 9780702047473

Stevens & Lowe's Human Histology, Elsevier, 4th ed ISBN 978-0-723435020, 2015.

Functional Anatomy, Histology and Embryology for medical and dental students by M. Réthelyi and J. Szentágothai, Medicina, 2018.

RECOMMENDED LITERATURE

The Developing Human – Clinically Oriented Embryology, 10th ed. by KL Moore, TVN Persaud and M Torchia, Saunders, 2015; ISBN 9780323313384

Histology Manual 1-3. by A. Nemeskéri and K. Kocsis: István Apáthy's Foundation, 2019.

A. L. Kierszenbaum Histology and Cell Biology: An Introduction to Pathology, 4th Edition, Paperback with STUDENT CONSULT Online Access and E-Book ISBN: 9780323085885; 2015

Junqueira's Basic Histology: Text and Atlas; 13th Edition by Anthony Mescher, New York, McGraw-Hill Medical, 01/03/2013 ISBN13 978007178033

Further study aids:

To be downloaded from the homepage of the Department of Anatomy, Histology and Embryology (<http://semmelweis.hu/anatomia>) or from Knowledgebase on the Library homepage: (https://lib.semmelweis.hu/knowledge_base).

TOPIC LIST OF THE FINAL EXAMINATION

(Written pretest and 2 Histology slides)

General Histology

Concept of basic tissues
Definition and classification of epithelial tissue
Simple epithelia
Stratified epithelia
Membrane specializations of epithelia
Glandular epithelia
Pigment epithelium, sensory neuroepithelium
Cells of connective tissue
Ground substance and fibres of connective tissue
Types of connective tissue
Blood and the corpuscular elements of blood
Histology of the bone marrow, maturation of erythrocytes and platelets
Differentiation of granulocytes, lymphocytes and monocytes
Histology of cartilage
Histology of the bone tissue
Intramembranous ossification
Endochondral ossification
Growth and remodeling of bone
Smooth muscle and myoepithelial cells
Skeletal muscle tissue
Cardiac muscle tissue
Nervous tissue

Histology of organs

Histological structure of arteries and arterioles
Composition of capillaries and veins
Wall structure of hollow organs
Histology of the lip, tongue and teeth
Structure of the esophagus
Histology of the airways (epiglottis, larynx, trachea, lung)
Histology of the stomach
Structure of the small and large intestines
Histology of the liver and biliary passages including the gall bladder
Histology of the pancreas
Histology of the kidney and the urinary passages (ureter, urinary bladder)
Histology of the testicles together with the epididymis
Histology of the prostate, seminal vesicle, spermatic cord
Histology of the penis
Histology of the ovary, uterine tube; corpus luteum
Histology of the uterus
Histology of the vagina
Placenta, umbilical cord

General Embryology

Spermatogenesis, spermiogenesis
Oogenesis
Fertilization, cleavage of the zygote
Blastocyst formation; the bilaminar embryonic disc
Implantation

Formation of body axes, parts of the early embryo (yolk sac, amnion, chorion, body stalk)

Gastrulation

Formation of the intraembryonic mesoderm; the notochord

Neurulation (neural tube and neural crest)

Derivatives of ectoderm, endoderm and mesoderm

Folding of the embryo

The structure and function of the placenta

Development of the fetal membranes (chorion and amnion), umbilical cord

Twin formation

Development of internal organs

Development of the primitive vascular systems

Development of the heart

Development of arteries

Development of veins (inferior vena cava, portal vein, superior vena cava, azygos and hemiazygos)

Fetal circulation

Face development (oral and nasal cavities)

Development and differentiation of the foregut

Derivatives of pharyngeal pouches and grooves

Derivatives of pharyngeal arches

Development of the tongue, tooth development

Development and differentiation of the midgut

Development and differentiation of the hindgut

Formation of the liver and pancreas

Development of the peritoneum

Development of the lower airways including the lungs

Development of the diaphragm, divisioning of the body cavities

Kidney development

Development of the urinary passages

Gonadal development, formation and migration of primordial stem cells

Development of the male genital tract

Development of the female genital tract

Development of the male/female external genitals

Lymphatic organs

Lymphatic tissues in general, cellular components

Histological structure of lymph nodes

Spleen (fine structure and circulation)

Thymus

Tonsils, MALT

Development of the nervous system and organs of special senses

Development and primary differentiation of the neural tube

Development of brain vesicles

Development of the peripheral nervous system (neural crest, placodes)

Development of the organ of vision

Development of the organ of hearing&equilibrium

Development of the locomotor system

Membranous and cartilaginous neurocranium and viscerocranium

Development of the limbs and vertebral column

Development of the muscular system

Neurohistology

Histology of the neurons developing from the neural tube

Glial cells

Histology of the neurons and supporting cells developing from the neural crest

Fine structure of peripheral nerves

Receptors and effectors

Interneuronal synapses

Microscopy of the central nervous system

Fine structure (microscopy) of the spinal cord

Proprioceptive reflexes

Nociceptive reflexes

Autonomic reflexes

Fine structure of the medulla oblongata

Fine structure of the pons

Fine structure of the midbrain

Classification of cranial nerve nuclei

Tracts of the brain stem

Reticular formation, monoaminergic systems

Fine structure of the cerebellum

Cerebellar afferents and efferents

Fine structure of the thalamus

Hypothalamo-hypophyseal system

Fine structure of the basal ganglia

Fine structure of the cerebral cortex, cortical fields

Tracts of the protopathic sensibility (anterolateral system)

Tracts of the epicritic sensibility (posterior funiculus/medial lemniscus)

Corticospinal tract (pyramidal tract)

Extrapyramidal system

Limbic system (nuclei and tracts)

Microscopy of the autonomic nervous system, tracts

Endocrine organs

Microscopical anatomy and development of the pituitary gland. Portal circulation

Microscopical anatomy of the pineal gland

Microscopical anatomy and the development of the thyroid gland

Microscopical anatomy and the development of the parathyroid gland

Microscopical anatomy and the development of the suprarenal gland

Histology of the islands of Langerhans

Organs of special senses

Microscopical structure of the skin (scalp and palm)

Histology of the mammary gland (mamma lactans et non-lactans)

Coats of the eyeball

Chambers of the eye, vitreous body

Lens, accommodation

Visual pathway, visual reflexes

External ear, tympanic membrane. Tympanic cavity, auditory tube, hearing ossicles.

Organ of Corti. Auditory pathway

Vestibular system

Bony and membranous labyrinth

Cochlea and cochlear duct

Organs of olfaction and taste