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:
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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)

ACCEPTENCE 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 2020/2021
EM II. Microscopic Anatomy and Embryology II.

<table>
<thead>
<tr>
<th>Weeks</th>
<th>Lectures (online)</th>
<th>Lecturer</th>
<th>Departmental personal consultations</th>
<th>Groups in lecture halls</th>
<th>Histology laboratory</th>
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<tbody>
<tr>
<td>Week 1 09. 7- 11.</td>
<td>1. Cellular components of lymphatic tissue. Thymus, tonsils, MALT 2. Structure and circulation of lymph nodes and spleen</td>
<td>1 Nagy 2 Nagy</td>
<td>Selected Mondays 14.00 - 15.40</td>
<td>Lenhossék</td>
<td>Thymus, tonsils 43a, 43c, 47, 42a, 42b, 46, 48</td>
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<td>Week 2 09. 14- 18.</td>
<td>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</td>
<td>3 Alpár 4 Áldófer</td>
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<td>Lymph node, spleen 40, 45, 1a, 1b</td>
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<td>Week 3 09. 21- 25.</td>
<td>5. Microscopy of the CNS – Nerve tissue. Fine structure of the cerebral cortex 6. Microscopy of the CNS – Diencephalon, thalamic nuclei</td>
<td>5 Pálfi 6 Dobolyi</td>
<td>1.1 Lymphatic organs, spinal cord 1.2 Lymphatic organs, spinal cord</td>
<td>EM 1-5 EM 1-15 Alpár Nagy</td>
<td>Histology of the peripheral nervous system 88, 67, 53, 79, 75, 6, 151b, 33b</td>
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<td>Week 4 09. 28- 10. 2.</td>
<td>7. Microscopy of the CNS – Sensory systems, epicritical and protopathic sensibilities 8. Microscopy of the CNS – Motor systems, pyramidal tract</td>
<td>7 Kozsurek 8 Neméskéri</td>
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<td>Histology of the central nervous system 101, 22, 111, 80, 96, 16, 20</td>
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<td>Week 14 12.7-11.</td>
<td>27. Microscopy of the CNS – Olfactory and gustatory systems 28. Drugs of abuse, opiates and receptor mediated actions in the CNS</td>
<td>27 Vereczki 28 Wenger</td>
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<td>Revision</td>
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<td>Weeks</td>
<td>Histology laboratory</td>
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<td>Tuesdays EM 1-6 12.00-13.30 and EM 7-12 14.00-15.30</td>
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<td>Wednesdays EM 13-17 10.00-11.30  Fridays EM 18-19 8.00-9.30</td>
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**Week 1**
09. 7-11.

- 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. 14-18.

- 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. 21-25.

- 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)

**Week 4**
09.28 -10. 2.

- 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)

**Midterm test 1**
(Histology slides of weeks 1-4)

Microscopy of the CNS – consultation 1.

**Week 6**
10. 12-16.

- Microscopy of the CNS – consultation 2.

**Week 7**
10. 19-23.


**Week 8**

- Microscopy of the CNS – consultation 4. Development of the CNS

**Week 9**
11. 2-6.

- 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**

- 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**
11.16-20.

- Histology of palm skin, scalp skin. Mammary gland
  - 59. Palm skin (HE)
  - 153. Gomus 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. 23-27

- Histology of the organ of vision 2
  - 29. Eye bulb (HE)
  - 30. Retina (semithin, toluidine blue)
  - 113. Lacrimal gland (HE)

**Week 13**
11.30-12.4.

- Histology of the organ of hearing
  - 36. Cochlea / organ of Corti (semithin, toluidine blue)
  - 4. Macula (semithin, toluidine blue)

**Week 14**
12.7-11.

- Revision
ONLINE LECTURES AND PERSONAL CONSULTATIONS  
DURING THE PRESENT SEMESTER

covid19 protocol

There will be two lectures a week during the present semester. Lectures listed in the schedule (see above) will be held as online lectures since a safe social distance would not be possible to keep within the lecture halls.

Lectures (including a voice over) or theirs links together with the lecture notes will be uploaded in Moodle where students may access them as well as further study aids. Here the students may log in via SeKA using a personal name and password. (https://itc.semmelweis.hu/moodle/login/index.php)

In order to help our students we are willing to regularly hold personal consultations in the lecture halls where only the designated groups are entitled to participate. See the schedule for the topics and order of appearance. We expect you to watch the uploaded lectures to gain the most from these consultations where we would summarize the most important core material and you may ask questions.

Please thoroughly check the order of appearance because only members of the listed groups are eligible to participate.
SUBJECT MATTER OF THE PRESENT SEMESTER

I. Histology of the 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

III. 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

IV. 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

VI. 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

VII. 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 (identification of structures on 2 digitized tissue slides, as well as
      1 theoretical question from the subject matter of the two semesters (see the Topic list).
**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 or the semester is not accepted. Students absent from the test should reattend at a given timepoint or their semester will not be accepted. The results of all tests will appear on the personal achievement cards.

**Exemptions form part of the semifinal examination** - if the average of the two midterm marks is at least 4.00, students are offered to be exempted from the written part of the semifinal examination with the following marks: good (4) - if the midterm results are 4+4 or 3+5; excellent (5) - if the midterm results are 4+5 or 5+5. These students only need to take the oral part of the final examination.

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.

**The final examination is composed of the following parts:**

- **Topics:** Subject matter of the two semesters
- Written pretest (if not exempted)
- Oral examination (identification of structures on 2 digitized tissue slides, as well as 1 theoretical question from the subject matter of the two semesters (see the Topic list).

**Please note:** Students may register for, or deregister from, the examinations via the neptun system. In case neither the first nor the repeated takes of a semifinal exam have been successful the exam has to be postponed to the following exam period as a "CV" exam (if there are possibilities left).
WORK / ENVIRONMENTAL PROTOCOL AND INFECTION CONTROL

GENERAL RULES

1. Students may only enter following temperature control at the main entrance.
2. **Masks are to be worn at all times** while on the premises of the Department.
3. Please keep a **1.5 - 2m social distance** towards everybody.
4. Do not touch, or come into close contact with, other people (e.g., no handshakes).
5. Frequently wash your hands using soap and warm water.
6. Sanitise your hand frequently.
7. Do not touch your face or eye.
8. It is **STRICTLY FORBIDDEN** to 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).
9. Use paper tissues in case you cough or sneeze and dispose of them immediately in the designated bins.

SPECIFIC RULES CONCERNING THE HISTOLOGY LABORATORIES

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<tr>
<td>1.</td>
<td>Use hand sanitizers upon entering.</td>
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<td>2.</td>
<td>Use <strong>rubber gloves</strong> when touching the keyboard or the mouse of the digital equipment.</td>
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<tr>
<td>3.</td>
<td>You may clean the surfaces with wet towels before you start using them.</td>
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<tr>
<td>4.</td>
<td>Food and drinks are <strong>strictly forbidden</strong> on the premises of the department.</td>
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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 **STRICKLY 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 posted on every floor.
3. The use of elevators is **STRICKLY 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 different from the designated ones. Only electrical devices in an intact and perfect condition should be used.
LIST OF TEXTBOOKS


RECOMMENDED LITERATURE

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


Further study aids:

To be downloaded from the homepage of the Department of Anatomy, Histology and Embryology (http://semmelweis.hu/anatomiap) or from Knowledgebase on the Library homepage: (https://lib.semmelweis.hu/knowledge_base).
TOPIC LIST OF THE FINAL EXAMINATION
(2 Histology slides and 1 theory question from the topics of Embryology and Microscopy of the nervous system)

**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, accomodation
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