Doctoral Study Board in Anatomy, Histology, and Embryology, Faculty of Medicine in Pilsen, Charles University

Doctoral state exam – structure, topics, and recommended reading

The final exam consists of two parts and it lasts approx. 50 - 60 minutes.

1. During the first part, the candidate briefly presents the current progress in the preparation of his/her dissertation thesis (within 5 - 7 minutes). This is followed by an approximately 10-minutes discussion in which the candidate responds to questions from members of the committee directed to the topic of his/her studies.
2. In the second part of the exam, the candidate chooses one of the five areas (Anatomy, Histology, Embryology, Cell Biology, Methods). Three questions will be drawn randomly from the selected area. No written preparation is expected for being ready to answer the questions and subsequent supplementary questions from the members of the committee. The expected duration of this part of the oral exam is 30 - 40 minutes.

June 23, 2021

Anatomy

1. Skeleton. Characteristic and classification of bones. Individual parts of skeleton.
2. Joints. Classification of joints. Movements in the joints.
3. Muscle structure and function. Tendons, fasciae and spaces.
4. Peripheral nervous system.
5. Structure and function of the telencephalon and diencephalon.
6. Structure and function of the brainstem and cerebellum, cranial nerves.
7. Spinal cord, spinal nerves.
8. Structure and function of the visual system.
9. Structure and function of the auditory and vestibular systems.
10. Autonomic nervous system.
11. Sensory systems: general structure. Receptors. Taste and smell.
12. Endocrine system: hypothalamus, pituitary gland, thyroid and parathyroid glands, suprarenal glands, pancreas, gonads, diffuse endocrine system.
13. Heart: wall structure, skeleton, supply, conducting system, pericardium.
14. Circulatory system: blood circulation in the body and lungs. Portal circulation.
15. Circulatory system: types of blood vessels, blood circulation of the adult and the fetus.
16. Lymphatic system: types of vessels, lymph nodes. Primary and secondary lymphatic organs.
17. Respiratory system: Upper and lower respiratory tracts. Lung. Mechanics of breathing.
18. Digestive system: Oral cavity, teeth, pharynx. Associated glands.
19. Digestive system: Digestive tube, liver, pancreas, peritoneum.
20. Urinary system: Kidneys and excretory urinary tract.
21. Circulation of water and body fluids: plasma, lymph, extracellular and transcellular fluids.
22. Male genital system.
23. Female genital system.
24. Basics of comparative anatomy of mammals with regard to laboratory and experimental species (including directions and planes).
25. General anatomy and anatomical terminology.
26. Topographical anatomy (spaces and passages) of the head and neck and its clinical significance.
27. Topographical anatomy (spaces and passages) of the thorax, abdomen, pelvis and back and its clinical significance.
28. Topographical anatomy (spaces and passages) of limbs and its clinical significance.
29. Imaging methods in anatomy.

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Histology and microscopic anatomy

1. Types of tissues. Epithelia – general characteristics, classification, cell polarity, function.
2. Covering and glandular epithelia – classification and examples.
3. Connective tissue- general characteristics, classification. Cells and the extracellular matrix.
4. Connective tissue proper – characteristics, classification, examples.
5. Cartilage – characteristics, classification, examples.
6. Microscopic structure of bone tissue – characteristics, classification, examples.
7. Intramembranous and endochondral ossification.
8. Peripheral blood. Formed blood elements. Blood count. Differential blood count.
9. Hemopoiesis – ontogeny, blood lines. Erythropoiesis, granulopoiesis, lymphopoiesis, monopoiesis.
10. Muscle tissue – characteristics, classification, examples. Smooth muscle; skeletal muscle; cardiac muscle.
11. Nerve tissue – characteristics, classification, examples. Neuron; synapsis; neuroglia.
12. Teeth; oral cavity; tongue, and soft palate.
13. Esophagus, stomach, small and large intestine.
14. Liver; gall bladder; biliary passages; pancreas.
15. Airway passages; larynx, trachea, bronchi; lungs. Alveolo-capillary membrane.
16. Renal cortex and medulla; nephron; excretory passages.
17. Testis and epididymis; male genital passages; prostate and seminal vesicles.
18. Ovary and ovarian follicles; uterine tube; vagina; greater and lesser labia; breast and the mammary gland.
19. Uterus; menstruation cycle; placenta; umbilical cord.
20. Skin.
21. Brain. Architectonics of the brain cortex; cerebellum; spinal cord. Structure of peripheral nerves.
22. Eye – layers of the bulb including the retina; lens. External ear, middle ear, internal ear. Olfactory mucosa.
23. Blood vessels – classification, structure, and function. Microscopic anatomy of the heart. Cardiac conducting system.
24. Lymph vessels. Thymus. Bone marrow. Tonsils. Spleen.
25. Pituitary gland. Thyroid gland. Parathyroid gland. Suprarenal gland.
26. Structure of hollow organs and their layers. Structure of parenchymal organs- parenchyma, stroma.

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Embryology

1. Progenesis – sperm and oocyte maturation, morphometry of gametes. Fertilization and the first cleavage.
2. Blastocyst development, implantation, gastrulation, bilaminar disc.
3. Fetal membranes, placenta.
4. Development of nerve tissue, neural tube, and brain vesicles. Neural crest. Development of eye and ear.
5. Origin and development of circulatory system, primitive embryonic and extraembryonic blood circulation.
6. Development and remodeling of aortic arches. Origin and destiny of main embryonic vessels.
7. Origin of the heart tube, septation of atria and ventricles. Genesis of heart malformations.
8. Development of digestive system. Primitive gut.
9. Stomodeum. Development of tooth, tongue, thyroid gland, and hypophysis.
10. Pharyngula, derivatives of pharyngeal arches, ectodermal clefts, and endodermal pouches.
11. Development of fore- and midgut. Rotation of the intestine, stomach, and mesenteries. Development of liver, pancreas, and spleen.
12. Development of respiratory system.
13. Face and skull development, definitive palate.
14. Development of urinary system.
15. Development of gonads – testis, ovary, ducts, external genital organs.
16. Development of vertebrae, ribs, and limbs, skeletal muscle.
17. Comparative embryology of mammals, in particular, biomedicine models for human embryology: differences in early development (gastrulation, placentation), pregnancy length.
18. Calculation of delivery date, labor phases. Determination of fetal age.
19. Congenital growth and development defects, teratogens. Instances of defects of individual systems.
20. Pre-implantation and post-implantation genetic testing. Prenatal screening of congenital growth and development defects.
21. Ontogenesis and evolution: relations, postulates, and examples.
22. Morphological assessment of gametes and embryos. Assisted reproductive technologies.
23. Ethical issues of human embryology and assisted reproductive technologies.

Cell biology

1. Chemical components of a cell. Cell metabolism.
2. Types of cells – prokaryotic vs. eukaryotic cells; plant cell and animal cell. Cellular compartments.
3. Cell cycle. Cell division – mitosis and meiosis. Cell death.
4. Membrane structure and function.
5. Cell organelles and cytoplasmic inclusions – structure and function.
6. Basement membrane, basal lamina. Apical cell surface specializations.
7. Cellular junctions. Lateral cell surface specializations.
8. Cell signaling. Cell adhesion. Cell movement.
9. The cell nucleus – structure and function.
10. Proteostasis – mechanisms, signaling events, and localization.
11. Cell transport; vesicular traffic.
12. The cytoskeleton – its components and their function.
13. Stem cells. Differentiation of cells.
14. Types of tissues.
15. The extracellular matrix – structure and function.
16. Nucleic acids – classification, structure, and function.
17. Modification of structure and function of nucleic acids.
18. Replication and repair of nucleic acids.
19. Transcription. Post-transcriptional modification.
20. Classification and function of various types of RNA.
21. Translation. Post-translational modification.
22. Regulation of gene expression.
23. Mutagenesis and its role in evolution.
24. Control of gene expression. Structure of genes. Alternative splicing.
25. The use of nucleic acids in diagnostics and in therapy.
26. Interplay of the components of the immune system.
27. MHC/HLA – genetic background; classes of proteins; function.

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Methods in Anatomy, Histology, Embryology, and Cell Biology

1. Fixation and conservation methods in anatomy.
2. Formalin-fixed paraffin embedded sectioning technique. Cryomicrotomy. Artifacts in histological preparations.
3. Processing samples for electron microscopy.
4. Histological processing of mineralized tissues – ground undemineralized sections; demineralized paraffin sections.
5. Fundamentals of light microscopy. Brightfield microscopy.
6. Light microscopy techniques I: darkfield and oblique illumination; polarization microscopy; phase contrast; differential interference contrast.
7. Light microscopy techniques II: fluorescence microscopy; confocal laser scanning microscopy.
8. Transmission electron microscopy.
9. Scanning electron microscopy.
10. Histochemistry, immunocytochemistry, and immunohistochemistry: principles and examples.
11. Chromogens; microscopic study of localization and dynamics of biomolecules.
12. Cytochemistry and enzyme histochemistry.
13. Lectin histochemistry.
14. Principles of PCR, sequencing, in situ hybridization.
15. Cytotoxicity assay, proliferation assay – principles and examples.
16. Laser-capture microdissection.
17. Virtual slides and whole slides scanning. X-ray microtomography (micro-CT).
18. Model organisms in experimental biology – examples, pros and cons. Tissue cultures; cell cultures.
19. Atomic force microscopy. Fluorescence-activated cell sorting; flow cytometry. Raman spectroscopy.
20. Immunochemical methods – principles and examples. ELISA, RIA, Western blot, multiplex assay.
21. Methods in cytogenetics and karyotyping. FISH.
22. Biobanking. Cryopreservation.
23. Mechanical properties of and bimechanical modelling of cells, tissues, organs – examples of studies, explaining the experimental identification of parameters; interpretation.

Recommended reading *(with additional resources in Czech in italics)*

Anatomy

- Moore K., L.., Agur A.M., Dalley A.F. Essential clinical anatomy, Wolters Kluwer – Lippincott – Williams and Wilkins, 4th Ed. 2011/
- *Čihák, R.: Anatomie I., II., III., Praha: Grada, 2011–2016.*
- *Druga, R., Grim, M., Dubový, P.: Anatomie Centrálního Nervového Systému, Praha: Galén Karolinum, 2011.*
- *Grim M., Druga R., et al.: Základy anatomie , Karolinum , Galén, 5 dílů , 2001 – 2011.*

Histology

- Mescher A.L. Junqueira's Basic Histology. Text & Atlas. McGraw Hill Medical, 2010.
- Balko, J., Tonar, Z., Varga, I. et al.: Memorix histology, Praha: Triton, 2018.
- *Lüllmann-Rauch R.: Histologie. Překlad 3. vydání. Grada, Praha, 2012.*

Embryology

- Sadler T.: Langman´s Medical Embryology, 13th edition, Wolters Kluwer, 2014./*Sadler T.W.: Langmanova lékařská embryologie. Překlad 10. vydání. Grada, Praha, 2011.*
- *Trávník P.: Klinická embryologie. Mladá fronta, Praha, 2018.*
- Peer-reviewed articles from scholarly journals (review papers of original articles found in the PubMed, Web of Science, ResearchGate databases etc.)

Cell biology

- Alberts B., Johnson A., Lewis J., Morgan D., Raff M. Molecular Biology of the Cell, 6th Ed., Garland Science, 2014./*Alberts B., Bray D., Johnson A., Lewis J., Raff M., Roberts K., Walter P. Základy buněčné biologie – Úvod do molekulární biologie buňky. Espero Publishing, 2005.*
- Peer-reviewed articles from scholarly journals (review papers of original articles found in the PubMed, Web of Science, ResearchGate databases etc.)

Methods in Anatomy, Histology, Embryology, and Cell Biology

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