

Course description

Informing students on course requirements

From September 2025

Program: PhD elective course
Course: Cerebral Blood Flow and Metabolism
Course code: AOKDI-SZV-31
Academic year/Semester: Fall semester
Educator and contact details (e-mail): Dr. Eszter Farkas (farkas.eszter.1@med.u-szeged.hu ; farkas.eszter@szte.hu)
Type of course: <u>lecture</u> /seminar/practice/laboratory
Weekly hours of the course: 2
Credit vale of the course: 2
Type of examination: final exam at the end of semester, practice exam, other: final exam at the end of semester
Preliminary requirements (preliminary academic performance or completed course required to fulfill the purposes and requirements of the course): Physiology
Purpose of course: The aim of the course is to provide students with a comprehensive understanding of the physiological, pathophysiological, and experimental mechanisms underlying cerebral blood flow, as well as their clinical significance. The course presents the main processes involved in the regulation of cerebral circulation (endothelial, neural, and metabolic mechanisms), the function of the blood–brain barrier, the principles of neurovascular coupling, and the pathomechanisms and imaging diagnostics of cerebral circulation disorders (e.g. stroke, aging, dementia).
Outcome requirements of the course (specific academic results to be established by the course): • Knows the anatomical and physiological foundations of cerebral circulation, as well as the main regulatory mechanisms (endothelial, neural, metabolic, and neurovascular processes). • Understands the structure and function of the blood–brain barrier and its importance in maintaining cerebral homeostasis. • Understands the pathophysiology of cerebral circulation disorders (e.g. ischemic stroke, dementia, age-related changes). • Is familiar with experimental methods used to study cerebral circulation and metabolism. • Has an overview of the cerebrovascular aspects of clinical brain imaging techniques (e.g. MRI, fMRI, PET).
Topics: 1. Introduction to the regulation of cerebral circulation: The physiological significance of cerebral blood flow; the principles of cerebral autoregulation.

2. Experimental methods for investigating the cerebral circulation: In vivo and in vitro models; microscopic and imaging techniques for studying cerebral perfusion and vascular tone.
3. The blood–brain barrier (BBB): Anatomical and molecular structure; functional role and the consequences of its disruption.
4. Regulation of cerebral vascular tone – endothelial mechanisms: The role of endothelial mediators (NO, prostaglandins, endothelin); function of cerebrovascular smooth muscle.
5. Regulation of cerebral vascular tone – neural control: Sympathetic, parasympathetic, and sensory neural influences; the role of neurotransmitters in cerebral blood supply.
6. Regulation of cerebral vascular tone – neurovascular coupling: Function of the neuron–glia–vessel unit (neurovascular unit); the relationship between neural activity and blood flow.
7. Disorders of cerebral circulation: stroke: Types of ischemic and hemorrhagic stroke; pathophysiological processes and reperfusion injury.
8. Brain metabolism: Energy supply and metabolism of brain tissue; the relationship between metabolism and cerebral blood flow.
9. Cerebral circulation in the newborn: Developmental characteristics; risk factors for hypoxic–ischemic brain injury.
10. Disorders of cerebral circulation: aging: Changes in cerebral perfusion and autoregulation during aging.
11. Disorders of cerebral circulation: dementia and cerebral small vessel disease: Mechanisms of vascular dementia, Alzheimer’s disease, and small vessel pathology.
12. Clinical brain imaging: MRI, fMRI, PET, and SPECT techniques; examination of cerebral perfusion and metabolism in clinical practice.

Supporting methods to achieve learning outcomes:

- Lecture-based knowledge transfer: Instructors from the fields of physiology, pathophysiology, and clinical sciences provide up-to-date, research-based knowledge. Students gain insight into the mechanisms regulating cerebral circulation, experimental models, and their clinical relevance.
- Visualization and demonstration: Educational materials (figures, microscopic and imaging recordings, videos) are used to visually illustrate physiological and pathophysiological processes. Neurovascular phenomena are interpreted through examples from research.
- Research-based learning: During the course, students become familiar with current scientific publications, fostering their ability to navigate the literature and develop critical thinking skills. Lecturers use examples from their own research to demonstrate the practical relevance of theoretical knowledge.
- Interactive discussions and Q&A sessions: At the end of lectures, students have the opportunity to discuss topics and ask questions, enhancing their problem-solving and analytical abilities.
- Use of digital learning tools (CooSpace platform): Course materials, illustrative content, and tests are available online. Self-assessment exercises support deeper learning and exam preparation.
- Analysis of case studies and clinical examples: Students deepen their understanding through clinical cases related to cerebrovascular disorders (stroke, dementia, small vessel disease).

• Final test (summative assessment): A written, in-person test conducted via the CooSpace platform serves to comprehensively assess the knowledge acquired in the course.
Evaluation of the acquisition of expected learning outcomes: 1. Continuous, summative assessment at the end of the semester: Students' knowledge is assessed through a written CooSpace test, conducted in person during the final lecture. The test covers the entire semester's material, including physiological, pathophysiological, and clinical topics. 2. Method of assessment: Evaluation is based on a five-grade scale (1–5), according to the proportion of correctly solved tasks. Student performance is determined objectively based on the total score achieved. 3. Assessed learning outcomes: The written assessment evaluates students' knowledge (understanding of physiological and pathophysiological processes), skills (recognition, application, and analysis of relationships), and attitudes (research orientation, clinical reasoning). 4. Attendance requirement: Attendance at lectures is recommended, while participation in the final assessment is mandatory.
Mandatory reading list: Benyó Zoltán, Sándor Péter: Az agyi vérkeringés élettani alapjai. Önszabályozó mechanizmusok; Semmelweis Kiadó és Média Kft. 2016. ISBN: 9789633313756
Recommended reading list: Marilyn J. Cipolla: The Cerebral Circulation; San Rafael (CA): Morgan & Claypool Life Sciences; 2009. ISSN: 21545626, 2154560X

Indicating course requirements on CooSpace scene (summary)

Description (public): This course provides a comprehensive overview of the physiological and pathophysiological mechanisms regulating cerebral blood flow. Topics include the function of the blood–brain barrier, endothelial and neural control of vascular tone, neurovascular coupling, and experimental and imaging methods for studying cerebral circulation. Clinical aspects such as stroke, aging, and dementia are also addressed. Emphasis is placed on integrating basic physiological concepts with translational and clinical perspectives to enhance understanding of cerebrovascular regulation and dysfunction.
Requirements: Expected Learning Outcomes - Upon successful completion of the course, students will be able to: - Describe the anatomical and physiological foundations of cerebral circulation and the major mechanisms regulating cerebral blood flow (endothelial, neural, metabolic, and neurovascular). - Explain the structure and functional significance of the blood–brain barrier and its role in maintaining cerebral homeostasis. - Analyze the pathophysiological mechanisms of cerebrovascular disorders such as stroke, dementia, and age-related vascular changes.

- Identify and interpret experimental and clinical methods used to investigate cerebral perfusion and metabolism, including MRI, fMRI, PET, and related imaging techniques.
- Integrate theoretical and experimental knowledge to interpret cerebrovascular function and dysfunction in research and clinical contexts.

Assessment and Evaluation of Learning Outcomes

- Method of assessment: Summative written test conducted in person via the CooSpace platform at the end of the semester.
- Scope: Covers the entire course content, including physiological, pathophysiological, and clinical topics.
- Grading scale: Five-point grading system (1–5), based on the proportion of correct responses.
- Attendance: Participation in the final assessment is mandatory; attendance at lectures is recommended.

Topics:

Topics - The course covers the physiological, pathophysiological, and clinical aspects of cerebral blood flow regulation. Main topics include:

- Regulation of cerebral circulation: endothelial, neural, metabolic, and neurovascular mechanisms
- Structure and function of the blood–brain barrier (BBB)
- Experimental and imaging methods in cerebrovascular research
- Brain metabolism and its relationship with cerebral perfusion
- Disorders of cerebral circulation: stroke, aging, dementia, and small vessel disease
- Clinical brain imaging: MRI, fMRI, PET, and SPECT applications

Teaching and Learning Methods Supporting the Achievement of Learning Outcomes

- Lecture-based knowledge transfer providing research-based theoretical foundations
- Visualization and demonstration using figures, videos, and imaging data to illustrate physiological and pathological processes
- Research-based learning involving analysis of current scientific literature to foster critical thinking
- Interactive discussions and Q&A sessions to strengthen analytical and problem-solving skills
- Digital learning tools via the CooSpace platform for access to materials, self-assessment, and feedback
- Case study analysis of clinical examples related to cerebrovascular disorders

Mandatory reading list:

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