Faculty of Medicine in Rijeka

**Curriculum**
**2026/2027**

For course

# Neurophysiology

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| Study program: | **Medical Studies in English (R)**<br>University integrated undergraduate and graduate study |
| Department: | **Department of Physiology, Immunology and Pathophysiology** |
| Course coordinator: | **doc. dr. sc. Ćurko-Cofek Božena, dr. med.** |
| Year of study: | **2** |
| ECTS: | **5** |
| Incentive ECTS: | **0 (0.00%)** |
| Foreign language: | **Possibility of teaching in a foreign language** |

## Course information:

Course aims, tasks, and learning outcomes

**Neurophysiology** is a compulsory course in the second year of the Integrated Undergraduate and Graduate University Study of Medicine in English, in the IV (summer) semester. It consists of **26** hours of lectures, **18** hours of seminars, and **16** hours of practicals, for a total of 60 hours (**5 ECTS)**.

**This course aims** to enable the student to apply previously acquired knowledge of Neuroanatomy, Physiology and Pathophysiology, and to gain knowledge of the normal functioning of the nervous system, and of the pathophysiological mechanisms that lead to disturbances in normal functioning and to the occurrence of a particular disease. Knowledge of basic neurophysiological and neuropathological processes will help students learn the material of the pre-clinical and clinical courses that follow in the programme.

Classes are performed in the form of lectures, seminars, and practicals. The practicals include the use of computer programs Biopack and PhysioEx which simulate physiological and pathophysiological processes in humans/animals. Some seminars can be conducted as problem-oriented lessons so that students can solve physiological and pathophysiological problems with the help of the teacher based on typical anamnestic and diagnostic data. At seminars and practicals, the student actively discusses the physiological and pathophysiological mechanisms with the professor.

**The student is obligated to prepare the material to be discussed in seminars and practicals.**

Following the Law and Ordinance of the Faculty of Medicine in Rijeka, all forms of classes (lectures, seminars, and practicals) are **mandatory**. For justified reasons, a student may be absent from **a maximum of 30%** of each form of class (30% of lectures, 30% of seminars, 30% of practicals).

Lectures, seminars, and practicals take place according to the Syllabus. During the course, the acquired knowledge will be assessed by two midterm exams which make up 50% of the final grade. A student who passes both midterms and obtains 25 grade points or more will have access to the final exam which will be organised immediately after the end of the course..

All information about the course and course materials will be available online on the Merlin platform - access is via an AAI address.

Course outline

General organisation of the nervous system: central, peripheral, and autonomic; Neuronal cell biology: the microenvironment of a neuron – glial cells; Cerebral blood flow and its disorders; Blood-brain barrier and its disorders; Cerebrospinal fluid and hydrocephalus; General energy metabolism of the brain; Basic neurophysiological processes: membrane and action potentials; Origin and propagation of the nerve impulse; Structure and function of synapses; Neurotransmitters and their receptors: biochemical features of synthesis and degradation, distribution and interaction of neurotransmitter systems; Membrane receptors: classification, structure, activation, distribution; pathophysiology of the impulse transmission; Neuronal circuits for information processing; Organisation of sensory systems and sensory functions: somatic (receptors) and special senses (vision, hearing, balance, taste, smell); Sensory disorders, pathophysiological background of pain; General organisation of the motor system: spinal and supraspinal reflexes; Pyramidal and extrapyramidal motor system; Function of the basal ganglia: cerebellar motor control, motor nerve disorders; Autonomic nervous system: physiological and pathophysiological aspects; General and controlling brain functions: ascending reticular activating system (attention, wakefulness, sleep); Limbic system (emotions, neuroendocrinology of behaviour), sexuality; Higher brain functions: laminar and vertical organisation of the cerebral cortex: integrative function of the nervous system; Intellectual functions (memory, thinking, speech); disorders of mental functions.

Development of general competencies (knowledge and skills)

At the end of this course, the student will be able to:

1. Interpret and explain the basics of nervous system functioning

2. Interpret and explain the basics of nervous system disorders

3. Connect and determine the importance of the nervous system within the organism

Development of specific competencies (knowledge and skills)

At the end of this course, the student will be able to:

1. Explain the principles of of the generation and propagation of the action potential (impulse) and the basis for the pathophysiology of nerve transmission

2. Explain the concept of synaptic transmission, the biochemical characteristics of synthesis and degradation, and the distribution and interaction of neurotransmitter systems

3. List and describe the division, structure, distribution, and activation of membrane receptors

4. Explain the somatic (touch, pressure, position, pain, temperature) and special senses (vision, hearing, taste, smell, balance), from the sensory receptors and the input (afferent) fibers to the cerebral cortex

5. Explain pathophysiological processes associated with damage to somatosensory and special senses

6. Explain the role of the nervous system in motor control: organization of the motor unit, control of the spinal motor system, voluntary motor movements, posture, role of the basal ganglia and small brain in motor control

7. Explain the general and controlling brain functions, states of vigilance and consciousness, emotions and mood

8. Explain the response and importance of the autonomic nervous system

9. Describe types of learning and memory, cellular learning and memory mechanisms, and learning and memory disorders

10. Describe the structure and function of the blood-brain barrier, the cerebrospinal fluid, the mechanisms for regulating blood flow and circulatory disorders (cerebrovascular insult)

## [Ishodi učenja]:

**Lecture 1: Organisation of the Nervous System, Basic Functions of Synapses**

LEARNING OUTCOMES: to describe the organization of the nervous system; to explain the main levels in the function of the central nervous system (CNS); to describe the cellular structure of neurons and glial cells; to describe the structure and function of synapses; to list types of synapses; to describe the physiological structure of synapses; to explain the role of calcium ions; to describe the function of receptor proteins on a postsynaptic neuron; to explain the signal transmission and processing in neuronal groups; to explain signal divergence and convergence and lateral inhibition; to explain the term reverberation, permanent signal output, and rhythmic signal output.

**Lecture 2: Neurotransmitters, Neuropeptides, and Receptors**

LEARNING OUTCOMES: to define the term neurotransmitter; to group the low-molecular fast-acting transmitters; to group slow-acting transmitters of neuropeptides; to describe the differences between these two groups of transmitters; to describe the procedures for identifying neurotransmitters and neuropeptides (according to Sheperd 1988); to describe the effects of neurotransmitters mediated by ionotropic or metabotropic postsynaptic receptors; to explain the concept and significance of receptor desensitisation; to explain glutamate metabolism in the brain; to describe the structure and function of NMDA and non-NMDA receptors; to explain the mechanism of action of inhibitory GABA and glycine neurotransmitters; to describe the formation and effect of acetylcholine via acetylcholine receptors; to describe the formation and effect of monoamine neurotransmitters (dopamine, noradrenaline and adrenaline) and serotonin; to describe the synthesis and processing of neuropeptides.

**Lecture 3: Electrical Events During Neuronal Excitation and Inhibition**

LEARNING OUTCOMES: to describe the membrane potential of neuronal soma: to review the ion concentrations on both sides of the neuron’s membrane; to define the term Nernst potential; to describe the role of diffusion and the Na/K pump in the generation of the nerve’s membrane potential; to describe the generation and all phases of the nerve’s action potential; to define the role of voltage-gated sodium and potassium channels; to describe the ‘all or nothing’ law; to explain the concept of saltatory impulse conduction in nerves; to explain the generation of excitatory and inhibitory postsynaptic potentials; to describe the generation of the action potential at the axon of the neuron and the concept of threshold stimulus; to define the term presynaptic inhibition; to explain the term spatial and temporal neuron summation; to explain the term neuronal facilitation; to describe the terms "electronic current" and decremental conduction along the dendrite to the soma; to explain synaptic transmission fatigue; to describe the effects of acidosis and alkalosis on synaptic transmission; to describe the concept of synaptic decay; to explain the consequences of the demyelination process on nerve conduction.

**Lecture 4: Sensory Receptors, Somatic Sensation, Sensory Pathways for Transmitting Somatic Signals**

LEARNING OUTCOMES: to group senses; to define sensory receptors; to group sensory receptors; to define the concept of sensory modality and the principle of the "labelled line"; to describe the origin of the receptor (generator) potential using the Pacinian corpuscle as an example; to define the relationship between receptor and action potential; to describe the mechanisms of receptor adaptation; to explain the term "tonic" and "phasic" receptor; to describe the physiological classification and function of nerve fibres; to describe the relationship between touch, pressure, and vibration; to describe the tactile receptors; to describe the structure and function of the sensory pathways for the transmission of somatic signals to the central nervous system: 1. a dorsal column–medial lemniscus and anterolateral system 2; to describe the location, parts and layers of the somatosensory cortex; to explain the functions of specific parts of the somatosensory cortex; to describe the

somatosensory homunculus; to define the sense of position; to define the term dermatome.

**Lecture 5: Special Senses**

LEARNING OUTCOMES: to describe the physical principles of optics of the eye; to describe the structure of the retina; to explain the photochemistry of vision; to explain the phenomena of adaptation and accommodation; to describe the visual pathway; to describe the eye movements and their control; to describe the creation of visual images from the signals of both eyes; to describe the anatomical structures of the ear; to explain the mechanism of impedance matching; to describe the function of the organ of Corti; to explain the mechanism of sound frequency discrimination; to describe the auditory pathway and auditory cortex; to describe the structure and function of the vestibular apparatus; to define different taste modalities; to describe the structure and function of the taste bud; to describe the gustatory pathways; to describe the sense of smell, types of odors and the transmission of olfactory signals.

**Lecture 6: Pathophysiology of the Nervous System; Peripheral and Central Sensory Disorders; Pain**

LEARNING OUTCOMES: to explain nerve conduction disorders; to elaborate on disorders of hypo- and hyperfunction of the neurotransmitters dopamine, acetylcholine, serotonin; to explain the development of myasthenia gravis; to review the mechanism of desensitisation; to describe the phenomenon of tardive dyskinesia, and the mechanism of the abstinence crisis; to explain the concepts of denervation hypersensitivity, hypoesthesia, paraesthesia and the concept of backward decay; to describe the anatomical isthmus syndrome; to define neuropathies and polyneuropathies; to describe Brown-Sequard syndrome, conus and epiconus syndromes; to describe a thalamic syndrome; to describe phantom sensations; to define types of pain; to describe pain receptors; to describe pathways pain signalling pathways: the neospinothalamic tract and paleospinothalamic tract; to describe the functions of reticular formation, thalamus, and cerebral cortex in pain perception; to describe the analgesic system in the brain and spinal cord; to explain the importance of the opiate system in the brain; to explain the terms of reflected and visceral pain; to describe and list types of headache.

**Lecture 7: Cerebral Cortex, Intellectual Functions of the Brain, Learning, and Memory**

LEARNING OUTCOMES: to describe the physiological structure of the cerebral cortex; to describe the thalamocortical system; to explain the functions of specific cortical areas: association areas (parietal-occipital-temporal, prefrontal and limbic association areas); to explain the location and importance of the Wernicke's area; to explain the concept of the dominant hemisphere; to explain the importance of the non-dominant hemisphere; to describe brain function in communication (speech); to name and describe types of speech disorders; to describe the importance of the corpus callosum; to define the thought, consciousness, and memory; to explain the concept of positive and negative memory; to describe the mechanism of short-term, intermediate and long-term memory formation; to describe the phenomenon of memory consolidation: the role of the hippocampus in the process of memory.

**Lecture 8: States of Brain Activity – Sleep, Brain Waves, Epilepsy**

LEARNING OUTCOMES: to describe two types of sleep; to explain basic theories of sleep; to describe the development and origin of brain waves; to distinguish epilepsies; to define schizophrenia, Alzheimer's disease, and dementia; to describe parts of the limbic system and the activation-stimulating brain system; to describe the functions of the hypothalamus; to explain the importance of reward and punishment in behaviour; to describe the functions of the hippocampus and the amygdala.

**Lecture 9: Motor Neurophysiology: Motor Functions of the Spinal Cord**

LEARNING OUTCOMES: to define three types of motor activities: voluntary, unconscious, and reflex; to describe the structure of the spinal cord; to describe the function of alpha and gamma motoneurons, interneurons, and Renshaw cells; to describe the structure of the muscle spindle and the sensory and motor innervation of the spindle; to explain the receptor function of the muscle spindle; to describe the reflex arc; to describe the stretch reflex (dynamic and static part of the reflex); to describe the importance of control of the gamma-motor system; to describe the term clonus; to describe Golgi tendon reflex; to describe the polysynaptic flexor reflex and the withdrawal pattern; to describe the cross-linked extensor reflex; to define the term reciprocal inhibition; to describe the postural and gait; to describe the spinal shock.

**Lecture 10: Cortical and Brain Stem Control of Motor Function**

LEARNING OUTCOMES: to define the location and functional parts of the motor cortex; to describe the motor homunculus; to highlight specialised motor control areas; to define the medial and lateral motor systems; to describe the corticospinal tract; to describe other neural pathways leaving the motor cortex; to describe the input pathways in the motor cortex; to describe the structure and function of the cerebral cortex neuronal columns; to describe the stimulation of spinal cord motor neurons; to describe the role of the brainstem in the control of motor function – the role of reticular and vestibular nuclei (to describe reticulospinal and vestibulospinal tracts); to describe the location and the anatomical and functional parts of the cerebellum; to define the afferent tracts to the cerebellum; to describe the deep nuclei and efferent tracts of the cerebellum; to describe the parts and the functional unit of the cerebellar cortex; to describe the parts and function of the vestibulocerebellum; to describe the parts and function of the spinocerebellum; to describe the parts and function of the cerebrocerebellum; to describe the clinical disorders of the cerebellum.

**Lecture 11: Contributions of the Cerebellum and Basal Ganglia to Overall Motor Control**

LEARNING OUTCOMES: to name the basal ganglia; to describe the putamen circuit; to describe the caudate circuit; to explain the function of neurotransmitters in the basal ganglia system; to explain the development of Parkinson's disease; to explain the development and clinical presentation of Huntington's disease; to explain the development of athetosis and hemiballismus; to explain the functional connection of the basal ganglia with the brainstem and motor cortex; to describe the basics of motor nerve disorders; to describe the consequences of damage to the corticospinal tract; to describe disorders of cerebellar control; to describe disorders of neuromuscular junction (myasthenia gravis); to describe disorders of peripheral motor neurones; to describe disorders of motor unit.

**Lecture 12: The Autonomic Nervous System; Disorders of Neurovegetative Regulation**

LEARNING OUTCOMES: to describe the general organisation of the ANS; to describe the structure of the sympathetic nervous system: preganglionic and postganglionic neurons; to describe the organisation of the parasympathetic nervous system: preganglionic and postganglionic neurons; to describe cholinergic and adrenergic fibres; to describe adrenergic and cholinergic receptors and their functions; to describe the effects of sympathetic and parasympathetic stimulation of certain organs: the eye, the glands, the digestive system, the heart, the blood vessels, the blood pressure; to describe the function of the adrenal medulla; to explain sympathetic and parasympathetic tone; to describe autonomic reflexes; to describe the sympathetic nervous system alarm response; to describe ANS control; to name the aetiological factors of neurovegetative disorders; to explain the concepts of primary and secondary ANS disorders; to describe circadian rhythm disorders; to describe sleep disorders; to explain the concept of psychosomatic illness; to describe chronic fatigue syndrome.

**Lecture 13: Cerebral Blood Flow, Cerebrospinal Fluid and Brain Metabolism**

LEARNING OUTCOMES: to describe the circle of Willis; to explain the role of the perivascular space; to describe the structure of the blood-brain barrier (BBB); to explain the function of the BBB; to describe the characteristics of microcirculation in the brain; to discuss transmission through the BBB; to describe the regulation of the cerebral blood flow: autonomic and nervous; to explain the origin and clinical presentation of stroke (ischaemic and haemorrhagic); to describe the cerebral metabolism; to describe the cerebrospinal fluid (CSF) system: formation, flow, and absorption of CSF; to explain the function of CSF; to describe the composition of CSF; to describe the blood-cerebrospinal fluid barrier; to describe the development of communicating and non-communicating hydrocephalus; to describe the functions of the ependyma; to name and define the functions of the circumventricular organs.

**List of seminars (with titles and learning outcomes):**

**Seminar 1: Organisation of the Nervous System, Basic Functions of Synapses**

LEARNING OUTCOMES: to group cells of the nervous system; to describe the structure and function of neurons; to describe the structure and function of glial cells; to describe the parts and function of central and peripheral synapses; to describe the process of neurotransmitter exocytosis; to describe the activation of ionotropic receptors; to describe the term EPSP and IPSP; to describe the synthesis, action, and degradation of acetylcholine; to describe the effects of certain medications and drugs on the neuromuscular junction.

**Literature:**

Chapter 46. Organization of the Nervous System, Basic Function of Synapses, Electrical Events during Neuronal Excitation

**Textbook: Medical Physiology, Guyton and Hall**

**Seminar 2: Sensory Receptors; Somatic Sensations**

LEARNING OUTCOMES: To group senses; to define and group sensory receptors; to define the term sensory modality and the principle of the "labelled line"; to describe the origin of the receptor (generator) potential using the Pacinian corpuscle as an example; to define the relationship between receptor and action potential; to describe the mechanisms of receptor adaptation; to explain the term "tonic" and "phasic" receptor; to describe the physiological classification and function of nerve fibres; to describe the relationship between touch, pressure and vibration; to describe the tactile receptors; to describe the structure and function of the sensory pathways for the transmission of somatic signals to the central nervous system: 1. system of the dorsal column– medial lemniscus and anterolateral system 2; to describe the location, parts, and layers of the somatosensory cortex; to explain the functions of specific parts of the somatosensory cortex; to describe the somatosensory homunculus; to define the sense of position; to define the term dermatome.

**Literature**:

Chapter 47. Sensory receptors

Chapter 48. Somatic Sensation: General Organisation, The Tactile and Position Senses

**Textbook: Medical Physiology, A.C. Guyton and Hall**

**Seminar 3: The Sense of Vision**

LEARNING OUTCOMES: to review the physical principles of optics; to describe the optics of the eye; to explain the concept of visual acuity; to describe the structure of the retina; to explain the photochemistry of vision; to explain the adaptation and accommodation; to explain the principles of colour vision; to describe the neuronal function of the retina and all its cells; to explain the importance of lateral inhibition in the transmission of visual signal; to describe the visual pathway and its damage; to explain the method of determining of the visual field; to describe eye movements and their control; to describe the fusion of visual images from both eyes.

**Literature:**

Chapter 50. The Eye I: Optics of Vision

Chapter 51. The Eye II: Receptor and Neural Function of the Retina

Chapter 52. The Eye: III. Central Neurophysiology of Vision

**Textbook: Medical Physiology, Guyton and Hall**

**Seminar 4: The Sense of Hearing, The Sense of Taste and Smell, Vestibular Sensations**

LEARNING OUTCOMES: to describe the anatomical structure of the outer, middle, and inner ear; to explain the mechanism of impedance adaptation using the ossicular system; to describe the "travelling wave"; to describe the function of the organ of Corti; to explain the phenomenon of sound frequency determination (spatial principle); to describe the determination of sound volume; to describe the auditory nerve pathway; to understand the role of the auditory cortex; to name hearing disorders; to define types of taste; to describe the structure and function of the taste bud; to describe the taste pathways; to describe the sense of smell: types, signal transmission into the nervous system; to describe the structure and function of the vestibular apparatus in maintaining balance.

**Literature:**

Chapter 53. The Sense of Hearing

Chapter 54. The Chemical Senses – Taste and Smell

Chapter 56. Vestibular Sensations (p. 714-719)

**Textbook: Medical Physiology, Guyton and Hall**

**Seminar 5: Cerebral Cortex and Intellectual Functions**

LEARNING OUTCOMES: to describe the parts and function of the association areas; to describe all intellectual brain functions (communication, thinking, consciousness, memory); to describe the mechanisms of short-term, intermediate and long-term memory; to describe the excitatory-activating

system of the brain; to describe the parts and function of the limbic system (hypothalamus, hippocampus, amygdala, limbic cortex); to describe the stages of sleep; to review the basic theories of sleep; to define the types of brain waves; to describe epilepsies; to define depression, schizophrenia, and Alzheimer's disease.

**Literature:**

Chapter 58. Cerebral Cortex, Intellectual Functions of the Brain, Learning, and Memory

Chapter 59. Behavioural and Motivational Mechanisms of the Brain – The Limbic System and the Hypothalamus

Chapter 60. State of Brain Activity – Sleep, Brain Waves

**Textbook: Medical Physiology, Guyton and Hall**

**Seminar 6: Motor Neurophysiology**

LEARNING OUTCOMES: to define the structure of the motor system; motor functions of the spinal cord and brainstem; cortical and cerebellar control of motor functions and the contribution of the basal ganglia to motor control.

**Literature**:

Chapter 55. Motor Functions of the Spinal Cord; The Spinal Cord Reflexes

Chapter 56. Cortical and Brain Stem Control of Motor Function

Chapter 57. Contributions of the Cerebellum and Basal Ganglia to Overall Motor Control

**Textbook: Medical Physiology, A.C. Guyton and Hall**

**List of practicals (with titles and learning outcomes):**

**Practical 1: The Neuromuscular Junction**

LEARNING OUTCOMES: to describe the membrane and the action potential; to describe the structure and function of the neuromuscular junction; to describe the effect of strychnine on the spinal cord; to explain the concept and meaning of electromyography; to describe the concept of muscle fatigue.

**Practical part:**

- EMG I and II – illustration of the effects of muscle contraction on electrical voltage and frequency; recording of electrical changes in muscles during motor unit recruitment and muscle fatigue using the Biopac system.
- video on the effects of strychnine intoxication

For this practical, students should prepare the following material:

- from the textbook *A. C. Guyton and Hall, Medical Physiology*, **Chapter 5. Membrane Potentials and Action Potentials; Chapter 6. Contraction of Skeletal Muscle; Chapter 7. Excitation of Skeletal Muscle: Neuromuscular Transmission and Excitation-Contraction Coupling**
- from the *Handbook for Practicals in Neurophysiology, Rijeka, 2019,* **Practical 1.1. (EMG I), 1.2. (EMG II), and 1.3. (The effect of Strychnine on the Spinal Cord).**

**Practical 2: The Sense of Vision**

LEARNING OUTCOMES: to examine eye movements; to perform a pupillary reflex; to perform a corneal reflex; to determine visual acuity; to check colour vision; to determine the width of the visual field; to perform the optokinetic test; to describe the concept of visual fixation.

**Practical part:**

1.) determination of visual acuity; 2.) colour recognition; 3.) reflex responses; 4.) ocular motility; 5.) perimetry (visual field examination); 6.) optokinetic nystagmus.

The student should prepare the following material:

- from the textbook *A. C. Guyton and Hall*, *Medical Physiology*, **Chapter 50. The Eye I: Optics of Vision; Chapter 51. The Eye II: Receptor and Neural Function of the Retina; Chapter 52: The Eye III: Central Neurophysiology of Vision**

- from the *Handbook for Practicals in Neurophysiology, Rijeka, 2019* , **Practicals 2.1. (Ocular Motility), 2.2. (Pupillary Light Reflex), 2.3. (Corneal Reflex), 2.4. (Visual Acuity), 2.5. (Perimetry), 2.6. (Color Blindness), 2.7. (Electrooculogram).**

**Practical 3: The Sense of Hearing, Taste and Smell; Vestibular Sensation**

LEARNING OUTCOMES: to examine the sense of hearing with a tuning fork; to examine the sense of balance; to examine the excitability of the vestibular system; and the sense of taste and smell.

**Practical part:**

**A. Ear:** 1) The sense of hearing; 2) Functional tests of the vestibular organs

**B. Taste:** 1) Testing the sense of taste for sour, salty and bitter

**C. Smell:** 1) Measuring the sense of smell according to Bornstein

The student should prepare the following material:

- from the textbook *A. C. Guyton and Hall, Medical Physiology* , **Chapter 53. The Sense of Hearing; Chapter 54. The Chemical Senses – Taste and Smell; Chapter 56. Vestibular Sensations (p. 714-719)**
- from the *Handbook for Practicals in Neurophysiology, Rijeka, 2019* , **Practicals 3.1. (Sense of Hearing), 3.2. (Sense of Balance), 3.3. (Sense of Taste), 3.4. (Sense of Smell).**

**Practical 4: Motor Neurophysiology**

LEARNING OUTCOMES: to describe the concept of decerebration; to explain the method of electroencephalography (EEG) method; to describe the motor function of the spinal cord (spinal reflexes); to describe the role of the cerebral cortex and brainstem in motor functions; to describe the role of the cerebellum and basal ganglia in motor functions; to describe the states of brain activity: waves, sleep, epilepsies.

**Practical part:**

- examination of spinal reflexes,
- measurement of motor reaction time to sensory stimuli with Biopac,
- recording of EEG with Biopac,
- decerebrate rigidity (video).

The student should prepare the following material:

- from the textbook A. C. Guyton and Hall, Medical Physiology, **Chapter 55: Motor Functions of the Spinal Cord, the Cord Reflexes; Chapter 56: Cortical and Brain Stem Control of Motor Function; Chapter 57: Contributions of the Cerebellum and Basal Ganglia to Overall Motor Control**
- from the Handbook for Practicals in Neurophysiology, Rijeka, 2019, **Practicals 4.1. (Spinal Reflexes), 4.2. (Reaction Time), 4.3. (Decerebrate Rigidity), 4.4. (Electroencephalography).**

## List of assigned reading:


1. Medical Physiology, Guyton and Hall, Medicinska naklada Zagreb,13th edition, 2016.
2. Handbook for Practicals in Neurophysiology. Vesna Barac-Latas and Associates, Faculty of Medicine, University of Rijeka, 2019.
3. Pathophysiology, basic mechanisms of disease – textbook, book one – volume one; Stjepan Gamulin, Matko Marušić, Zdenko Kovač: Medicinska naklada -Zagreb, 2014.
4. Pathophysiology, basic mechanisms of disease – textbook, book one – volume two; Stjepan Gamulin, Matko Marušić, Zdenko Kovač: Medicinska naklada -Zagreb, 2014.


## List of optional reading:


1. Neuroscience, Dale Purvis: Oxford University Press – New York, 6th edition, 2018.
2. Principles of Neural Science, Eric R. Kandel: McGraw-Hill, 5th edition, 2013.
3. Pathophysiology, Study guide algorithms – problem solver; Zdenko Kovač, Stjepan Gamulin; book two, Medicinska naklada, 2014.

## Method of examination.:

**The final examination** is an oral. To pass the final exam, the student must receive a passing grade on the oral examination.

In the oral examination, the student can obtain **25 to 50 grade points,** as shown in the table:

| Grade obtained at the oral examination | Grade points obtained at the oral examination |
|---|---|
| excellent (5) | **45-50** |
| very good (4) | **38-44** |
| good (3) | **31-37** |
| sufficient (2) | **25-30** |
| insufficient (1) | **0** |

The final grade is the sum of ECTS grade points obtained during classes and the final examination.

| | |
|---|---|
| **A** (90-100 %) | **excellent (5)** |
| **B** (75-89,99 %) | **very good (4)** |
| **C** (60-74,99 %) | **good (3)** |
| **D** (50-59,99 %) | **sufficient (2)** |
| **F** (students who obtained less than 25 grade points during course classes or did not pass the final exam) | **insufficient (1)** |

## Detailed overview of grading within the European Credit Transfer System:

**ECTS grading system**

Students' work will be assessed and graded **during the course** and on **the final exam**. During the course, students can earn a total of 100 grade points - up to 50 grade points during the course and up to 50 grade points on the final exam.

Student assessment is performed using ECTS (A-F) and a numerical system (1-5). Assessment in the ECTS system is by absolute distribution and follows the assessment criteria for graduates.

Of the maximum 50 points that can be earned in class, a student must achieve at least 50% (25) of the points to be eligible to take the final exam. Students who achieve 0-49.9% (0-24.9%) of the grade points during the course will receive an F grade (insufficient), will not receive ECTS credits, and will have to re-enrol for the course.

## Curriculum:

### Lectures list (with titles and explanation):

#### Lecture 1: Organization of the Nervous System. Basic Functions of Synapses.

To describe the organization of the nervous system; to explain the main levels in the function of the central nervous system (CNS); to describe the cellular structure of neurons and glial cells; to describe the structure and function of synapses; to list types of synapses; to describe the physiological structure of synapses; to explain the role of calcium ions; to describe the function of receptor proteins on a postsynaptic neuron; to explain the signal transmission and processing in neuronal groups; to explain signal divergence and convergence and lateral inhibition; to explain the term reverberation, permanent signal output, and rhythmic signal output.

#### Lecture 2: Electrical Events During Neuronal Excitation and Inhibition

To describe the membrane potential of neuronal soma: to review the ion concentrations on both sides of the neuron's membrane; to define the term Nernst potential; to describe the role of diffusion and the Na/K pump in the generation of the nerve's membrane potential; to describe the generation and all phases of the nerve's action potential; to define the role of voltage-gated sodium and potassium channels; to describe the 'all or nothing' law; to explain the concept of saltatory impulse conduction in nerves; to explain the generation of excitatory and inhibitory postsynaptic potentials; to describe the generation of the action potential at the axon of the neuron and the concept of threshold stimulus; to define the term presynaptic inhibition; to explain the term spatial and temporal neuron summation; to explain the term neuronal facilitation; to describe the terms "electronic current" and decremental conduction along the dendrite to the soma; to explain synaptic transmission fatigue; to describe the effects of acidosis and alkalosis on synaptic transmission; to describe the concept of synaptic decay; to explain the consequences of the demyelination process on nerve conduction.

#### Lecture 3: Neurotransmitters, Neuropeptides, and Receptors

To define the term neurotransmitter; to group the low-molecular fast-acting transmitters; to group slow-acting transmitters of neuropeptides; to describe the differences between these two groups of transmitters; to describe the procedures for identifying neurotransmitters and neuropeptides (according to Sheperd 1988); to describe the effects of neurotransmitters mediated by ionotropic or metabotropic postsynaptic receptors; to explain the concept and significance of receptor desensitisation; to explain glutamate metabolism in the brain; to describe the structure and function of NMDA and non-NMDA receptors; to explain the mechanism of action of inhibitory GABA and glycine neurotransmitters; to describe the formation and effect of acetylcholine via acetylcholine receptors; to describe the formation and effect of monoamine neurotransmitters (dopamine, noradrenaline and adrenaline) and serotonin; to describe the synthesis and processing of neuropeptides.

#### Lecture 4: Sensory Receptors, Somatic Sensation, Sensory Pathways for Transmitting Somatic Signals

To group senses; to define sensory receptors; to group sensory receptors; to define the concept of sensory modality and the principle of the "labelled line"; to describe the origin of the receptor (generator) potential using the Pacinian corpuscle as an example; to define the relationship between receptor and action potential; to describe the mechanisms of receptor adaptation; to explain the term "tonic" and "phasic" receptor; to describe the physiological classification and function of nerve fibres; to describe the relationship between touch, pressure, and vibration; to describe the tactile receptors; to describe the structure and function of the sensory pathways for the transmission of somatic signals to the central nervous system: 1. a dorsal column–medial lemniscus and anterolateral system 2; to describe the location, parts and layers of the somatosensory cortex; to explain the functions of specific parts of the somatosensory cortex; to describe the somatosensory homunculus; to define the sense of position; to define the term dermatome.

#### Lecture 5: Special senses: The Sense of Vision

To describe the eye optics; to describe the structure of the retina; to explain the photochemistry of vision; to explain the adaptation and accommodation; to describe the visual pathway; to describe the contrast analysis in the visual image; to explain the method for determining the visual field; to describe eye movements and their control; to describe the creation of visual images from the signals of both eyes; to explain the formation and function of the intraocular fluid.

#### Lecture 6: Pathophysiology of the Nervous System. Peripheral and Central Sensory Disorders. Pain.

To explain nerve conduction disorders; to elaborate on disorders of hypo- and hyperfunction of the neurotransmitters dopamine, acetylcholine, serotonin; to explain the development of myasthenia gravis; to review the mechanism of desensitisation; to describe the phenomenon of tardive dyskinesia, and the mechanism of the abstinence crisis; to explain the concepts of denervation hypersensitivity, hypoesthesia, paraesthesia and the concept of backward decay;

to describe the anatomical isthmus syndrome; to define neuropathies and polyneuropathies; to describe Brown-Sequard syndrome, conus and epiconus syndromes; to describe a thalamic syndrome; to describe phantom sensations; to define types of pain; to describe pain receptors; to describe pathways pain signalling pathways: the neospinothalamic tract and paleospinothalamic tract; to describe the functions of reticular formation, thalamus, and cerebral cortex in pain perception; to describe the analgesic system in the brain and spinal cord; to explain the importance of the opiate system in the brain; to explain the terms of reflected and visceral pain; to describe and list types of headache.

**Lecture 7: Cerebral Cortex, Intellectual Functions of the Brain, Learning, and Memory**

To describe the physiological structure of the cerebral cortex; to describe the thalamocortical system; to explain the functions of specific cortical areas: association areas (parietal-occipital-temporal, prefrontal and limbic association areas); to explain the location and importance of the Wernicke's area; to explain the concept of the dominant hemisphere; to explain the importance of the non-dominant hemisphere; to describe brain function in communication (speech); to name and describe types of speech disorders; to describe the importance of the corpus callosum; to define the thought, consciousness, and memory; to explain the concept of positive and negative memory; to describe the mechanism of short-term, intermediate and long-term memory formation; to describe the phenomenon of memory consolidation: the role of the hippocampus in the process of memory.

**Lecture 8: States of Brain Activity – Sleep, Brain Waves, Epilepsy**

To describe two types of sleep; to explain basic theories of sleep; to describe the development and origin of brain waves; to distinguish epilepsies; to define schizophrenia, Alzheimer's disease, and dementia; to describe parts of the limbic system and the activation-stimulating brain system; to describe the functions of the hypothalamus; to explain the importance of reward and punishment in behaviour; to describe the functions of the hippocampus and the amygdala.

**Lecture 9: Motor Neurophysiology - Motor Functions of the Spinal Cord**

To define three types of motor activities: voluntary, unconscious, and reflex; to describe the structure of the spinal cord; to describe the function of alpha and gamma motoneurons, interneurons, and Renshaw cells; to describe the structure of the muscle spindle and the sensory and motor innervation of the spindle; to explain the receptor function of the muscle spindle; to describe the reflex arc; to describe the stretch reflex (dynamic and static part of the reflex); to describe the importance of control of the gamma-motor system; to describe the term clonus; to describe Golgi tendon reflex; to describe the polysynaptic flexor reflex and the withdrawal pattern; to describe the cross-linked extensor reflex; to define the term reciprocal inhibition; to describe the postural and gait; to describe the spinal shock.

**Lecture 10: Cortical and Brain Stem Control of Motor Function**

To define the position and functional parts of the motor cortex; to describe the motor homunculus; to emphasize specialized motor control areas; to define the medial and lateral motor system; to describe the corticospinal tract; to describe other neural pathways leaving the motor cortex; to describe the input pathways in the motor cortex; to describe the structure and function of cerebral cortex neuronal columns; to describe the stimulation of the spinal cord motoneurons; to describe the role of brainstem in the control of the motor function – the role of reticular and vestibular nuclei (to describe reticulospinal and vestibulospinal tracts); to describe the location, anatomical and functional parts of the cerebellum; to define the afferent tracts to the cerebellum; to describe the deep nuclei and efferent tracts of the cerebellum; to describe the parts and the functional unit of the cerebellar cortex; to describe the parts and function of vestibulocerebellum; to describe the parts and function of spinocerebellum; to describe the parts and function of the cerebrocerebellum; to describe clinical disorders of the cerebellum.

**Lecture 11: Contributions of the Cerebellum and Basal Ganglia to Overall Motor Control**

To name the basal ganglia; to describe the putamen circuit; to describe the caudate circuit; to explain the function of neurotransmitters in the basal ganglia system; to explain the development of Parkinson's disease; to explain the development and clinical presentation of Huntington's disease; to explain the development of athetosis and hemiballismus; to explain the functional connection of the basal ganglia with the brainstem and motor cortex; to describe the basics of motor nerve disorders; to describe the consequences of damage to the corticospinal tract; to describe disorders of cerebellar control; to describe disorders of neuromuscular junction (myasthenia gravis); to describe disorders of peripheral motor neurones; to describe disorders of motor unit.

**Lecture 12: The Autonomic Nervous System. Disorders of Neurovegetative Regulation.**

To describe the general organization of the ANS; to describe the structure of the sympathetic nervous system: preganglionic and postganglionic neurons; to describe the organisation of the parasympathetic nervous system: preganglionic and postganglionic neurons; to describe cholinergic and adrenergic fibres; to describe adrenergic and cholinergic receptors and their functions; to describe the effects of sympathetic and parasympathetic stimulation of certain organs: the eye, the glands, the digestive system, the heart, the blood vessels, the blood pressure; to describe

the function of the adrenal medulla; to explain sympathetic and parasympathetic tone; to describe autonomic reflexes; to describe the sympathetic nervous system alarm response; to describe ANS control; to name the aetiological factors of neurovegetative disorders; to explain the concepts of primary and secondary ANS disorders; to describe circadian rhythm disorders; to describe sleep disorders; to explain the concept of psychosomatic illness; to describe chronic fatigue syndrome.

**Lecture 13: Cerebral Blood Flow, Cerebrospinal Fluid, and Brain Metabolism**

To describe the circle of Willis; to explain the role of the perivascular space; to describe the structure of the blood-brain barrier (BBB); to explain the function of the BBB; to describe the characteristics of microcirculation in the brain; to discuss transmission through the BBB; to describe the regulation of the cerebral blood flow: autonomic and nervous; to explain the origin and clinical presentation of stroke (ischaemic and haemorrhagic); to describe the cerebral metabolism; to describe the cerebrospinal fluid (CSF) system: formation, flow, and absorption of CSF; to explain the function of CSF; to describe the composition of CSF; to describe the blood-cerebrospinal fluid barrier; to describe the development of communicating and non-communicating hydrocephalus; to describe the functions of the ependyma; to name and define the functions of the circumventricular organs.

**Practicals list (with titles and explanation):**

**Practical 1: The Neuromuscular Junction**

To describe the membrane and action potential; to describe the structure and function of the neuromuscular junction; to describe the effect of strychnine on the spinal cord; to explain the term and meaning of electromyography; to describe the concept of muscular fatigue.

Practical part: EMG I and II - showing the impact of muscle contraction on the electric current voltage and the frequency; recording of electrical changes in muscles during motor unit recruitment and muscle fatigue using Biopac System.

For this practical, students should prepare the material from the textbook A. C. Guyton and Hall, Medical Physiology: Chapter 5. Membrane Potentials and Action Potentials; Chapter 6. Contraction of Skeletal Muscle; Chapter 7. Excitation of Skeletal Muscle: Neuromuscular Transmission and Excitation-Contraction Coupling, and from the Handbook for Practicals in Neurophysiology, Rijeka, 2019, practicals 1.1. (EMG I), 1.2. (EMG II), and 1.3. (The effect of Strychnine on the Spinal Cord).

**To attend (ALL) practicals, it is necessary to have a lab coat and Handbook for Practicals in Neurophysiology!**

**Practical 2: The Sense of Vision**

To examine eye movements; to perform a pupillary reflex; to perform a corneal reflex; to determine visual acuity; to check the color vision; to determine the width of the visual field; to perform the optokinetic test, to describe the concept of visual fixation.

Practical part: Eye: 1.) Determining visual acuity; 2.) Color recognition; 3.) Reflex reactions; 4.) Ocular motility; 5.) Perimetry (visual field examination); 6.) Optokinetic nystagmus.

The student should prepare the following material: from the textbook A. C. Guyton and Hall, Medical Physiology, Chapter 50. The Eye I: Optics of Vision; Chapter 51. The Eye II: Receptor and Neural Function of the Retina; Chapter 52: The Eye III: Central Neurophysiology of Vision, and from the Handbook for Practicals in Neurophysiology, Rijeka, 2019, practicals 2.1. (Ocular Motility), 2.2. (Pupillary Light Reflex), 2.3. (Corneal Reflex), 2.4. (Visual Acuity), 2.5. (Perimetry), 2.6. (Color Blindness), 2.7. (Electrooculogram).

**Practical 3: The Sense of Hearing, Taste and Smell; Vestibular Sensation**

To examine hearing with a tuning fork; to examine the sense of balance; to examine the excitability of the vestibular system; and the senses of taste and smell.

Practical part: A. Ear: 1) A sense of hearing; 2) Functional tests for balance; B. Taste: 1) Testing the sense of taste for sour, salty, sweet, and bitter; C. Smell: 1) Measuring smell by Bornstein

The student should prepare the following material: from the Textbook A. C. Guyton and Hall, Medical Physiology: Chapter 53. The Sense of Hearing; Chapter 54. The Chemical Senses – Taste and Smell; Chapter 56. Vestibular Sensations (p. 714-719) and from the Handbook for Practicals in Neurophysiology, Rijeka, 2019, practicals 3.1. (Sense of Hearing), 3.2. (Sense of Balance), 3.3. (Sense of Taste), 3.4. (Sense of Smell).

**Practical 4: Motor Neurophysiology**

To describe the term decerebration; to explain the electroencephalography (EEG) method; to describe the motor function of the spinal cord (spinal reflexes); to describe the role of the cerebral cortex and brainstem over motor functions; to describe the role of the cerebellum and basal ganglia in the motor functions; to describe brain activity states: waves, sleep, epilepsies.

The practical part: the examination of spinal reflexes, measuring motor reaction time to sensory stimulus on Biopac, recording of EEG on Biopac, decerebrate rigidity (video).

The student should prepare the following material from the Textbook A.C. Guyton and Hall, Medical Physiology: Chapter 55. Motor Functions of the Spinal Cord, the Cord Reflexes; Chapter 56. Cortical and Brain Stem Control of Motor Function; Chapter 57. Contributions of the Cerebellum and Basal Ganglia to Overall Motor Control, and from the Handbook for Practicals in Neurophysiology, Rijeka, 2019, practicals 4.1. (Spinal Reflexes), 4.2. (Reaction Time), 4.3. (Decerebrate Rigidity), 4.4. (Electroencephalography).

**Seminars list (with titles and explanation):**

**Seminar 1: Organization of the Nervous System. Basic Functions of Synapses**

To group cells of the nervous system; to describe the structure and function of neurons; to describe the structure and function of glial cells; to describe the parts and function of central and peripheral synapses; to describe the process of neurotransmitter exocytosis; to describe the activation of ionotropic receptors; to describe the term EPSP and IPSP; to describe synthesis, action, and decomposition of acetylcholine; to describe the effects of certain medicaments and drugs on the neuromuscular junction.

Literature:

Chapter 46. Organization of the Nervous System, Basic Function of Synapses, Electrical Events during Neuronal Excitation

Textbook: Medical Physiology, Guyton and Hall

**Seminar 2: Sensory Receptors; Somatic Sensations**

To group senses; to define and group sensory receptors; to define the term sense modality and the principle of the "marked line"; to describe the emergence of receptor (generator) potential on the example of Pacinian corpuscle; to define the relationship between receptor and action potential; to describe the mechanisms of receptor adaptation; to explain the term "tonic" and "phasic" receptor; to describe the physiological classification and function of nerve fibers; to describe the relationship of tactile senses, pressure, and vibration; to describe tactile receptors; to describe the structure and function of sensory pathways for transmitting somatic signals into the central nervous system: 1. a dorsal column system – a medial lemniscus and anterolateral system 2; to describe the position, parts, and layers of the somatosensory cortex; to explain the functions of certain parts of the somatosensory cortex; to describe somatosensory homunculus; to define the position sense; to define the term dermatome.

Literature:

Chapter 47. Sensory receptors

Chapter 48. Somatic Sensation: General Organization, The Tactile and Position Senses. Textbook: Medical Physiology, A.C. Guyton and Hall

**Seminar 3: The Sense of Vision**

To review the physical principles of optics; to describe the eye optics; to explain the notion of visual acuity; to describe the structure of the retina; to explain the photochemistry of vision; to explain the adaptation and accommodation; to explain the principles of color vision; to describe the neural function of the retina and all of its cells; to explain the significance of lateral inhibition in the visual signal transmission; to describe the visual pathway and its damages; to explain the method for determination of the visual field; to describe eye movements and their control; to describe the fusion of visual images from both eyes.

Literature:

Chapter 50. The Eye I: Optics of Vision

Chapter 51. The Eye II: Receptor and Neural Function of the Retina

Chapter 52. The Eye: III. Central Neurophysiology of Vision

Textbook: Medical Physiology, Guyton and Hall

**Seminar 4: The Sense of Hearing, The Sense of Taste and Smell, Vestibular Sensations**

To describe the anatomical structure of the outer, middle, and inner ear; to explain the mechanism of impedance adaptation using the ossicle system; to describe the "travelling wave"; to describe the function of the organ of Corti; to explain the phenomenon of sound frequency determination (the place principle); to describe the determination of sound volume; to describe the auditory nerve pathway; to understand the role of the auditory cortex; to name hearing disorders; to define types of flavour; to describe the structure and function of the taste bud; to describe taste pathways; to describe the sense of smell: types, signal transmission into the nervous system; to describe the structure and function of the vestibular apparatus in the maintaining of balance.

Literature:

Chapter 53. The Sense of Hearing

Chapter 54. The Chemical Senses – Taste and Smell

Chapter 56. Vestibular Sensations (p. 714-719)

Textbook: Medical Physiology, Guyton and Hall

**Seminar 5: Cerebral Cortex and Intellectual Functions**

To describe the parts and function of the association areas; to describe all intellectual brain functions (communication, thought, consciousness, memory); to describe the mechanisms of short-term, medium-long, and long-term memory; to describe the excitatory-activating system of the brain; to describe the parts and function of the limbic system (hypothalamus, hippocampus, amygdala, limbic cortex); to describe stages of sleep; to repeat the basic theories of sleep; to define types of brain waves; to describe epilepsies; to define depression, schizophrenia, and Alzheimer's disease.

Literature:

Chapter 58. Cerebral Cortex, Intellectual Functions of the Brain, Learning, and Memory

Chapter 59. Behavioural and Motivational Mechanisms of the Brain – The Limbic System and the Hypothalamus

Chapter 60. State of Brain Activity – Sleep, Brain Waves

Textbook: Medical Physiology, Guyton and Hall

**Seminar 6: Motor Neurophysiology**

To define the structure of the motor system; motor functions of the spinal cord and brainstem; cortical and cerebellar control of motor functions and the contribution of basal ganglia to motor control.

Literature:

Chapter 55. Motor Functions of the Spinal Cord; the Cord Reflexes

Chapter 56. Cortical and Brain Stem Control of Motor Function

Chapter 57. Contributions of the Cerebellum and Basal Ganglia to Overall Motor Control

Textbook: Medical Physiology, A.C. Guyton and Hall

## Student obligations:

Students are required to bring to the practicals **a lab coat and the Handbook** for Practicals in Neurophysiology.

Students are not allowed **to switch groups** unless they find a replacement.

A student is obligated to prepare the material that will be discussed in seminars and practicals.

In accordance with the Law and Ordinance of the Faculty of Medicine in Rijeka, all forms of classes (lectures, seminars, and practicals) are mandatory. For justified reasons, a student may be absent from **a maximum of 30%** of each form of class (30% of lectures, 30% of seminars, 30% of exercises).

## Exam (exam taking, description of the written/oral/practical part of the exam, point distribution, grading criteria):

I. Evaluation during the course (up to 50 grade points)

During the course, the aquired knowledge wil be evaluated by **two midterm tests comprising 50 questions.**

A student may obtain up to 25 grade points for each test, as indicated in the table:

| Correct answers | **Grade points** |
|---|---|
| 49,50 | **25** |
| 47,48 | **24** |
| 45,46 | **23** |
| 43,44 | **22** |
| 41,42 | **21** |
| 39,40 | **20** |
| 37,38 | **19** |
| 35,36 | **18** |
| 33,34 | **17** |
| 31,32 | **16** |
| 29,30 | **15** |
| 27,28 | **14** |
| 26 | **13** |
| 25 | **12.5** |
| <25 | **0** |

Each test has **one retake** available for students who did not achieve the minimum grade points required to access the final exam, did not participate in the midterm exam, or are not satisfied with the grade points they obtained . If a student retakes the midterm exam because he/she is not satisfied with the score achieved, only the grade points obtained in the retaken midterm will be considered. Retakes of the midterm exams will be held before the first date of the final exam.

II. Final exam (up to 50 grade points)

The final exam is **oral** and assesses specific learning outcomes defined for each course section.

**Who can take the final exam**: Students who have passed both midterm exams and have earned **25 to 50 grade points** are eligible to take the final examination. The final examination is worth a maximum of 50 points.

**Who CANNOT take the final exam**: Students who have **not** passed both midterm exams, have earned **fewer than 25**

**points** during the course, or have been **absent for more than 30% of classes,** are not eligible to take the final examination. They must re-enrol in the course in the following academic year and receive a **failing grade (F)**.

**The final examination** is an oral. To pass the final exam, the student must receive a passing grade in the oral examination.

In the oral examination, the student can obtain **25 to 50 grade points,** as shown in the table:

| Grade obtained at the oral examination | Grade points obtained at the oral examination |
|---|---|
| excellent (5) | **45-50** |
| very good (4) | **38-44** |
| good (3) | **31-37** |
| sufficient (2) | **25-30** |
| insufficient (1) | **0** |

**III. Final grade**

The final grade is a sum of ECTS grade points obtained during classes and the final examination.

| | |
|---|---|
| **A** (90-100 %) | **excellent (5)** |
| **B** (75-89,99 %) | **very good (4)** |
| **C** (60-74,99 %) | **good (3)** |
| **D** (50-59,99 %) | **sufficient (2)** |
| **F** (students who obtained less than 25 grade points during course classes or did not pass the final exam) | **insufficient (1)** |

**MIDTERM EXAMS:**

**16.04.2027.** **(L1 – L6; S1 – S3; P1 – P2)**

**31.05.2027.** **(L7 -L13; S4 – S6; P3 - P4)**

**FINAL EXAMS:**

**14.06.2027.**

**30.06.2027.**

**14.07.2027.**

**02.09.2027.**

**16.09.2027.**

Other notes (related to the course) important for students:

Teaching content and all information related to the course can be found on the Merlin.

## Other notes (related to the course) important for students:

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## COURSE HOURS 2026/2027

Neurophysiology

| **Lectures**<br>(Place and time or group) | **Practicals**<br>(Place and time or group) | **Seminars**<br>(Place and time or group) |
|---|---|---|
| **02.03.2027** | | |
| Lecture 1: Organization of the Nervous System. Basic Functions of Synapses.:<br>• P08 (11:15 - 13:00) [395]<br>  ○ N_319 | | |
| doc. dr. sc. Ćurko-Cofek Božena, dr. med. [395] | | |
| **09.03.2027** | | |
| Lecture 2: Electrical Events During Neuronal Excitation and Inhibition:<br>• P08 (11:15 - 13:00) [395]<br>  ○ N_319 | | |
| doc. dr. sc. Ćurko-Cofek Božena, dr. med. [395] | | |
| **16.03.2027** | | |
| Lecture 3: Neurotransmitters, Neuropeptides, and Receptors:<br>• P08 (11:15 - 13:00) [399]<br>  ○ N_319 | | |
| prof. dr. sc. Kučić Natalia, dr. med. [399] | | |
| **17.03.2027** | | |
| | | Seminar 1: Organization of the Nervous System. Basic Functions of Synapses:<br>• v (13:15 - 15:30) [393]<br>  ○ N-S1 |
| Lukanović Jurić Silvija, dr. med. [393] | | |
| **18.03.2027** | | |
| | | Seminar 1: Organization of the Nervous System. Basic Functions of Synapses:<br>• v (13:15 - 15:30) [393]<br>  ○ N-S2 |
| Lukanović Jurić Silvija, dr. med. [393] | | |
| **23.03.2027** | | |
| Lecture 4: Sensory Receptors, Somatic Sensation, Sensory Pathways for Transmitting Somatic Signals:<br>• P08 (11:15 - 13:00) [396]<br>  ○ N_319 | | |
| prof. dr. sc. Jakovac Hrvoje, dr. med. [396] | | |
| **24.03.2027** | | |

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|---|---|---|
| | Practical 1: The Neuromuscular Junction:<br>• Department of Physiology - Exercise room (16:00 - 19:00) [1132]<br>○ N-P2 | Seminar 2: Sensory Receptors; Somatic Sensations:<br>• Department of Physiology - Seminarska (13:15 - 15:30) [395]<br>○ N-S1 |
| Omerović Alen, dr. med. [1132] · doc. dr. sc. Ćurko-Cofek Božena, dr. med. [395] | | |
| **25.03.2027** | | |
| | Practical 1: The Neuromuscular Junction:<br>• Department of Physiology - Exercise room (16:00 - 19:00) [395]<br>○ N-P1 | Seminar 2: Sensory Receptors; Somatic Sensations:<br>• Department of Physiology - Seminarska (13:15 - 15:30) [395]<br>○ N-S2 |
| doc. dr. sc. Ćurko-Cofek Božena, dr. med. [395] | | |
| **30.03.2027** | | |
| Lecture 5: Special senses: The Sense of Vision:<br>• P08 (11:15 - 13:00) [395]<br>○ N_319 | | |
| doc. dr. sc. Ćurko-Cofek Božena, dr. med. [395] | | |
| **31.03.2027** | | |
| | | Seminar 3: The Sense of Vision:<br>• Department of Physiology - Seminarska (13:15 - 15:30) [395]<br>○ N-S1 |
| doc. dr. sc. Ćurko-Cofek Božena, dr. med. [395] | | |
| **01.04.2027** | | |
| | | Seminar 3: The Sense of Vision:<br>• Department of Physiology - Seminarska (13:15 - 15:30) [395]<br>○ N-S2 |
| doc. dr. sc. Ćurko-Cofek Božena, dr. med. [395] | | |
| **06.04.2027** | | |
| Lecture 6: Pathophysiology of the Nervous System. Peripheral and Central Sensory Disorders. Pain.:<br>• P08 (11:15 - 13:00) [395]<br>○ N_319 | | |
| doc. dr. sc. Ćurko-Cofek Božena, dr. med. [395] | | |
| **07.04.2027** | | |
| | Practical 2: The Sense of Vision:<br>• Department of Physiology - Exercise room (16:00 - 19:00) [395]<br>○ N-P1 | |

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|---|---|---|
| doc. dr. sc. Ćurko-Cofek Božena, dr. med. [395] | | |
| **08.04.2027** | | |
| | Practical 2: The Sense of Vision:<br>• Department of Physiology - Exercise room (16:00 - 19:00) [1102]<br>◦ N-P2 | |
| Kostelac Elizabeta, dr.med. [1102] | | |
| **13.04.2027** | | |
| Lecture 7: Cerebral Cortex, Intellectual Functions of the Brain, Learning, and Memory:<br>• P08 (11:15 - 13:00) [399]<br>◦ N_319 | | |
| prof. dr. sc. Kučić Natalia, dr. med. [399] | | |
| **14.04.2027** | | |
| | | Seminar 4: The Sense of Hearing, The Sense of Taste and Smell, Vestibular Sensations:<br>• Department of Physiology - Seminarska (13:15 - 15:30) [393]<br>◦ N-S1 |
| Lukanović Jurić Silvija, dr. med. [393] | | |
| **15.04.2027** | | |
| | | Seminar 4: The Sense of Hearing, The Sense of Taste and Smell, Vestibular Sensations:<br>• Department of Physiology - Seminarska (13:15 - 15:30) [393]<br>◦ N-S2 |
| Lukanović Jurić Silvija, dr. med. [393] | | |
| **20.04.2027** | | |
| Lecture 8: States of Brain Activity – Sleep, Brain Waves, Epilepsy:<br>• P08 (11:15 - 13:00) [395]<br>◦ N_319 | | |
| doc. dr. sc. Ćurko-Cofek Božena, dr. med. [395] | | |
| **21.04.2027** | | |
| | Practical 3: The Sense of Hearing, Taste and Smell; Vestibular Sensation:<br>• Department of Physiology - Exercise room (16:00 - 19:00) [395]<br>◦ N-P1 | |
| doc. dr. sc. Ćurko-Cofek Božena, dr. med. [395] | | |
| **22.04.2027** | | |

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|---|---|---|
| | Practical 3: The Sense of Hearing, Taste and Smell; Vestibular Sensation:<br>• Department of Physiology - Exercise room (16:00 - 19:00) [1132]<br>◦ N-P2 | |
| Omerović Alen, dr. med. [1132] | | |
| **27.04.2027** | | |
| Lecture 9: Motor Neurophysiology - Motor Functions of the Spinal Cord:<br>• P08 (11:15 - 13:00) [396]<br>◦ N_319 | | |
| prof. dr. sc. Jakovac Hrvoje, dr. med. [396] | | |
| **28.04.2027** | | |
| | | Seminar 5: Cerebral Cortex and Intellectual Functions:<br>• P08 (13:15 - 15:30) [395]<br>◦ N-S1 |
| doc. dr. sc. Ćurko-Cofek Božena, dr. med. [395] | | |
| **29.04.2027** | | |
| | | Seminar 5: Cerebral Cortex and Intellectual Functions:<br>• v (13:15 - 15:30) [396]<br>◦ N-S2 |
| prof. dr. sc. Jakovac Hrvoje, dr. med. [396] | | |
| **04.05.2027** | | |
| Lecture 10: Cortical and Brain Stem Control of Motor Function:<br>• P08 (11:15 - 13:00) [395]<br>◦ N_319 | | |
| doc. dr. sc. Ćurko-Cofek Božena, dr. med. [395] | | |
| **11.05.2027** | | |
| Lecture 11: Contributions of the Cerebellum and Basal Ganglia to Overall Motor Control:<br>• P08 (11:15 - 13:00) [395]<br>◦ N_319 | | |
| doc. dr. sc. Ćurko-Cofek Božena, dr. med. [395] | | |
| **12.05.2027** | | |
| | | Seminar 6: Motor Neurophysiology:<br>• v (13:15 - 15:30) [396]<br>◦ N-S1 |
| prof. dr. sc. Jakovac Hrvoje, dr. med. [396] | | |
| **13.05.2027** | | |

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|---|---|---|
| | | Seminar 6: Motor Neurophysiology:<br>• v (13:15 - 15:30) [395]<br>○ N-S2 |
| doc. dr. sc. Ćurko-Cofek Božena, dr. med. [395] | | |
| **18.05.2027** | | |
| Lecture 12: The Autonomic Nervous System. Disorders of Neurovegetative Regulation.:<br>• P08 (11:15 - 13:00) [396]<br>○ N_319 | | |
| prof. dr. sc. Jakovac Hrvoje, dr. med. [396] | | |
| **19.05.2027** | | |
| | Practical 4: Motor Neurophysiology:<br>• Department of Physiology - Exercise room (08:00 - 11:00) [395]<br>○ N-P2 | |
| doc. dr. sc. Ćurko-Cofek Božena, dr. med. [395] | | |
| **20.05.2027** | | |
| | Practical 4: Motor Neurophysiology:<br>• Department of Physiology - Exercise room (08:00 - 11:00) [396]<br>○ N-P1 | |
| prof. dr. sc. Jakovac Hrvoje, dr. med. [396] | | |
| **25.05.2027** | | |
| Lecture 13: Cerebral Blood Flow, Cerebrospinal Fluid, and Brain Metabolism:<br>• P08 (11:15 - 13:00) [395]<br>○ N_319 | | |
| doc. dr. sc. Ćurko-Cofek Božena, dr. med. [395] | | |

### List of lectures, seminars and practicals:

| LECTURES (TOPIC) | Number of hours | Location |
|---|---|---|
| Lecture 1: Organization of the Nervous System. Basic Functions of Synapses. | 2 | P08 |
| Lecture 2: Electrical Events During Neuronal Excitation and Inhibition | 2 | P08 |
| Lecture 3: Neurotransmitters, Neuropeptides, and Receptors | 2 | P08 |
| Lecture 4: Sensory Receptors, Somatic Sensation, Sensory Pathways for Transmitting Somatic Signals | 2 | P08 |
| Lecture 5: Special senses: The Sense of Vision | 2 | P08 |
| Lecture 6: Pathophysiology of the Nervous System. Peripheral and Central Sensory Disorders. Pain. | 2 | P08 |

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| Lecture 7: Cerebral Cortex, Intellectual Functions of the Brain, Learning, and Memory | 2 | P08 |
| Lecture 8: States of Brain Activity – Sleep, Brain Waves, Epilepsy | 2 | P08 |
| Lecture 9: Motor Neurophysiology - Motor Functions of the Spinal Cord | 2 | P08 |
| Lecture 10: Cortical and Brain Stem Control of Motor Function | 2 | P08 |
| Lecture 11: Contributions of the Cerebellum and Basal Ganglia to Overall Motor Control | 2 | P08 |
| Lecture 12: The Autonomic Nervous System. Disorders of Neurovegetative Regulation. | 2 | P08 |
| Lecture 13: Cerebral Blood Flow, Cerebrospinal Fluid, and Brain Metabolism | 2 | P08 |

| PRACTICALS (TOPIC) | Number of hours | Location |
|---|---|---|
| Practical 1: The Neuromuscular Junction | 4 | Department of Physiology - Exercise room |
| Practical 2: The Sense of Vision | 4 | Department of Physiology - Exercise room |
| Practical 3: The Sense of Hearing, Taste and Smell; Vestibular Sensation | 4 | Department of Physiology - Exercise room |
| Practical 4: Motor Neurophysiology | 4 | Department of Physiology - Exercise room |

| SEMINARS (TOPIC) | Number of hours | Location |
|---|---|---|
| Seminar 1: Organization of the Nervous System. Basic Functions of Synapses | 3 | v |
| Seminar 2: Sensory Receptors; Somatic Sensations | 3 | Department of Physiology - Seminarska |
| Seminar 3: The Sense of Vision | 3 | Department of Physiology - Seminarska |
| Seminar 4: The Sense of Hearing, The Sense of Taste and Smell, Vestibular Sensations | 3 | Department of Physiology - Seminarska |
| Seminar 5: Cerebral Cortex and Intellectual Functions | 3 | P08<br>v |
| Seminar 6: Motor Neurophysiology | 3 | v |

### EXAM DATES (final exam):

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|---|---|
| 1. | 14.06.2027. |
| 2. | 30.06.2027. |
| 3. | 14.07.2027. |
| 4. | 02.09.2027. |
| 5. | 16.09.2027. |