Faculty of Medicine, University of Rijeka

Course: Neurophysiology
Course Coordinator: Prof. dr. sc. Vesna Barac-Latas, dr. med.
Department: Department of Physiology, Immunology, and Pathophysiology
Study: Integrated Undergraduate and Graduate University Study of Medicine in English
Year of the study: Second
Academic year: 2021/2022

COURSE SYLLABUS

Course information (basic description, general information, teaching overview, required equipment, and preparation, etc.)

Course aims, tasks, and learning outcomes

The aim of this course is to enable the student to apply previously acquired knowledge of Neuroanatomy and Physiology and Pathophysiology, and to acquire knowledge about the normal functioning of the nervous system, as well as knowledge about the pathophysiological mechanisms that lead to the disorders of the normal functioning and the occurrence of a specific disease.

Classes are held in the summer semester of the second year of study: 28 hours of lectures, 16 hours of seminars and 16 hours of practicals, which totals **5 ECTS**. Immediately after held classes, **two exam dates are planned**.

The objective of the course is to gain knowledge about the normal and disturbed functioning of the nervous system to the extent necessary for further successful study monitoring. The task of teaching is to acquire basic knowledge about the functional organization of the nervous system as a substrate of physiological and pathophysiological conditions, as well as to acquire knowledge about basic neurophysiological and neuropathological processes.

Classes are performed in the form of lectures, seminars, and practicals, which include using computer programs like Biopack and SymBioSys that present physiological functions or certain diseases in humans, and program-oriented class. Certain pathological conditions are also demonstrated on animal models. Part of the seminars is conducted as a problem-oriented class 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 exercises, the student with the teacher actively discusses the physiological and pathophysiological mechanisms.

The student is obligated to prepare the material that is being 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. The validity of absence from seminars and practicals is proven by a valid certificate.

Lectures, seminars, and practicals take place according to the Syllabus. Schedule of students by groups can be found on the SharePoint platform of the Department of Physiology and Immunology on the following website: https://spp.uniri.hr/ss_medri/katedre/427 - accessed via an **AAI address**.

Course outline

General organization of the nervous system: central, peripheral, and autonomous; Neuronal cellular biology: 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; Fundamental neurophysiological processes: membrane and action potentials; Emergence and spreading of the nerve impulse; Structure and function of synapses; Neurotransmitters and their receptors: biochemical features of synthesis and decomposition, distribution and interaction of neurotransmitter systems; Membrane receptors: division, structure, activation, distribution; pathophysiology of the nervous transmission; Neural circuits for information processing; Organization of sensory systems and sensory functions: somatic (receptors) and special senses (vision, hearing, balance, taste, smell); Sensory disorders, pathophysiological background of pain; General organization of the motor system: spinal and

supraspinal reflexes; Pyramidal and extrapyramidal motor system; Basal ganglia function: cerebellar motoric control, motoric nervous disorders; Autonomic nervous system: physiological and pathophysiological aspects; General and managing brain functions: ascending reticular activation system (attention, vigilance, sleep); Limbic system (emotions, neuroendocrinology of behavior), sexuality; Higher brain functions: laminar and vertical organization of the cerebral cortex: integrative function of the nervous system; Intellectual functions (memory, thinking, speech); Mental function disorders.

Developing 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

Developing specific competencies (knowledge and skills)
At the end of this course, the student will be able to:
1. explain the principles of emergence and spreading of the action potential (impulse), as well as the basis for the pathophysiology of the nervous transmission
2. explain the concept of synaptic transmission, biochemical features of synthesis and decomposition, and distribution and interaction of neurotransmitter systems
3. list and describe the division, structure, distribution, and activation of membrane receptors
4. explain somatic (touch, pressure, position, pain, temperature) and special senses (vision, hearing, taste, smell, balance), from sensory receptors and input (afferent) fibers to the cerebral cortex
5. explain pathophysiological processes associated with damages to somatosensory and special senses
6. explain the role of the nervous system in motor control: organization of the motor unit, spinal motor system control, voluntary motor movements, posture, role of basal ganglia and small brain in motion control
7. explain the general and managing brain functions, states of vigilance and consciousness, emotions and mood
8. explain the reaction 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, cerebrospinal fluid, blood flow regulation mechanisms and circulatory disorders (cerebrovascular insult)

Required textbooks:

1. Medical Physiology, Guyton and Hall, Medicinska naklada Zagreb, thirteenth edition, 2016.
2. Pathophysiology, basic mechanisms of disease – textbook, book one – volume one; Stjepan Gamulin, Matko Marušić, Zdenko Kovač: Medicinska naklada -Zagreb, 2014.
3. Pathophysiology, basic mechanisms of disease – textbook, book one – volume two; Stjepan Gamulin, Matko Marušić, Zdenko Kovač: Medicinska naklada -Zagreb, 2014.
4. Pathophysiology, Study guide algorhythms – problem solver; Zdenko Kovač, Stjepan Gamulin; book two, Medicinska naklada, 2014.
5. Handbook for Practicals in Physiology, Neurophysiology, and Immunology. Department of Physiology, Neurophysiology, and Pathological Physiology, Faculty of Medicine in Rijeka, October 2001 and 2003 (2006), 2001. – available in electronic form on the Department's website (can be downloaded from the *SharePoint* platform of the Department of Physiology: http://sp.medri.hr/Studenti/

(username and password can be found on the notice board of the Department of Physiology)

Recommended for additional reading:

1. Judaš M, Kostović I. Basics of Neuroscience, MD, Zagreb, 1997.

Course teaching plan:

List of lectures (with titles and learning outcomes):

Lecture 1: Organization 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 transmission and signal 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.

2: Neurotransmitters, Neuropeptides, and Receptors

LEARNING OUTCOMES: to define the term neurotransmitter; to group low-molecular fast-acting transmitters; to group neuropeptide slow-acting transmitters; 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 through ionotropic or metabotropic postsynaptic receptors; to explain the term and meaning of receptor desensitization; to explain the glutamate metabolism in the brain; to describe the structure and function of NMDA and non-NMDA receptors; to explain the action mechanism of inhibitory GABA and glycine neurotransmitters; to describe the emergence and action of acetylcholine via acetylcholine receptors; to describe the emergence and action 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 soma neuron inaction: to repeat the ion concentrations on both sides of the neuron membrane; to define the term Nernst potential; to describe the role of diffusion and the Na/K pump in the emergence of the membrane potential of the nerve; to describe the emergence and all phases of the action potential of the nerve; to define the role of sodium and potassium channels regulated by voltage; to describe the law ‘all or nothing’; to explain the term saltatory impulse conduction in the nerves; to explain the emergence of excitatory and inhibitory postsynaptic potential; to describe the emergence of action potential on 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 "decrementary" guidance along the dendrite towards the soma; to explain the synaptic transmission fatigue; to describe the effect of acidosis and alkalosis on the synaptic transmission; to describe the concept of synaptic decay.

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 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.

Lecture 5: Specific sensations: The Sense of Vision

LEARNING OUTCOMES: to describe the eye optics; to explain the formation and function of the intraocular fluid; to describe the structure of the retina; to explain the photochemistry of vision; to explain the phenomenon of adaptation and accomodation; to describe the visual pathway; to describe the contrast analysis in the visual image; to explain the method of determining the visual field; to describe eye movements and control over it; to describe the joining of visual images from both eyes;

Lecture 6: Pathophysiology of the Nervous System; Peripheral and Central Sensory Disorders; Pain
LEARNING OUTCOMES: to explain nerve conduction disorders; to extract disorders of hypofunction and hyperfunction of dopamine, acetylcholine, serotonin neurotransmitters; to explain the emergence of Myasthenia gravis; to repeat the mechanism of desensitization; to describe the phenomenon of tardive dyskinesia, as well as the mechanism of abstinence crisis; to explain the concepts of denervation supersensitivity, hypoesthesia, paresthesia, as well as the concept of backward decay; to describe the anatomic isthmus syndrome; to define neuropathies and polyneuropathies; to describe the Brown-Sequard syndrome, conus and epiconus syndrome; to describe a thalamic syndrome; to describe phantom sensations; to define types of pain; to describe pain receptors; to describe twice for pain: 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 the spinal cord; to explain the importance of the opiate system in the brain; to explain the term reflected and visceral pain; to describe and list types of headaches.

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 area; to explain the position and meaning of the Wernicke area; to explain the notion of a dominant hemisphere; to explain the significance of a non-dominant hemisphere; to describe the brain function in communication (speech); to name and describe types of speech disorders; to describe the significance of the corpus callosum; to define the notion of thought, consciousness, and memory; to explain the concept of positive and negative memory; to group memory; to describe the mechanism of short-term, medium-long and long-term memory emergence; to describe the memory consolidation phenomenon: 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 emergence 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 behavior; 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 abilities: voluntary, subconscious, and reflexive; to describe the structure of the spinal cord; to describe the function of alpha and gamma motoneurons, interneurons, Renshaw's 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 reflex to stretch (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's tendon reflex; to describe the polysynaptic flexor reflex; to explain the removal pattern; to describe the crosslinked extensor reflex; to define the term reciprocal inhibition; to describe the reflex for body posture and walk; to describe the spinal shock.

Lecture 10: Cortical and Brain Stem Control of Motor Function
LEARNING OUTCOMES: to define the position and functional parts of the motor cortex; to describe the motor homunculus; to extract 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 corticospinal tract; to describe the structure and function of cerebral cortex neuron pillars; 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 position and the anatomical and functional parts of the small brain; to define the input tracts into the small brain; to describe the deep nuclei and output tracts of the small brain; to describe the functional unit of the small brain 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 small brain.

Lecture 11: Contributions of the Cerebellum and Basal Ganglia to Overall Motor Control
LEARNING OUTCOMES: to name 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 emergence of Parkinson's disease; to explain the emergence and clinical image of Huntington's disease; to explain the formation of athetosis and hemiballism; to explain the functional connection of the basal ganglia with the brainstem and the motor cortex; to describe the basics of motor neural disorders; to describe the consequences of damage to the corticospinal tract; to describe cerebellar control disorders; to describe disorders of neuromuscular junction (Myasthenia gravis); to describe peripheral motoneuron disorders; to describe motor unit disorders.

Lecture 12: The Autonomic Nervous System; Disorders of Neurovegetative Regulation
LEARNING OUTCOMES: to describe the general organization of ANS; to describe the structure of the sympathetic nervous system: preganglionic and postganglionic neurons; to describe the organization of the parasympathetic nervous system: preganglionic and postganglionic neurons; to describe cholinergic and adrenergic fibers; 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 gland medulla; to explain sympathetic and parasympathetic tone; to describe autonomous reflexes; to describe the alarming reaction of the sympathetic system; to describe ANS control; to name the etiological factors of the neurovegetative disorder; to explain the concepts of primary and secondary ANS disorders; to describe disorders of circadian rhythms; to describe sleeping disorders - awakeness; to explain the concept of psychosomatic disease; 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; to explain the function of the blood-brain barrier; to describe the specificities of the brain microcirculation; to discuss transmission through the blood-brain barrier; to describe the regulation of the cerebral blood flow: autonomous and nervous; to explain the emergence and the clinical image of a stroke (ischemic and hemorrhagic); to describe the cerebral metabolism; to describe the cerebrospinal fluid system: formation, flow, and absorption of the cerebrospinal fluid; to explain the function of the cerebrospinal fluid; to describe the composition of the cerebrospinal fluid; to describe the blood-cerebrospinal fluid barrier; to describe the emergence of the communicating and non-communicating hydrocephalus; to describe the functions of the ependyma; to name and define the functions of circumventricular organs.

Lecture 14: Clinical Correlates and Experimental Model(s)
LEARNING OUTCOMES: the central nervous system as an immune-privileged system; the role of microglial cells; to describe possible mechanisms of disease emergence associated with damages to certain subpopulations of nerve cells; to become acquainted with the possibilities of a scientific research approach to diseases of the nervous system.

List of seminars (with titles and learning outcomes):

Seminar 1: Organization 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 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

LEARNING OUTCOMES: sensory receptors; sensory pathways for the transmission of somatic signals; somatic sensations.

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 4: The Sense of Vision – I part
LEARNING OUTCOMES: to repeat the physical principles of optics; to describe the eye optics; to explain the notion of visual acuity; to explain the formation and function of the intraocular fluid; to describe the structure of the retina; to explain the photochemistry of vision; to explain the phenomenon of adaptation and accommodation.

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

LEARNING OUTCOMES: to explain the phenomenon of color vision; to describe the neural function of the retina and all of its cells; to explain the phenomenon of lateral inhibition in the visual signal transmission; to describe the visual pathway; to describe the contrast analysis in the visual image; to explain the method of determining the visual field; to describe eye movements and control over it; to describe the joining of visual images from both eyes;

Seminar 5: 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 ossicle system; to describe the "traveling wave"; to describe the function of the organ of Corti; to explain the phenomenon of sound frequency determination (principle of place); 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 flavor; 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.

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 6: Cerebral Cortex and Intellectual Functions
LEARNING OUTCOMES: 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 emergence; 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. Behavioral 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

List of practicals (with titles and learning outcomes):

Practical 1: The Neuromuscular Junction

LEARNING OUTCOMES: to describe the membrane and action potential; to describe the skeletal muscle contraction; 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_1- Biopac
video recordings
showing the dependence of the electric current voltage and the frequency of stimulation on the muscle contractions in rats (continuous amplification of the stimulation until tetany) - neuromuscular connection
strychnine

For this practical class, 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** and from the *Handbook for Practicals in Physiology, Neurophysiology and Immunology*, Rijeka, 2001, **exercises number 25, 28 and 29**.

Practical 2: The Sense of Vision

LEARNING OUTCOMES: to examine eye movements and to describe control over it; to perform pupillary reflex; to perform a corneal reflex; to determine visual acuity; to examine color recognition; to determine the width of the visual field by the perimeter method; 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.) Fundus in rats; 7.) Optokinetic record.

The student is expected to be prepared for this practical based on the previously acquired knowledge from the lecture. 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 Physiology, Neurophysiology and Immunology*, Rijeka, 2001, **exercises number 31 and 32.**

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

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

Practical part:
A. Ear: 1) A sense of hearing; 2) Functional tests of balance organs
B. Taste: 1) Testing the sense of taste for sour, salty and bitter (clinical application)
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 Physiology, Neurophysiology, and Immunology*, Rijeka, 2001, **exercises number 33, 34, 35 and 36.**

Practical 4: Motor Neurophysiology

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

Practical part:

studying spinal reflexes in humans
- motor function of the brainstem, basal ganglia, and medulla spinalis
- reticular activation system
- cerebral cortex
- video recordings
- decerebration

symptoms of epilepsy

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 Physiology, Neurophysiology and Immunology*, Rijeka, 2001, **exercises number 24, 26, 27 and 30.**

Student obligation:

WARNING: students are required to bring with them to practicals: a) lab coat and b) Handbook for Practicals in Neurophysiology
Students ARE NOT ALLOWED to switch groups unless they find their replacement!

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

ECTS grading system

Student assessment is carried out according to the current Ordinance on studies at the University of Rijeka, and according to the Ordinance on student assessment at the Faculty of Medicine in Rijeka (adopted by the Faculty Council of the Medical Faculty in Rijeka).
Student work will be evaluated and graded during classes and at the final exam.
Out of a total 100 points, during the classes the student can achieve 50 points, and at the final exam 50 points. Student assessment is performed using ECTS (A-D) and number system (1-5). Assessment in the ECTS system is performed by absolute distribution and according to graduate assessment criteria. Of the maximum 50 grade points that can be earned during class, a student must collect at least 50% (25) of the grade points to take the final exam. Students who collect 0-49.9% (0-24.9) of grade points during the course, gain an F grade (unsuccessful), cannot gain ECTS credits and must re-enroll in the course.
During classes, the student can achieve a maximum of 50 grades.

During the course, the **acquired knowledge will** be evaluated **by two midterm exams comprising 50 questions.**

A student may obtain up to 25 grade points on each exam, as shown in the table:

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

Each test has one corrective period for students who, for justified reasons, did not take the tests or did not collect the minimum number of points or are not satisfied with the number of points collected (then its previous result is deleted).

II. Final exam (up to 50 grade points)

Who can take the final exam:

Students who have achieved 25 or more points during the course take the final exam where they can achieve a maximum of 50 points.

Who can NOT take the final exam:

Students who have achieved less than 25 points during classes or were absent for more than 30% of classes do not have the right to take the final exam (re-enroll in the course of the next academic year).

The final exam consists of a written and an oral part. The student must pass at least 50% of the written test at the final exam and be positively graded at the oral part of the exam.

The method of scoring in the final exam is shown in Table 2.

Written test in percentage / grade points	Oral exam
50 – 54,99% = 11 points	sufficient = 5 – 15 points
55 – 59,99% = 12 points	good = 16 – 20 points
60 – 64,99% = 13 points	very good = 21 – 25 points
65 – 69,99% = 14 points	excellent = 26 – 30 points
70 – 74,99% = 15 points	
75 – 79,99% = 16 points	
80 – 84,99% = 17 points	
85 – 89,99% = 18 points	
90 – 94,99% = 19 points	
95 – 100% = 20 points	

Grading in the ECTS system is done by absolute distribution, ie on the basis of the final achievement (points acquired during the course are added to the points from the final exam):

A = 90 - 100%
B = 75 - 89.9%
C = 60 - 74.9%
D = 50 - 59.9%
F = 0 - 49.9%

Grades in the ECTS system are translated into a numerical system as follows:

A = excellent (5)
B = very good (4)
C = good (3)
D = sufficient (2)
F = insufficient (1)

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

Teaching content and all information related to the course can be found on the Share-portal for internal communication of the Department of Physiology and Immunology.

IMPORTANT NOTE:
If the epidemiological measures related to Covid-19 determine the ban on gathering students in large numbers at the faculty, we will adjust the INP and the method of assessment to the current situation. In that case, classes would be conducted online (via audio presentations, using the MS teams platform, etc.), and the writing of tests would be conducted via the Merlin system. Students will be notified in a timely manner of any changes to the INP.
In addition, in accordance with the recommendations of the University of Rijeka, classes can be held in a hybrid, ie up to 40% of classes can be held online, and 60% or more regularly, ie in contact with students at the faculty.

Possibility of teaching in another language:

Other important information regarding the course:

COURSE SCHEDULE for academic year 2019/2020

Date	Lectures	Seminars and Practicals	Lecturer
01/03/2022	L1 (11,15-13,00)		V. Barac-Latas, Full Professor
08/03/2022	L2 (11,15-13,00)		N. Kučić, Full Professor
15/03/2022	L3 (11,15-13,00)		V. Barac-Latas, Full Professor
16/03/2022		S1 I (13,15-15,30)	N. Kučić, Full Professor
17/03/2022		S1 II (13,15-15,30)	N. Kučić, Full Professor
22/03/2022	L4 (11,15-13,00)		H. Jakovac, Associate Professor
23/03/2022		S2 I (13,15-15,30)	I.Šutić Udović, dr.med.
24/03/2022		S2 II (13,15-15,30)	I.Šutić Udović, dr.med.
29/03/2022	L5 (11,15-13,00)		V. Barac-Latas, Full Professor
30/03/2022		S3 I (13,15-15,30)	B. Ćurko-Cofek, PhD
31/03/2022		S3 II (13,15-15,30)	B. Ćurko-Cofek, PhD

05/04/2022	L6 (11,15-13,00)		V. Barac-Latas, Full Professor
06/04/2022		P1 I (16,00-19,00)	B. Ćurko-Cofek, PhD
07/04/2022		P1 II (16,00-19,00)	B. Ćurko-Cofek, PhD
12/04/2022	L7 (11,15-13,00)		N. Kučić, Full Professor
13/04/2022		S4 I (13,15-15,30)	V. Barac-Latas, Full Professor
14/04/2022		S4 II (13,15-15,30)	V. Barac-Latas, Full Professor
19/04/2022	L8 (11,15-13,00)		V. Barac-Latas, Full Professor
20/04/2022		P2 I (16,00-19,00)	B. Ćurko-Cofek, PhD
21/04/2022		P2 II (16,00-19,00)	B. Ćurko-Cofek, PhD
26/04/2022	L9 (11,15-13,00)		H. Jakovac, Associate Professor
27/04/2022		S5 I (13,15 – 15,30)	I.Šutić Udović, dr.med.
28/04/2022		S5 II (13,15–15,30))	I.Šutić Udović, dr.med.
03/05/2022	L10 (11,15-13,00)		V. Barac-Latas, Full Professor
04/05/2022		P3 I (16,00-19,00)	I.Šutić Udović, dr.med.
05/05/2022		P3 II (16,00-19,00)	I.Šutić Udović, dr.med.
10/05/2022	L11 (11,15-13,00)		V. Barac-Latas, Full Professor
11/05/2022		S6 I (13,15-15,30)	V. Barac-Latas, Full Professor
12/05/2022		S6 II (13,15-15,30)	V. Barac-Latas, Full Professor
17/05/2022	L12 (11,15-13,00)		H. Jakovac, Associate Professor
18/05/2022		P4A (8,00-11,00)	B. Ćurko-Cofek, PhD
19/05/2022		P4B (8,00-11,00)	I.Šutić Udović, dr.med.
24/05/2022	L13 (11,15-13,00)		V. Barac-Latas, Full Professor
31/05/2022	L14 (11,15-13,00)		V. Barac-Latas, Full Professor

Lectures

	Topic	Teaching hours	Place
L1	Organization of the Nervous System, Basic Functions of Synapses	2	Lecture hall 1
L2	Neurotransmitters, Neuropeptides, and Receptors	2	Lecture hall 8
L3	Electrical Events During Neuronal Excitation and Inhibition	2	Lecture hall 8
L4	Sensory Receptors, Somatic Sensation, Sensory Pathways for Transmitting Somatic Signals	2	Lecture hall 1
L5	Specific Sensations: The Sense of Vision	2	Lecture hall 8
L6	Pain; Peripheral and Central Sensory Disorders	2	Lecture hall 8
L7	Cerebral Cortex, Intellectual Functions of the Brain, Learning, and Memory	2	Lecture hall 1
L8	States of Brain Activity – Sleep, Brain Waves, Epilepsy	2	Lecture hall 8
L9	Motor Neurophysiology: Motor Functions of the Spinal Cord	2	Lecture hall 8
L10	Cortical and Brain Stem Control of Motor Function	2	Lecture hall 1
L11	Contributions of the Cerebellum and Basal Ganglia to Overall Motor	2	Lecture hall 8

	Control		
L12	The Autonomic Nervous System; Disorders of Neurovegetative Regulation	2	Lecture hall 1
L13	Cerebral Blood Flow, Cerebrospinal Fluid and Brain Metabolism	2	Lecture hall 8
L14	Clinical Correlates and Experimental Model(s)	2	Lecture hall 1
	Total number of lecture hours	**28**	

Seminars

	Topic	Teaching hours	Place
S1	Organization of the Nervous System, Basic Functions of Synapses	3	Seminar hall and Lecture hall 9
S2	Sensory Receptors; Somatic Sensations	3	Seminar hall and Lecture hall 9
S3	The Sense of Vision	3	Seminar hall and Lecture hall 9
S4	The Sense of Hearing, The Sense of Taste and Smell, Vestibular Sensations	3	Seminar hall and Lecture hall 9
S5	Cerebral Cortex and Intellectual Functions	3	Seminar hall and Lecture hall 9
S6	Motor Neurophysiology	3	Seminar hall and Lecture hall 9
	Total number of seminar hours	**18**	

Practicals

	Topic	Teaching hours	Place
P1	The Neuromuscular Junction	4	Department Laboratory
P2	The Sense of Vision	4	Department Laboratory
P3	The Sense of Hearing, Taste and Smell, Vestibular Sensation	4	Department Laboratory
P4	Motor Neurophysiology	4	Department Laboratory
	Total number of practical hours	**16**	

EXAM DATES: **15/06/2022**
29/06/2022
13/07/2022
06/09/2022
20/09/2022

MIDTERM EXAMS: **1st: 15/04/2022/**
(L1 – L6; S1 -S4; P1)
2nd: 27/05/2022/
(L7 – L13; S5-S6; P4)