

**SCHOOL OF MEDICINE UNIVERSITY OF BELGRADE
PROGRAMME OF EXERCISES IN MEDICAL PHYSIOLOGY**

III (winter) semester 2025/2026 academic year

Exercises will be held on Monday and Tuesday at Classrooms A/C (group I-A/II-A) and at Classrooms B/D (group I-B/II-B) of the Institute of Medical physiology, from 13:00 to 16:00	
First part of exercise (13:00 – 15:15) will be performed at the Classroom A (group I-A/II-A) and Classroom B (group I-B/II-B), while the rest (15:15 – 16:00) will be held at Classrooms C (group I-A/II-A) and Classroom D (group I-B/II-B)	
There are exceptions for exercises I, II, and VII. Please look carefully at the schedule. The first exercise will be held only on Monday, November 10th, 2025. The second and seventh exercises will last for three class periods.	
WEEK	EXERCISE
WEEK 2 (10-14.11.2025.)	Exercise 1. INTRODUCTION TO MEDICAL PHYSIOLOGY (3hrs) - Institute of Medical Physiology “Rihard Burian”, Faculty of Medicine, University of Belgrade - Teaching programme, laboratory class protocols in Medical Physiology, and methods of knowledge assessment - Educational programs at the Institute of Medical Physiology - Experiment as a method of scientific research in medicine - Research techniques in biomedicine - Experiment and the selection of laboratory animals - Introduction to the principles of protection and welfare of laboratory animals (“5-R” principle) November 10, 2025; 15:00-17:15 Group I-A (Monday, Classroom A): dr R. Jeremić, Assistant Professor; lab. J. Despotović Group I-B (Monday, Classroom B): dr D. Todorović, Assistant Professor; lab. K. Živanović Group II-A (Monday, Classroom C): dr S. Mutavdžin Krneta, Assistant Professor; lab. M. Diković Group II-B (Monday, Classroom D): dr N. Šutulović, Assistant Professor; lab. B. Ranković
WEEK 3 (17-21.11.2025.)	Exercise 2. GENERAL PRINCIPLES AND TECHNIQUES OF INJECTION ADMINISTRATION (MODEL-BASED PRACTICE) (3hrs) - Preventive measures and procedures for controlling infections during injection administration: - Rules of asepsis and antisepsis - Medical hand washing and drying - Use of personal protective equipment - Correction of imbalanced homeostasis: - Routes of drug administration - Parenteral drug administration - injections - Injection procedures: execution and model-based practice - Intramuscular injection* (i.m.) - Intravenous injection (i.v.) and blood sampling by venipuncture* - Other injection application routes (subcutaneous and intracutaneous injection) November 17, 2025, 13:00-15:15 Group I-A (Monday, Classroom A/C): dr J. Maričić, Teaching Assistant; lab. J. Despotović Group I-B (Monday, Classroom B/D): dr E. Đurić, Teaching Assistant; lab. lab. M. Diković November 18, 2025, 13:00-15:15 Group II-A (Tuesday, Classroom A/C): dr J. Maričić, Teaching Assistant; lab. J. Despotović Group II-B (Tuesday, Classroom B/D): dr E. Đurić, Teaching Assistant; lab. lab. M. Diković

WEEK 4 (24-28.11.2025.)	Exercise 3. CELL VOLUME HOMEOSTASIS: WATER-ELECTROLYTE BALANCE AND WATER BALANCE IN THE ORGANISM, TASKS (4hrs) 1. Fingertip blood collection for analysis: capillary sampling 1.1. Erythrocyte volume homeostasis 1.1.a. Erythrocyte membrane flexibility 1.1.b. Changes in physiological erythrocyte aging 1.2. Osmotic balance – basic concept 1.3. Classification of solutions according to osmotic concentration 1.4. Classification of solutions according to tonicity 1.4.a. Examination of erythrocyte behavior and volume changes in iso-, hypo-, and hypertonic solutions* 1.4.b. Testing the osmotic resistance of erythrocytes to haemolysis in different concentrations of hypotonic solutions (osmotic stress)* 1.4.c. The energy needs and metabolism of erythrocytes 1.4.d. Examination of the significance of the osmotic reflection coefficient ($\sigma=0-1$) 2. Body fluid compartments 2.1. Physiological disruption of water balance: physical activity and dehydration 2.2. Physiological solutions 3. Water-electrolyte balance and water balance in the organism 3.1. Negative water balance in the organism, water deficiency: dehydration 3.2. Positive water balance in the organism, excess water: hyperhydration 3.3. Calculation tasks 4. Tasks in the computer classroom: water-electrolyte balance (Darrow–Yanet program) 4.1. Loss of water and/or electrolytes (dehydration) 4.2. Excess water or electrolytes (hyperhydration) 4.3. Shipwrecked on the ocean November 24, 2025, 13:00-16:00 Group I-A (Monday, Classroom A/C): dr R. Jeremić, Assistant Professor; lab. K. Živanović Group I-B (Monday, Classroom B/D): dr N. Šutulović, Assistant Professor; lab. B. Ranković November 25, 2025, 13:00-16:00 Group II-A (Tuesday, Classroom A/C): dr R. Jeremić, Assistant Professor; lab. K. Živanović Group II-B (Tuesday, Classroom B/D): dr N. Šutulović, Assistant Professor; lab. B. Ranković
WEEK 5 (01-05.12.2025.)	Exercise 4. EXAMINE THE EXCITABILITY OF INDIVIDUAL NERVE FIBER AND THE STRENGTH-DURATION CURVE (4hrs) 1. Excitable tissues – individual nerve fiber 1.1. Resting membrane potential 1.2. Action potential 1.3. Strength-duration curve (rheobase) 2. Examination of the characteristics of individual nerve fibers (»AP7«): 2.1. Investigate the effect of changes in extracellular ion concentrations on the equilibrium potential of specific ions 2.2. Record and analyse the action potential of individual nerve fibers to determine the characteristics of the threshold stimulus* 2.3. Examine the effect of changes in extracellular concentrations of Na⁺, K⁺, and Ca²⁺ on the resting membrane potential, AP amplitude, and excitability of individual nerve fibers* 2.4. Assess the excitability of individual nerve fibers using a strength-duration curve* 2.5. Demonstrate nerve fiber accommodation by applying a threshold stimulus of gradually increasing intensity December 01, 2025, 13:00-16:00 Group I-A (Monday, Classroom A/C): dr D. Todorović, Assistant Professor; lab. lab. M. Diković Group I-B (Monday, Classroom B/D): dr R. Jeremić, Assistant Professor; lab. J. Despotović December 02, 2025, 13:00-16:00 Group II-A (Tuesday, Classroom A/C): dr D. Todorović, Assistant Professor; lab. lab. M. Diković Group II-B (Tuesday, Classroom B/D): dr R. Jeremić, Assistant Professor; lab. J. Despotović

WEEK 6 (08-12.12.2025.)	Exercise 5. EXAMINATION OF THE EXCITABILITY OF A PERIPHERAL NERVE: SINGLE AND COMPOUND ACTION POTENTIAL (4hrs) 1. Application of anesthesia in experimental research 1.1. Introduction to general surgical anesthesia – inhalatory, intravenous, and rectal methods 1.2. Stages of general anesthesia 1.3. Local anesthesia 1.4. Demonstration of anesthesia on a laboratory animal (mouse or rat) 1.5. Presentation on the types of anesthesia and their application in rats (>>Rat Blood Pressure<<) 2. Local Membrane Potentials 3. Investigation of the nerve compound action potential properties (>>SimNerv<<) 3.1. Recording and analysis of the compound action potential of the nervus ischiadicus of the frog 3.2. Change the polarity sign of the voltage pulse. What changes are noted in the action potential? 3.3. Demonstration that the cathode is an active electrode 3.4. Demonstration of the induced polarization currents 3.5. Determination of the minimal and maximal stimulus intensity (demonstration of the graded response) 3.6. Demonstration of absolute and relative refractory periods and calculation of their duration 3.7. Calculation of the nerve conduction velocity of the action potential * 4. Interactive video presentation of the central nervous system (A.D.A.M.) December 08, 2025, 13:00-16:00 Group I-A (Monday, Classroom A/C): dr J. Jakovljević Uzelac, Assistant Professor; lab. B. Ranković Group I-B (Monday, Classroom B/D): dr S. Mutavdžin Krneta, Assistant Professor; lab. K. Živanović December 09, 2025, 13:00-16:00 Group II-A (Tuesday, Classroom A/C): dr J. Jakovljević Uzelac, Assistant Professor; lab. B. Ranković Group II-B (Tuesday, Classroom B/D): dr S. Mutavdžin Krneta, Assistant Professor; lab. K. Živanović
WEEK 7 (15-19.12.2025.)	Exercise 6. EXAMINATION OF SKELETAL MUSCLE EXCITABILITY, CONTRACTILITY, AND TONE (4hrs) 1. Types of contraction and tone in skeletal muscles 1.1. Myogram of a single muscle contraction* 1.2. Development of muscle tone and its classification according to: activity of contractile elements (active, passive, and total tone), duration (postural tone, phasic tone) 1.3. Tests for the assessment of muscle tone (hypotonia and hypertonia) 1.4. Types of muscle contraction: isometric and isotonic 1.5. Motor units and graded response (spatial summation) 1.6. Difference in the response between a single motor unit and the whole muscle 2. Video presentation of frog neuromuscular preparation: <i>m. gastrocnemius – n. ischiadicus</i> (>>SimMuscle<<) 3. Computer classroom (tasks in the >>SimMuscle<<) 3.1. Record a single isotonic contraction of a skeletal muscle (myogram)* 3.2. Record a single isometric contraction of a skeletal muscle (myogram) 3.3. Demonstrate the dependence of contraction magnitude (amplitude) on stimulus strength (graded response), for both isotonic and isometric skeletal muscle contractions* 3.4. Record the summation of the effects of two electrical stimuli on a muscle* 3.5. Record a complex muscle contraction (tetanus) resulting from the summation of the effects of consecutive stimuli* 3.6. Demonstrate the effect of load on muscle contraction amplitude 3.7. Demonstrate the impact of fatigue on an isolated muscle December 15, 2025, 13:00-16:00 Group I-A (Monday, Classroom A/C): dr J. Jakovljević Uzelac, Assistant Professor; lab. J. Despotović Group I-B (Monday, Classroom B/D): dr J. Maričić, Teaching Assistant; lab. lab. M. Diković December 16, 2025, 13:00-16:00 Group II-A (Tuesday, Classroom A/C): dr J. Jakovljević Uzelac, Assistant Professor; lab. J. Despotović Group II-B (Tuesday, Classroom B/D): dr J. Maričić, Teaching Assistant; lab. lab. M. Diković

WEEK 8 (22-26.12.2025.)	Exercise 7. EXAMINATION OF SKELETAL MUSCLE CONTRACTION, STRENGTH, TONE AND FATIGUE (3hrs) - Isometric and isotonic contraction - Examples of isometric and isotonic contractions and how to perform exercises - Lowering into and lifting from a push-up - Lowering into a squat, holding and lifting from a squat - Record a single isometric contraction (>>PhysioEx 4.0<<) and analyse the records - Register the complex muscle contraction (tetanus) and determine the tension that develops in the muscle - Show the „staircase“ phenomenon - Show the influence of muscle length on tension when applying a stimulus of constant intensity (maximum tension) and draw a diagram - Show the influence of the intensity of the stimulus on the tension in the muscle (at the length of the muscle at rest) and draw a diagram - Show the influence of load on the tonic muscle contraction speed and draw diagrams at different muscle lengths - Skeletal muscle strength test: examples of exercises - Manual muscle tests - Hand grip strength test using a dynamometer - Electromyoneurography (EMNG): determination of conduction velocity through the nerve and muscles - Examination of skeletal muscle fatigue: examples of exercises - Show the effect of fatigue on a muscle group <i>in situ</i> (ergogram) <i>Biering - Sorensen</i> test to assess trunk extensor muscle fatigue December 22, 2025, 13:00-15:15 Group I-A (Monday, Classroom A/C): dr J. Maričić, Teaching Assistant; lab. K. Živanović Group I-B (Monday, Classroom B/D): dr N. Radisavljević, Teaching Assistant; lab. B. Ranković December 23, 2025, 13:00-15:15 Group II-A (Tuesday, Classroom A/C): dr J. Jakovljević Uzelac, Assistant Professor; lab. K. Živanović Group II-B (Tuesday, Classroom B/D): dr N. Radisavljević, Teaching Assistant; lab. B. Ranković
WEEK 9 (05-09.01.2026.)	Exercise 8. FUNCTIONAL VISION ASSESSMENT METHODS (4hrs) - Visual and non-visual pathways of the eye; Examination of the ocular fundus (fundus oculi) with an ophthalmoscope - Optic disc (<i>macula coeca</i>, blind spot, <i>discus nervi optici</i>, physiological scotoma) - Macula lutea (<i>yellow spot</i>) - Blood vessels of the peripheral retina - Red reflex of the ocular fundus (reflection) - Color of the ocular fundus - Vision and functional anatomy of the eye - General principles of optics and light refraction in the dioptric apparatus of the eye - Image formation in the reduced-eye model* - Light refraction and refractive errors (emmetropia, myopia, and hyperopia) - Functional vision assessment: - Visual acuity (<i>visus oculi</i>, VA) - Visual acuity testing with an optotype* - Demonstration of the blind spot – Mariotte’s test (<i>Mariotte</i>)* - Accommodation and the range of accommodation - Visual field: - Visual field: definition, shape, and boundaries - Visual field defects - Visual field assessment by perimetry and confrontation method* - Color vision testing* - Assessment of Stereoscopic Depth Perception during Binocular Vision - Examination of the conjugated eyeball movements January 05, 2025, 13:00-16:00 Group I-A (Monday, Classroom A/C): dr J. Maričić, Teaching Assistant; lab. lab. M. Diković Group I-B (Monday, Classroom B/D): dr E. Đurić, Teaching Assistant; lab. J. Despotović January 06, 2025, 13:00-16:00 Group II-A (Tuesday, Classroom A/C): dr J. Maričić, Teaching Assistant; lab. lab. M. Diković Group II-B (Tuesday, Classroom B/D): dr E. Đurić, Teaching Assistant; lab. J. Despotović

WEEK 10 (12-16.01.2026.)	Exercise 9. FUNCTIONAL TESTS: SPECIAL (SOUND, SMELL AND TASTE) AND SOMATOSENSORY SENSITIVITY (TOUCH, TACTILE LOCALIZATION AND TEMPERATURE) (4hrs) - Adequate stimulus - sound wave (speed, height - frequency, strength - amplitude, direction) - Sound wave phenomena: masking and noise - Sound conduction pathways and hearing loss: conductive and sensorineural hearing loss - Quantitative hearing tests (orientation): - Fingertip rub test, whisper test, speaking loud test, clock ticking test - Qualitative examination of hearing with tuning forks - Examination of air and bone conduction of sound* <i>Rinne's</i> test <i>Weber</i> test <i>Schwabach</i> test - Functional hearing test - audiometry and audiogram examples - Determine the hearing threshold for sounds of different frequencies (audiometry - <i>BrainMetric</i>) - Somatosensory receptors and the size of the receptive field - Somatic sensibility: mechanoreceptors * - Test sensitivity to touch with a cotton ball - Testing the ability of tactile localization: on the body and the face - Determine the arrangement of touch points with the <i>Frey</i> aesthesiometer - Examination of spatial discrimination or tactile acuity: <i>Weber's</i> compass - Examination of sensitivity to temperature (thermoesthesiometer) * - Test the sensitivity of the sense of smell and taste - Qualitative and quantitative examination of the sense of smell - Qualitative examination of the sense of taste - Examining the connection between the senses of smell and taste January 12, 2025, 13:00-16:00 Group I-A (Monday, Classroom A/C): dr dr S. Mutavdžin Krneta, Assistant Professor; lab. B. Ranković Group I-B (Monday, Classroom B/D): dr E. Đurić, Teaching Assistant; lab. K. Živanović January 13, 2025, 13:00-16:00 Group II-A (Tuesday, Classroom A/C): dr dr S. Mutavdžin Krneta, Assistant Professor; lab. B. Ranković Group II-B (Tuesday, Classroom B/D): dr E. Đurić, Teaching Assistant; lab. K. Živanović
WEEK 11 (19-23.01.2026.)	Exercise 10. TESTS FOR EXAMINING PROPRIOCEPTIVE AND CORTICAL SENSIBILITY. CLINICALLY IMPORTANT SPINAL CORD REFLEXES AND TESTS FOR ASSESSING CEREBELLAR FUNCTION (4hrs) - Proprioception and Proprioceptors: Standard Neurological Tests for the Assessment of Deep Sensibility - Sense of passive and active movement testing – <i>kinesthesia</i>: Imitation test and Romberg test * - Vibratory sense (pallesthesia) testing* - Cortical Sensibility testing: Graphesthesia, Stereognosis, and Barognosis - Examination of Clinically Important Reflexes - Exteroceptive Reflexes testing: Cutaneous-muscular, corneal, and conjunctival reflexes* - Ocular Reflexes Testing - Pupillary Light Reflex Testing: Reflex arc and effector response (miosis)* - Pupillary Response to Darkness Testing: Reflex arc and effector response (mydriasis)* - Pupillary Reaction to Accommodation Testing: "Near response" - Myotatic Reflex or Stretch Reflex (Monosynaptic Reflex) * - Overview of Cerebellar Functions - Tests for the assessment of cerebellar function (gait, speech, eyeball movements, balance maintenance, etc.) - Movement coordination assessment - Evaluation of reaction time January 19, 2025, 13:00-16:00 Group I-A (Monday, Classroom A/C): dr N. Radisavljević, Teaching Assistant; lab. J. Despotović Group I-B (Monday, Classroom B/D): dr N. Šutulović, Assistant Professor; lab. lab. M. Diković January 20, 2025, 13:00-16:00 Group II-A (Tuesday, Classroom A/C): dr N. Radisavljević, Teaching Assistant; lab. J. Despotović Group II-B (Tuesday, Classroom B/D): dr N. Šutulović, Assistant Professor; lab. lab. M. Diković

WEEK 12 (26-30.01.2026.)	Exercise 11. EXAMINATION OF THE VESTIBULAR SYSTEM AND BRAIN ELECTRICAL ACTIVITY (ELECTROENCEPHALOGRAPHY, EEG) (4hrs) 1. Vestibular system: static and dynamic postural control 1.1. Static and dynamic balance in response to gravity, linear and angular acceleration 1.2. Vestibular reflexes: objective assessment of stability 1.2.a. <i>Medial vestibulospinal tract and vestibulo-ocular reflex (VOR)</i> 1.1.b. <i>Lateral vestibulospinal tract and vestibulocervical reflex</i> 2. Vestibulo-ocular reflex (VOR) – nystagmus 3. Static tests for assessing vestibular system function 3.1. Romberg test* 3.2. Caloric test (<i>vestibulometry</i>) 3.3. Head-impulse test 4. Dynamic tests for assessing vestibular system function: 4.1. Rotational test for assessment of semicircular canal function* 4.2. Compass walking test (<i>Babinski–Weil test</i>)* 4.3. Fukuda step test 4.4. Visual fixation suppression test of the vestibulo-ocular reflex 5. Principles of Electroencephalography (EEG) recording and analysis* 6. Frequency spectrum analysis of EEG during sleep–wake cycle and other clinical assessments* 7. Assessment of attention and attention span 7.1. Assessment of voluntary focused attention (<i>Trail-Making test</i>) 7.2. Assessment of voluntary divided attention (<i>Stroop test</i>) 8. Tests for assessing hemispheric lateralization – regional specialization 8.1. Hand dominance 8.2. Foot dominance 8.3. Eye (gaze) dominance January 26, 2025, 13:00-16:00 Group I-A (Monday, Classroom A/C): dr J. Jakovljević Uzelac, Assistant Professor; lab. K. Živanović Group I-B (Monday, Classroom B/D): dr N. Radisavljević, Teaching Assistant; lab. B. Ranković January 27, 2025, 13:00-16:00 Group II-A (Tuesday, Classroom A/C): dr J. Jakovljević Uzelac, Assistant Professor; lab. K. Živanović Group II-B (Tuesday, Classroom B/D): dr N. Radisavljević, Teaching Assistant; lab. B. Ranković COLLOQUIUM I - January 27, 2025
WEEK 13 (02-06.02.2026.)	Exercise 12. ELECTROCARDIOGRAPHY (4hrs) 1. Characteristics of the conduction system and cardiomyocytes 1.1. Generation of action potentials in the cardiac conduction system (<i>lat. systema conducens cordis</i>) 1.2. Cardiac automatism (pacemaker, pacemaker potentials) 2. Electrocardiography (calibration, adjustment or standardization) 2.1. Electrocardiographic leads 2.2. Method of recording electrocardiograms (ECG) 2.3. Formation of ECG records: waves, segments, and intervals 3. Analysis of the registered ECG* 3.1. Determining the pace leader of cardiac rhythm* 3.2. Determining the rhythmicity of cardiac work* 3.3. Determining the frequency of cardiac rhythm* 3.4. Determining the voltage and duration of waves, segments, intervals, and physiological values* 3.5. Constructing the vector of the mean electrical axis of the heart in <i>Einthoven's triangle</i>* 3.6. Clinical use of ECG (presence of pathological signs) February 02, 2025, 13:00-16:00 Group I-A (Monday, Classroom A/C): dr S. Mutavdžin Krneta, Assistant Professor; lab. lab. M. Diković Group I-B (Monday, Classroom B/D): dr N. Šutulović, Assistant Professor; lab. J. Despotović February 03, 2025, 13:00-16:00 Group II-A (Tuesday, Classroom A/C): dr S. Mutavdžin Krneta, Assistant Professor; lab. lab. M. Diković Group II-B (Tuesday, Classroom B/D): dr N. Šutulović, Assistant Professor; lab. J. Despotović

WEEK 14 (09-13.02.2026.)

Exercise 13. CHARACTERISTICS OF THE HEART MUSCLE, PALPATION AND AUSCULTATION OF THE HEART (4hrs)

1. Physiology of the heart – properties of cardiac muscle
2. Examine the properties of the heart using an experimental model of an isolated perfused heart according to Langendorff («SimHeart»)
 - 2.1. Record the contractions of rat cardiac muscle
 - 2.2. Examine and analyze the effects of substances on the frequency and amplitude of heart contractions
 - 2.2.a. Demonstrate the inotropic and chronotropic effects of adrenaline
 - 2.2.b. Demonstrate the inotropic and chronotropic effects of acetylcholine
 - 2.2.c. Inotropic and chronotropic effects of Ca^{2+} channel blockers
3. Demonstration of the Frank-Starling law (Langendorff)
 - 3.1. Examine the effect of altered extracellular concentrations of Ca^{2+} , K^{+} , and Na^{+} on heart function
4. Interactive exercise on the frog heart (program “Physio Ex 4.0”)
 - 4.1. Record a mechanogram of the heart under basal conditions
 - 4.2. Induce and record extrasystoles*
 - 4.3. Examine the effect of temperature on frog heart function
 - 4.4. Examine the effect of vagus nerve stimulation on heart rate*
5. Palpate the apical impulse (ictus cordis)*
6. Auscultation of heart sounds*
7. Determine heart rate and rhythm*

February 09, 2025, 13:00-16:00

Group I-A (Monday, Classroom A/C): dr R. Jeremić, Assistant Professor; lab. B. Ranković

Group I-B (Monday, Classroom B/D): dr D. Todorović, Assistant Professor; lab. K. Živanović

February 10, 2025, 13:00-16:00

Group II-A (Tuesday, Classroom A/C): dr R. Jeremić, Assistant Professor; lab. B. Ranković

Group II-B (Tuesday, Classroom B/D): dr D. Todorović, Assistant Professor; lab. K. Živanović