



## Physiology with pathophysiology elements

<b>1. IMPRINT</b>	
<b>Academic Year</b>	2022/2023
<b>Department</b>	Faculty of Medicine
<b>Field of study</b>	Medicine
<b>Main scientific discipline</b> <i>(in accord with appendix to the Regulation of Minister of Science and Higher education from 26th of July 2019)</i>	<b>Medical sciences</b>
<b>Study Profile</b> <i>(general academic / practical)</i>	General academic
<b>Level of studies</b> <i>(1<sup>st</sup> level / 2<sup>nd</sup> level / uniform MSc)</i>	Uniform MSc
<b>Form of studies</b>	<b>full time studies</b>
<b>Type of module / course</b> <i>(obligatory / non-compulsory)</i>	<b>obligatory</b>
<b>Form of verification of learning outcomes</b> <i>(exam / completion)</i>	<b>exam</b>
<b>Educational Unit / Educational Units</b> <i>(and address / addresses of unit / units)</i>	a). Chair and Department of Experimental and Clinical Physiology (1MA) ul. Pawińskiego 3c <b>02-106 Warszawa</b>

<b>Head of Educational Unit / Heads of Educational Units</b>	<b>a) prof. Agnieszka Cudnoch-Jędrzejewska, MD PhD</b>
<b>Course coordinator</b> (title, First Name, Last Name, contact)	<b>Kaja Kasarełło, PhD</b> <b>Michał Kowara, MD, PhD</b>
<b>Person responsible for syllabus</b> (First name, Last Name and contact for the person to whom any objections concerning syllabus should be reported)	<b>Michał Kowara, MD, PhD</b>
<b>Teachers</b>	Prof. Agnieszka Cudnoch-Jędrzejewska, MD, PhD; Kaja Kasarełło PhD, Michał Kowara, MD, PhD; Tymoteusz Żera, MD, PhD; Małgorzata Wojciechowska, MD, PhD; Katarzyna Kamińska, PhD; Anna Zalewska-Żmijewska, MD, PhD; Longin Niemczyk, MD, PhD; Emilian Snarski, MD, PhD; Katarzyna Romanowska-Próchnicka, MD, PhD; Sonia Borodzicz-Jażdżyk, MD, PhD; Kinga Jaworska, MD, PhD; Michał Skrzycki, PhD; Jagoda Kruszewska, MD; Jacek Dziedziak, MD; Michał Proczka, MD; Piotr Konopelski MD; Prof. Paweł Zalewski, PhD; Agnieszka Wsół, MD, PhD;

## 2. BASIC INFORMATION

<b>Year and semester of studies</b>	2 <sup>nd</sup> year, 3 and 4 semester	<b>Number of ECTS credits</b>	19.00
<b>FORMS OF CLASSES</b>		<b>Number of hours</b>	<b>ECTS credits calculation</b>
<b>Contacting hours with academic teacher</b>			
Lecture (L)		65	3
Seminar (S)		65	1
Discussions (D)			
e-learning (e-L)			
Practical classes (PC)		90	8
Work placement (WP)			
<b>Unassisted student's work</b>			
Preparation for classes and completions		280	7

## 3. COURSE OBJECTIVES

O1	Explain physiological mechanisms by applying basic principles of physics and chemistry
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O2	Describe the fundamental mechanisms underlying normal function of cells, tissues, organs, and organ systems of the human body, commensurate with the requirements for a physician providing primary care to patients.
O3	Explain the basic mechanisms of homeostasis by integrating the functions of cells, tissues, organs, and organ systems.
O4	Apply knowledge of functional mechanisms and their regulation to explain the pathophysiology underlying common diseases.

**4. STANDARDS OF LEARNING – DETAILED DESCRIPTION OF EFFECTS OF LEARNING** (concerns fields of study regulated by the Regulation of Minister of Science and Higher Education from 26 of July 2019; does not apply to other fields of study)

<b>Code and number of effect of learning in accordance with standards of learning</b> <i>(in accordance with appendix to the Regulation of Minister of Science and Higher education from 26th of July 2019)</i>	<b>Effects in time</b>
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**Knowledge – Graduate\* knows and understands:**

B.W1	water-electrolytes homeostasis in biological systems
B.W2	acid-base balance, functions of buffer solutions and their role in homeostasis
B.W3	definitions of: solubility, osmotic pressure, isotonicity, colloid solutions and Gibbs-Donnan effect
B.W7	physicochemical and molecular basis of the functioning of sensory organs
B.W16	metabolic profiles of the main organs and systems
B.W20	action potential, synaptic transmission and maintenance of nerve function, striated and smooth muscles function and blood function
B.W21	regulatory mechanisms of all organs and systems in human body including: circulatory system, respiratory system, alimentary system, urinary system and skin; relationship between these mechanisms
B.W22	physiology and regulation of reproductive functions of women and men
B.W23	mechanisms of aging of the body
B.W24	main quantitative parameters describing the capacity of particular systems and organs, including scopes of the standard and demographic factors affecting values of such parameters
B.W25	relationship between factors dysregulating homeostasis and physiological as well as pathophysiological changes
C.W6	genetic conditions of human blood groups and the Rhesus incompatibility
C.W27	basic mechanisms of cell and tissue damage

C.W29	definition and pathophysiology of shock, especially the differential diagnosis of shock and multiorgan failure
C.W30	etiology of hemodynamic disorders, regressive and progressive changes
C.W32	consequences of pathological processes at certain localization in the organism to surrounding organs
C.W33	external and internal disease agents, modifiable and non-modifiable
C.W34	clinical forms of the most frequent diseases of particular systems and organs, metabolic diseases, as well as water, electrolyte and acid-base balance disturbances
C.W45	symptoms of the most common acute intoxications, including intoxication with alcohol, drugs and other psychoactive substances, heavy metals and selected groups of medicines
C.W47	influence of oxidative stress on cells and its impact on pathogenesis of diseases and in aging processes
C.W48	consequences of deficiency or excess of vitamins and minerals in human organism
C.W49	enzymes participating in digestion, mechanism of hydrochloric acid production in the stomach, the role of bile, the course of digestion products' intestinal absorption
C.W50	consequences of improper nutrition, including long-term starvation, oversized meals, unbalanced diet as well as disorders of digestion and absorption of digestion products
C.W51	mechanism of hormone activity
<b>Skills– Graduate* is able to:</b>	
B.U1	use the knowledge of the laws of physics to explain the effects of external factors such as temperature, acceleration, pressure, electromagnetic fields and ionizing radiation on the body and its components
B.U7	perform simple functional tests assessing human body as a stable regulatory system (stress tests, exercise tests) and interpret numerical data on basic physiological variables
B.U9	use simple measuring instruments and evaluate the accuracy of performed measurements
C.U11	associate the images of tissue and organ damage with the clinical symptoms of the disease, history and laboratory test results
C.U20	describe changes in the functioning of the body in the event of disturbed homeostasis, in particular define its integrated response to physical exertion, exposure to high and low temperature, loss of blood or water, sudden upright standing, transition from sleep to wakefulness

\* In appendix to the Regulation of Minister of Science and Higher education from 26th of July 2019 „graduate”, not student is mentioned.

## 5. ADDITIONAL EFFECTS OF LEARNING (non-compulsory)

Number of effect of learning	Effects of learning time

Knowledge – Graduate knows and understands:	
K1	
K2	
Skills– Graduate is able to:	
S1	
S2	
Social Competencies – Graduate is ready for:	
SC1	
SC2	

6. CLASSES		
Form of class	Class contents	Effects of Learning
Seminar and practical classes	<p><b>Week 1: Cell physiology. Neurons.</b> Cell physiology and pathophysiology. Neural cell. Extracellular and intracellular fluid composition. Transport of the substances across cell membranes – functional properties of the cell membrane, diffusion, active transport of substances across the membrane. Ion channels function and classification. Sodium-potassium pump. Membrane potential and action potential – basis physics of membrane potential, resting membrane potential of neurons, neuron action potential, propagation of the action potential, reestablishing of sodium and potassium ionic gradients after action potentials are completed, plateau in some action potentials, rhythmicity of some excitable tissues – repetitive discharge.</p> <p>Mechanism of conduction across nerve fibers. Saltatory and continuous conduction. Factors affecting conduction velocity across nerve fiber. Classification of synapses. Mechanism of neurotransmitters release – synaptic vesicle cycle Channelopathies.</p>	B.W3, B.W20, B.W21 B.U1
Seminar and practical classes	<p><b>Week 2: Brain neurotransmission systems. Autonomic nervous system.</b> Brain neurotransmission systems. Acetylcholine, catecholamines, serotonin, excitatory and inhibitory aminoacids. Localization of neurons generating certain types of neurotransmitters. Neurotransmitters projections in central nervous system. Pre- and postsynaptic receptors. The role of neurotransmitters in regulation of physiological processes and emotional reactions. Psychoactive drugs influence on neurotransmission pathways. Pathophysiology of mood disturbances and psychosis (depression syndromes, bipolar disorder, schizophrenia). General organization of the autonomic nervous system. Basic characteristics of sympathetic and parasympathetic function. Selective stimulation of target organs by sympathetic and</p>	B.W20, B.W21, B.U1, C.W45

	<p>parasympathetic systems or “mass discharge”. Autonomic system impact on certain tissues and organs Atropine, muscarine and phosphoroorganic compounds intoxication. Horner syndrome</p>	
Seminar and practical classes	<p><b>Week 3: Physiology of the motor system – part I. Myocytes.</b> Physiological anatomy of skeletal muscle. Central mechanism of muscle contraction. Molecular mechanism of muscle contraction. Energetics of muscle contraction. Characteristics of the whole muscle contraction. Neuromuscular junction and transmission of impulses from nerve endings to skeletal muscle fibers. Muscle action potential. Excitation-contraction coupling. Contraction of smooth muscle. Regulation of contraction by calcium ions. Nervous and hormonal control of smooth muscle contraction. Physiology of cardiac muscle.</p>	B.W20, B.W21, B.U1, B.U9, C.U11
Seminar and classes	<p><b>Week 4: Physiology of the motor system - part II. Motor functions at the level of spinal cord, cortex, brainstem, basal ganglia and cerebellum.</b> Organization of the spinal cord for motor functions. Muscle sensory receptors – muscle spindles and Golgi tendon organs and their roles in muscle control. Flexor reflex and the withdrawal reflexes. Crossed extensor reflex. Reciprocal inhibition and reciprocal innervation. Reflexes of posture and locomotion. Motor cortex and corticospinal tract. Control of motor functions by the brain stem. Vestibular sensation and the maintenance of equilibrium. The cerebellum and its motor functions. The basal ganglia and their motor functions. Integration of the many parts of the total motor control system.</p>	B.W20, B.W21, B.U1, B.U7, B.U9
Seminar and classes	<p><b>Week 5: Pathophysiology of the motor system</b> Pre- and postsynaptic disturbances of neuromuscular junction (myasthenia gravis, Lamber-Eaton syndrome, botulism). Myopathies. Channelopathies of striates muscles. Multiple sclerosis. Pyramid tracts lesion. Pathophysiology of selected extrapyramidal system diseases: Parkinson’s disease, Huntington’s disease, hemiballismus, essential tremor, cerebellar ataxia. Decerebration. Pathological nystagmus. Motion sickness.</p>	B.W20, B.W21, B.U1, B.U7, B.U9, C.W27, C.W32, C.W33, C.W34,
Seminar and practical classes	<p><b>Week 6: Physiology and pathophysiology of the sensory system. Physiological and pathological pain.</b> Types of sensory receptors and the stimuli they detect. Transmission of sensory stimuli into nerve impulses. Signal intensity transmission in nerve tracts – spatial and temporal summation Classification of somatic senses. Detection and transmission of tactile sensations. Sensory pathways for transmitting somatic signals into the central nervous system. Transmission in the dorsal column-medial lemniscal system. Transmission of sensory signals in the anterolateral pathway. Somatosensory cortex lesions. Lesions of sensory integration, autism and Asperger syndrome Fast pain and slow pain and their qualities. Pain receptors and their stimulation. Dual pathways for transmission of signals into central nervous system. Pain suppression (analgesia) system in the brain and in the spinal cord. Referred pain. Visceral pain. Thermal sensations. Practical issues - pathological pain, principles of pain treatment: analgetic ladder, opioids in treatment of acute and chronic pain.</p>	B.W20, B.W21, B.W25, B.U1

Seminar and practical classes	<p><b>Week 7: Physiology and pathophysiology of sensory system. Vision, hearing, taste and smell.</b></p> <p>Physical principles of optics. Optics of the eye. Fluid system of the eye – intraocular fluid. Anatomy and function of the structural elements of the retina. Photochemistry of vision. Color vision. Eye adaptation to light and darkness. Visual field (stereoscopic vision). Neural function of the retina. Visual pathways. Organization and function of the visual cortex. Eye movements and their control. Autonomic control of accommodation and pupillary aperture.</p> <p>Eye refractive errors – nearsightedness (myopia), farsightedness (hyperopia), astigmatism. Strabismus. Cataracts. Glaucoma. Retinal Detachment. Night blindness. Color blindness.</p> <p>Tympanic membrane and the ossicular system. Cochlea. Corti's organ. Endolymph and perilymph. Mechanism of acoustic waves conversion into electric impulses. Central auditory mechanisms. Basis of laryngological examination – hearing tests. Conductive and sensorineural hearing loss. Hearing aids and cochlear implants. Vestibular sensation and the maintenance of equilibrium. Sense of taste. Sense of smell.</p>	B. W7, B.U1, B.U9
Seminar and classes	<p><b>Week 8: Cerebral cortex, intellectual functions of the brain, learning and memory. Limbic system. Behavior. Sleep. Basis of the bioelectric activity of brain (EEG). Pathophysiology – sleep disturbances, amnesia, dementia, mood disturbances, psychosis.</b></p> <p>Characteristics of limbic system. Function of prefrontal cortex. Congenital behavior: unconditional reflex, instinct, imprinting, impulse. Adaptive behavior (classical and instrumental conditioning). Reward system. Definition of learning and memory. Division and types of memory. Anatomy of memory. Long-term potentiation and long-term depression. Retrograde and anterograde amnesia. Results of prefrontal cortex, hippocampus and surrounding temporal lobes damage. Results of amygdala damage. Amnesic syndromes (Alzheimer's disease, vascular dementia, Lewy body dementia). Sleep. Role of reticular system in regulation of sleep and wake. Examination of cerebral bioelectric activity by electroencephalography (EEG). Stages of sleep in human. Characteristics and physiological meaning of REM and NREM sleep. Biological rhythms disturbances – jet lag. Sleep deprivation, narcolepsy, somnambulism. EEG record abnormalities. Epilepsy and its types.</p>	B.W20, B.W24, B.W25, B.U9, C.W32, C.W33, C.W34, C.U11, C.U20
Seminar and classes	<p><b>Week 9: Summary of the 1<sup>st</sup> Block</b></p>	B.W3, B.W7, B.W20, B.W21, B.W24, B.W25, B.U1 B.U7, B.U9, C.W227, C.W32, C.W33, C.W34, C.W45, C.U11, C.U20
Seminar and classes	<p><b>Week 10: 1<sup>st</sup> Midterm</b> – themes from the 1<sup>st</sup> Block.</p>	B.W3, B.W7, B.W20, B.W21, B.W24, B.W25, B.U1 B.U7, B.U9, C.W27, C.W32, C.W33, C.W34, C.W45, C.U11, C.U20
Seminar and classes	<p><b>Week 11: Physiology and pathophysiology of blood.</b></p> <p>Blood composition. Blood proteins and their functions. Role of erythropoietin. Structure and functions of erythrocytes. Classification of leukocytes. Functions of platelets. Iron turnover. Hemoglobin – types and characteristics, hemoglobin dissociation curve. Oxygen and carbon dioxide transport in blood. O-A-B blood types. Rh blood types.</p>	B.W21, B.W24, B.W25, B.U1, B.U7, B.U9, C.W6, C.W27, C.W32, C.W33, C.W34, C.W48, C.W50, C.U11, C.U20

	<p>Basic diagnostic tests – erythrocyte sedimentation rate (ESR), hematocrit, resistance of erythrocytes to hemolysis – application. Alterations in red cells system – anemias, polycythemias. Hemoglobinopathies. Alterations in white cells system – leukocytosis, leukopenia. Main serological conflicts.</p>	
Seminar and classes	<p><b>Week 12: Physiology of cardiovascular system – part I. Cardiac muscle – the heart as a pump and the function of the heart valves. Rhythmical excitation of the heart. Cardiac output. Overview of the circulation.</b></p> <p>Cardiac cycle. Specialized excitatory and conductive system of the heart. Control of excitation and conduction in the heart. Physical characteristics of the circulation. Vascular distensibility. Arterial pressure pulsations. Veins and their function. Normal values for cardiac output at rest and during activity. Control of cardiac output by venous return – Frank-Starling mechanism of the heart. Main cardiac hemodynamics parameters – end-diastolic and end-systolic volume, stroke volume, cardiac output, ejection fraction, contraction frequency. Preload and afterload. Regulation of cardiac muscle contraction – contractility (homeometric regulation), Frank-Starling law (heterometric regulation). Influence of afterload on muscle shortening velocity (Hill's equation).</p>	<p>B.W16, B.W20, B.W21, B.W23, B.W24, B.W25, B.U1, B.U7, B.U9,</p>
Seminar and classes	<p><b>Week 13: Physiology of cardiovascular system – part II. Nervous and humoral regulation of cardiovascular system activity. Sympathetic and parasympathetic innervation of the heart. Innervation of arteries and veins. Pre- and postsynaptic receptors and neurotransmitters.</b></p> <p>Humoral control of the tissue blood flow – vasoconstrictors, vasodilators, vascular control by ions and other chemical factors. Nervous regulation of the circulation. Special features of nervous control of arterial pressure. Renal-body fluid system for arterial pressure control. Role of the renin-angiotensin system in arterial pressure control. Summary of integrated multifaceted systems for arterial pressure regulation. Definition of the “set-point” of blood pressure. Blood pressure “set-point” changes during visceral and cutaneous pain, carotid sinus syndrome, brain hypoxia, increase of intracranial pressure (Cushing's sign), changes in oxygen and carbon dioxide level in arterial blood. Orthostatic hypotension.</p>	<p>B.W16, B.W20, B.W21, B.W23, B.W24, B.W25, B.U1, B.U7, B.U9, C.U20</p>
Seminar and classes	<p><b>Week 14: Physiology of cardiovascular system III. Principles of electrocardiography.</b></p> <p>Fundamentals of electrocardiography – waveforms of the normal electrocardiogram. Flow of the current around the heart during the cardiac cycle. Electrocardiographic leads. Vectorial analysis of the normal electrocardiogram. Mean electrical axis of the ventricular QRS and its significance. Structure and properties of heart conduction system. Sinus rhythm. Physical and electrophysiological basis of electrocardiography. Defibrillation and electrical cardioversion. Pathological ECG recordings: rhythm and conduction disturbances: respiratory sinus arrhythmia, bradycardia, tachycardia, supraventricular arrhythmias (supraventricular extrasystoles, atrial flutter, atrial fibrillation), ventricular arrhythmias (ventricular extrasystoles, ventricular tachycardia, ventricular fibrillation), atrioventricular blocks (1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> degree), asystole, ischemia and electrolyte balance disturbances, pre-excitation.</p>	<p>B.W16, B.W20, B.W21, B.W23, B.W24, B.W25, B.U1, B.U7, B.U9, C.W27, C.W30, C.W32, C.U11</p>



Seminar and classes	<p><b>Week 15: Physiology of cardiovascular system IV. Role of endothelium in vascular lumen regulation. Regulation of circulation in different organs. Microcirculation. Pathophysiology of the shock.</b></p> <p>Local control of blood flow in response to tissue needs. Mechanisms of blood flow control – acute control of local blood flow, long-term blood flow regulation. Control of tissue blood flow – endothelium-derived constricting and relaxing factors (nitric oxide, prostaglandins, prostacycline, thromboxane, endothelin, adenosine). Special mechanisms for acute blood flow control in specific tissues (kidney, brain, skin).</p> <p>Structure of the microcirculation and capillary system. Flow of blood in the capillaries – vasomotion. Exchange of water, nutrients and other substances between the blood and interstitial fluid. Interstitium and interstitial fluid. Fluid filtration across capillaries. Lymphatic system. Mechanism of edema generation: hydrostatic, oncotic, lymphatic. Blood flow regulation in skeletal muscle at rest and during exercise. Coronary circulation – physiology, physiological control, cardiac muscle metabolism. Circulatory shock and its treatment.</p>	B.W16, B.W20, B.W21, B.W23, B.W24, B.W25, B.U1, B.U7, B.U9, C.W27, C.W29, C.W30, C.W32, C.W33, C.W34, C.U11, C.U2)
Seminar and classes	<p><b>Week 16: Pathophysiology of cardiovascular system.</b></p> <p>Atherosclerosis – pathophysiology. Ischemic heart disease - myocardial infarction, causes of death after acute coronary occlusion, stages of recovery after myocardial infarction, pain in coronary heart disease, interventional treatment of coronary artery disease. Heart valves and heart sounds – valvular and congenital heart defects. The most frequent acquired vascular heart diseases (aortic stenosis and regurgitation, mitral stenosis and regurgitation, tricuspid regurgitation). Acute and chronic heart failure – systolic, diastolic, left ventricular and right ventricular. Hypertension – definition, causes (essential and secondary hypertension). Ischemic and hemorrhagic cerebral stroke (definition and causes).</p>	B.W16, B.W20, B.W21, B.W23, B.W24, B.W25, B.U1, B.U7, B.U9, C.W27, C.W30, C.W32, C.W33, C.W34, C.W47, C.U11, C.U20
Seminar and classes	<p><b>Week 17: Respiratory system – anatomical and biophysical basis of respiration.</b></p> <p>Mechanisms of pulmonary ventilation. Pulmonary volumes and capacities. Alveolar ventilation. Anatomy of the respiratory system. Structure and function of bronchial tree. Respiratory tracts innervation. Structure and function of pulmonary alveolus. Respiratory system resistances. Surface tension. Surfactant. Respiratory muscles work. Pulmonary leakage. Pulmonary circulation. Pulmonary vessels walls structure. Pressure and flow resistance in pulmonary circulation. Pulmonary vessels diameter regulation, influence of oxygen pressure on pulmonary vessels smooth muscles. Neuronal and humoral regulation of respiratory system activity. Regulation of respiration, generation of respiratory pattern. Regulation of respiratory center; central and peripheral receptors. Airways and lungs receptors and associated reflexes – cough, yawn, reaction to toxic substances (inspiration).</p>	B.W16, B.W20, B.W21, B.W24, B.W25, B.U1
Seminar and classes	<p><b>Week 18: Respiratory system – clinical physiology and pathophysiology.</b></p> <p>Respiratory system basic diagnostic tests (spirometry). Difference between obturation and restriction. Spirometry testing (obturation reversibility, provocation tests). Plethysmography in restrictive diseases diagnostics. Mechanism of lungs artificial ventilation. Acute and chronic respiratory failure. Pathophysiology of respiratory system</p>	B.W16, B.W20, B.W21, B.W24, B.W25, B.U1, B.U7, B.U9, C.W27, C.W30, C.W32, C.W33, C.W34, C.W47, C.U11, C.U20

	<p>inflammatory diseases (laryngitis, bronchitis, pneumonia). Pathophysiology of obstructive and restrictive diseases (bronchial asthma, COPD, emphysema, pneumoconiosis, pneumonia, viral respiratory infections – COVID-19 and others, tuberculosis). Cystis fibrosis. Pulmonary embolism. Pathological respiratory patterns. Obstructive sleep apnea. Nicotinismus. Mountain sickness.</p>	
Seminar and classes	<p><b>Week 19: Summary of the 2<sup>nd</sup> Block</b></p>	<p>B.W16, B.W20, B.W21, B.W23, B.W24, B.W25, B.U1, B.U7, B.U9, C.W6, C.W27, C.W29, C.W30, C.W32, C.W33, C.W34, C.W47, C.U11, C.U20</p>
Seminar and classes	<p><b>Week 20: 2<sup>nd</sup> Midterm</b> – themes from the 2<sup>nd</sup> Block.</p>	<p>B.W16, B.W20, B.W21, B.W23, B.W24, B.W25, B.U1, B.U7, B.U9, C.W6, C.W27, C.W29, C.W30, C.W32, C.W33, C.W34, C.W47, C.U11, C.U20</p>
Seminar and classes	<p><b>Week 21: Physiology and pathophysiology of urinary system.</b> Kidney structure and vasculature. Nephron as a basic functional unit of kidney. Mechanism of primary urine formation (glomerular filtration: filtration membrane, effective filtration pressure). Creatinine clearance – methods of calculation, Cocroft-Gault formula, MDRD formula. Final urine formation (tubular transport). Renal blood flow regulation and its autoregulation. Pressure diuresis. Other causes of diuresis change. Neurogenic regulation of renal flow and tubular transport (renal innervation, reflexive regulation). Hormonal and humoral regulation of renal flow and tubular transport (renin-angiotensin-aldosterone system, vasopressin, endothelins, nitric oxide, natriuretic peptides, dopamine, adrenomedullin, cytokines). Urine concentrating and diluting mechanisms (countercurrent multiplication, countercurrent exchange, urea recycling). Calcium and phosphate balance regulation by kidney. Hormonal functions of kindey - erithropoietin, vitamin D. Role of kidney in blood pressure regulation. Pathophysiology - polyuria, oliguria, anuria. Diabetes insipidus (central and renal form). Acute kidney failure and chronic kidney disease, proteinuria. Nephritic and nephotic syndrome. Nephrolithiasis. Influence of uremia on the whole organism. Cystitis and urinary tract infection.</p>	<p>B.W1, B.W2, B.W3, B.W21, B.W24, B.W25, B.U1, B.U7, C.W27, C.W32, C.W33, C.W34, C.W45, C.U11, C.U20</p>
Seminar and classes	<p><b>Week 22: Physiology and pathophysiology of water, electrolyte and acid-base balance</b> Water and electrolyte balance. Body fluid compartments – volumes and composition. Body fluids ion composition and osmolarity. Transport of osmotically active substances across biological membranes – regulation. Mechanisms regulating water and electrolytes intracorporeal translocations. Mechanisms regulating cellular volumes. Water, sodium, potassium, calcium and phosphate balance. Mechanisms regulating water and sodium balance. Dehydration and overhydration – types, mechanisms and consequences. Electrolyte balance disturbances – hyper- and hyponatremia, hyper- and hypokalemia, hyper- and hypocalcemia, hyper- and hypomagnesemia). Acid-base balance. Volatile and non-volatile acids. Inter- and intracellular buffering systems. Role of kidney and respiratory system in pH maintenance. Acid-base balance – methods of assessment. Cerebrospinal fluid pH regulation. Primary and secondary acid-base balance disturbances: acidosis (respiratory,</p>	<p>B.W1, B.W2, B.W3, B.W21, B.W24, B.W25, B.U1, B.U7, C.W27, C.W32, C.W33, C.W34, C.W45, C.U11, C.U20</p>

	metabolic – causes), alkalosis (respiratory, metabolic – causes). Compensatory mechanisms in primary acid-base balance disturbances (rules of respiratory and renal compensation). Influence of acid-base balance disturbances on electrolyte balance.	
Seminar and classes	<b>Week 23: Physiology and pathophysiology of gastrointestinal system</b> Neurohormonal regulation of food intake. Autonomic intestinal system. Gastrointestinal and biliary system motility. Secretory function of digestive glands – saliva excretion, gastric, pancreatic and intestinal secretion). Interaction between endocrine and exocrine pancreatic secretion. Structure and function of liver. Digestion and absorption (water, electrolytes, vitamins, minerals, carbohydrates, proteins, fats). Hepatic circulation – anatomic and functional peculiarities. Disturbances of gastrointestinal motility function (vomiting, diarrhea, constipation, achalasia, GERD, peptic ulcers). Gastric and duodenal ulcer disease. Pathophysiology of liver, gall bladder and biliary ducts (jaundice, viral hepatic diseases, acute liver failure, liver cirrhosis and portal hypertension, cholecystitis, autoimmune liver disease, Wilson's disease, non-alcoholic fatty liver disease)). Pathophysiology of pancreas (acute and chronic pancreatitis). Intestinal inflammation – Lesniowski-Crohn's disease, ulcerative colitis)– Disturbances of digestion and absorption (celiac disease, pernicious anemia). Gastrointestinal neoplastic diseases.	B.W21, B.W24, B.W25, B.U7, C.W27, C.W32, C.W33, C.W34, C.W48, C.W49, C.W50, C.U11
Seminar and classes	<b>Week 24: Endocrine system part I. Hypothalamic-pituitary-thyroid axis, Hypothalamic-pituitary-suprarenal axis – physiology and pathophysiology. Hypothalamic and pituitary hormones.</b> Hypothalamic-pituitary-thyroid axis. TRH and TSH – activity and regulation of secretion. Thyroid hormones regulatory function. Interaction between thyroid and other hormones. Hypothalamic-pituitary-suprarenal axis. CRH and ACTH – activity and regulation of secretion. Mineralocorticoids and glucocorticoids – regulatory function. Hyperprolactinemia. Cushing's syndrome and Cushing's disease. Conn's syndrome. Hyperthyroidism and hypothyroidism. Suprarenal cortex and medulla disturbances.	B.W21, B.W24, B.W25, B.U7, C.W27, C.W32, C.W34, C.W51, C.U11
Seminar and classes	<b>Week 25: Endocrine system part II. Pancreatic endocrine function. Endocrine regulation of growth and metabolism. Stress phenomenon.</b> Endocrine regulation of growth and metabolism. Growth hormone – regulation of secretion and mechanism of action. Specificity and selectivity of individual growth factors activity in organs and tissues. Gigantism, acromegaly, pituitary dwarfism. Pancreas as endocrine organ (glucagon and insulin). Type 1 and type 2 diabetes mellitus. Hypoglycemia. Islet cells tumors (insulinoma, gastrinoma). Theories of stress. Adaptative function of stress. Stress hormones (hypothalamic-pituitary-suprarenal axis, ADH). Brain neurotransmission systems alterations and sympathetic system excitement during stress. Human organism's reaction to acute and chronic stress. Stress influence on cardiovascular and psychiatric disorders development. PTSD.	B.W16, B.W21, B.W24, B.W25, B.U7, C.W27, C.W32, C.W34, C.W51, C.U11
Seminar and classes	<b>Week 26: Physiology and pathophysiology of reproductive system, pregnancy and bird. Lactation.</b> Endocrine regulation of reproductive function. Sex hormones in men and women – mechanism of action and regulation of secretion. Menstrual cycle (hormone levels alterations, endometrial alterations,	B.W21, B.W22, B.W23, B.W24, B.W25, B.U7, C.W33, C.W51, C.U11

	<p>vaginal mucosal alterations). Maturation and puberty. Menopause. Andropause.</p> <p>Klinefelter Syndrome, Turner Syndrome, true hermaphroditism, pseudohermaphroditism, hypogonadism, hyperprolactinemia, endometriosis.</p> <p>Fertilization and zygote implantation. Uterine-fetal unit (exchange between mother and fetus, hormones of uterine-fetal unit).</p> <p>Development of the fetus. Alterations in pregnant woman's organism (hormonal, metabolic, cardiovascular, respiratory, genitourinary, gastrointestinal and nervous system). Birth. Lactation. Female and male infertility. Miscarriage risk factors. Gestational diabetes and hypertension. Ectopic pregnancy., Fetal Alcoholic Syndrome (FAS), Fetal hypotrophy. Prematurity – causes and long-term consequences.</p>	
Seminar and classes	<p><b>Week 27: Resting and exercise energy expenditure. Thermoregulation. Obesity. Metabolic disturbances.</b></p> <p>Central regulation of hunger and satiety. Fat tissue as a source and target of hormones.. Basic and rest metabolism. Energetic balance of the organism. Rules of proper nutrition. Metabolic disorders. Obesity and malnutrition. Heat production and exchange with environment. Heat balance. Internal and skin temperature. Internal temperature alterations – tolerance limits. Thermoregulation system – mechanism of action central and peripheral thermoreceptors, cerebral thermoregulation center. Role of cutaneous circulation in thermoregulation. Regulation of perspiration. Human organism reaction to heat and cold. Acclimatization to cold and hot temperatures. Hypothermia. Hyperthermia (heat shock – mechanism, diagnosis). Malignant hyperthermia. Fever.</p>	<p>B.W20, B.W21, B.W24, B.W25, B.U9, C.W33, C.W34, C.W50, C.W51, C.U11, C.U20.W20, B.W21, B.W24, B.W25, B.U9, C.W33, C.W34, C.W50, C.W51, C.U11, C.U20</p>
Seminar and classes	<p><b>Week 28: Physiology of physical exercise.</b></p> <p>Male and female athletes. Muscles in exercise – strength, power, endurance of muscles, muscles metabolic systems. Nutrients used during muscles activity. Effects of athletic training on muscles and muscle performance. Cardiovascular system in exercise. Body heat in exercise. Body fluids and salt in exercise. Drugs and athletes. Body fitness benefits.</p>	<p>B.W1, B.W2, B.W16, B.W20, B.W21, B.W23, B.W24, B.W25, B.U7, B.U9, C.W27, C.W30, C.W33, C.U11, C.U20</p>
Seminar and classes	<p><b>Week 29: Summary of the 3<sup>rd</sup> Block</b></p>	<p>B.W1, B.W2, B.W3, B.W16, B.W20, B.W21, B.W22, B.W23, B.W24, B.W25, B.U1, B.U7, B.U9, CW.27, C.W30, C.W32, C.W33, C.W34, C.W45, C.W48, C.W49, C.W50, C.W51, C.U11, C.U20</p>
Seminar and classes	<p><b>Week 30: 3<sup>rd</sup> Midterm – themes from the 3<sup>st</sup> Block.</b></p>	<p>B.W1, B.W2, B.W3, B.W16, B.W20, B.W21, B.W22, B.W23, B.W24, B.W25, B.U1, B.U7, B.U9, C.W27, C.W30, C.W32, C.W33, C.W34, C.W45, C.W48, C.W49, C.W50, C.W51, C.U11, C.U20</p>
Lecture	<p><b>Inauguration lecture</b></p>	

Lecture	<b>Brain neuroplasticity. Developmental disorders of plasticity.</b>	B.W20, B.W21, B.W25, C.W27, C.W32, C.W34
Lecture	<b>Neurodegenerative diseases.</b>	B.W20, B.W21, B.W25, C.W27, C.W32, C.W34
Lecture	<b>Behaviour. Limbic system. Prefrontal cortex. Neurobiology of speech.</b>	B.W20, B.W21, B.W25, C.W27, C.W32, C.W34
Lecture	<b>Consciousness and awareness. Disturbances of consciousness.</b>	B.W20, B.W21, B.W25, C.W27, C.W32, C.W34
Lecture	<b>Neurodegeneration in ophthalmic diseases. Clinical aspects.</b>	B.W.7, B.W.24, C.W.22, C.W.33, C.W.34
Lecture	<b>Hemostasis. Hemostatic disorders</b>	B.W21, B.W25, C.W27, C.W33, C.W34
Lecture	<b>Hematologic disorders</b>	B.W25, C.W6, C.W34
Lecture	<b>Pathophysiology of the most common heart diseases</b>	B.W21, B.W25, C.W29, C.W30, C.W32, C.W33, C.W34
Lecture	<b>Short- and long-term regulation of blood pressure. Arterial hypertension.</b>	B.W1, B.W20, B.W21, B.W24, B.W25, C.W30, C.W32, C.W33, C.W34
Lecture	<b>Electrocardiography</b>	B.W20, B.W25, C.W32, C.W45
Lecture	<b>The conducting system of the heart. Mechanisms of cardiac arrhythmia. The examples of the most common arrhythmia.</b>	B.W1, B.W20, B.W21, B.W24, B.W25, C.W30, C.W32, C.W33, C.W34
Lecture	<b>Coronary artery disease. Myocardial infarction.</b>	B.W21, B.W24, B.W25, C.W30, C.W32, C.W33, C.W34
Lecture	<b>Pathophysiology of acute and chronic heart failure.</b>	B.W21, B.W24, B.W25, C.W30, C.W32, C.W33, C.W34
Lecture	<b>Pulmonary circulation. Deep vein thrombosis and pulmonary embolism. Pulmonary hypertension.</b>	B.W21, B.W25, C.W27, C.W33, C.W34
Lecture	<b>The pathophysiology of the most common respiratory system diseases. Basic diagnostic tests of the respiratory system. Mechanical ventilation.</b>	B.W21, B.W24, B.W25, C.W30, C.W32, C.W33, C.W34
Lecture	<b>Pathophysiology of urinary tract diseases. Basic diagnostic tests.</b>	B.W1, B.W2, B.W21, B.W24, B.W25, C.W30, C.W32, C.W33, C.W34
Lecture	<b>Pathophysiology of the most common diseases of the digestive system.</b>	B.W21, B.W24, B.W25, C.W30, C.W32, C.W33, C.W34, C.W49
Lecture	<b>Hormonal regulation of metabolism. Regulation of calcium homeostasis. Hormonal regulation of growth. Pathophysiology of endocrine system.</b>	B.W16, B.W21, B.W24, B.W25, C.W30, C.W32, C.W33, C.W34, C.W51

Lecture	<b>Physiology and pathophysiology of pregnancy.</b>	B.W21, B.W22, B.W24, B.W25, C.W30, C.W32, C.W33, C.W34, C.W51
Lecture	<b>Mechanisms of human adaptation to extreme conditions.</b>	B.W1, B.W2, B.W21, B.W25, C.U20
Lecture	<b>Physiology of ageing. Civilization diseases.</b>	B.W23, B.W24, C.W47

## 7. LITERATURE

### Obligatory

John E. Hall. Guyton and Hall Textbook of Medical Physiology, 14th Edition, 2021, Elsevier  
Gary D. Hammer, MD, PhD, Stephen J. McPhee, MD, Pathophysiology of Disease: An Introduction to Clinical Medicine, 2014, 7e, McGraw Hill.

### Supplementary

Rodney A. Rhoades, David R. Bell : Medical physiology : principles for clinical medicine — 2013, 4th ed. Wolter's Kluwer

## 8. VERIFYING THE EFFECT OF LEARNING

Code of the course effect of learning	Ways of verifying the effect of learning	Completion criterion
B.W1,2,3,7,16,20,21-25 B.U1,7,9 C.W6,20,27,29,30,32-34,45,47-51 C.U11,20	Seminars and classes – Students need to actively participate in the seminars classes, which is assessed by the assistant who perform the seminar or class. <b>In every week</b> , the MCQ (5 questions) on e-learning platform needs to be completed. There will be 2 trials for the MCQ. <b>Student must take all the MCQ, if a MCQ is not taken the vote from this MCQ is 0 point.</b> <b>The summary vote is calculated before every Midterm MCQ, from the MCQs in all didactic weeks preparing for the certain MCQ</b> (i.e. e.g. summary vote to the 2 <sup>nd</sup> Midterm MCQ is calculated from the MCQs only from weeks 11 <sup>th</sup> -18 <sup>th</sup> ).	MCQ after the seminars – student needs to obtain average vote 3/5 to be qualified for the Midterm MCQ. If average vote is lower than 3/5 the oral examination before qualification to the Midterm MCQ is needed.
B.U1,7,9 B.W1-3, 7,16,2-25,33 C.U11,20 C.W22,27,29,30,32-34,45,47-51	3 Midterm MCQs after completion of the block – test with 30 MCQ. Retake if the Midterm MCQ is failed – test with 10 MCQ If the retake is failed – 2 <sup>nd</sup> retake - oral examination directly by the assistant responsible for the didactic.	18/30 (60%) points to pass Retake – 6/10 points to pass 2 <sup>nd</sup> retake – completion confirmed by the lecturer
B.U1,7,9 B.W1-3, 7,16,2-25,33 C.U11,20 C.W22,27,29,30,32-34,45,47-51	Final exam – test with 100 MCQ Includes topics from lectures, seminars and classes. Retake exam – form and organization decided by the Chair and Department of Experimental and Clinical Physiology.	Final exam - 60% of points to pass  Retake – passing criteria decided by the Department.

## 9. ADDITIONAL INFORMATION *(information essential for the course instructor that are not included in the other part of the course syllabus e.g. if the course is related to scientific research, detailed description of, information about the Science Club)*

**Lectures: room 8 CBI/ e-learning – information will be given on e-learning platform**

**Seminars:**

- Monday Group 3 - 15.00-16.45 Classroom 6, low basement, Pawińskiego 3C
- Monday Group 4 - 17.00-18.45 – Classroom 6, low basement, Pawińskiego 3C
- Wednesday Group 1 - 15:00-16:40 Classroom 7, low basement, Pawińskiego 3C
- Wednesday Group 2 - 16.40-18.20 Classroom 7, low basement, Pawińskiego 3C

**Practical classes**

- Group 4 Friday 09:00-11:30 dept. Classroom, Pawińskiego 3C
- Group 3 Friday 11:30-14:00 dept. Classroom, Pawińskiego 3C
- Group 2 Friday 14:15-16.45 dept. Classroom, Pawińskiego 3C
- Group 1 Friday 16:45-19:15 dept. Classroom, Pawińskiego 3C

The presence on the seminars and classes is compulsory. 2 absences during each semester are permissible. However, the absence on seminar or classes doesn't release the obligation to take the MCQ in every week with seminars and classes.

- In every week the MCQ (5 questions) on e-learning platform needs to be completed. There will be 2 trials for the MCQ. Student should take all the MCQ, if a MCQ is not taken the vote from this MCQ is 0 point. The summary vote is calculated before every Midterm MCQ, from the MCQs in all didactic weeks. In order to be qualified for the Midterm from the block (I, II and III), the number of 60% of points from all the MCQs designated for the block (separately for I, II and III) needs to be collected. Importantly – the required knowledge to pass the MCQ covers the entire material arranged for the certain week.
- If summary vote from the MCQs before the certain Midterm MCQ is lower than 60% of total points the oral examination before qualification to the Midterm MCQ is needed.

**Final exam – 100 MCQs**

- 60% of points needs to be gained in order to pass the exam and obtain grade 3 (satisfactory). The scoring for the higher grades will be created after the exam, according to the Gaussian curve.
- In case of the failure in the Final Exam – the organization, form and complete criterion for the retake will be issued by the Chair and Department of Experimental and Clinical Physiology.

**Scientific Club – information on the Department website.**