FUNDAMENTALS OF HUMAN PHYSIOLOGY

INTEGRATED ACADEMIC STUDIES OF PHARMACY

FIRST YEAR OF STUDIES

school year 2024/2025.

Subject:

FUNDAMENTALS OF HUMAN PHYSIOLOGY

The course is evaluated with 5 ECTS. There are 6 active classes per week (4 classes of lectures and 2 classes of small group activities).

TEACHERS AND ASSOCIATES:

No	Name and surname	E-mail address	Title
1.	Vladimir Jakovljević	drvladakgbg@yahoo.com	Full professor
2.	Gvozden Rosic	grosic@medf.kg.ac.rs	Full professor
3.	Vladimir Zivkovic	vladimirziv@gmail.com	Full professor
4.	Ivan Srejović	ivan_srejovic@hotmail.com	Associate Professor
5.	Dragica Selaković	dragica984@gmail.com	Associate Professor
6.	Jovana Joksimović Jović	jovana_joksimovic@yahoo.com	Associate Professor
7.	Jasmina Sretenović	drj.sretenovic@gmail.com	Assistant professor
8.	Marina Nikolić	marina.rankovic.95@gmail.com	Assistant professor
9.	Maja Murić	majanikolickg90@gmail.com	Assistant

COURSE STRUCTURE:

Name of the subject	**Classes per week**	**Lectures**	**Work in a small group**	**Teacher - manager subject**
Fundamentals of human physiology	6	4	2	Prof. Ivan Srejović

ASSESSMENT:

The grade is equivalent to the number of points won (see tables). Points are earned in two ways:

ACTIVITY DURING THE CLASSES: In this way, the student can gain up to 15 points, by answering two exam questions from that week's lesson in a special part of the small group activity, and in accordance with the shown knowledge, he receives 0-1 point.

MODULE TEST: In this way, the student can earn up to 35 points according to the attached table.

Number of correct answers	**Number of points**
0-17	0
18-35	Number of correct answers

As part of pre-exam activities, a student can earn a maximum of 50 points.

ORAL EXAM: In this way, a student can gain 50 points by answering one question from 5 different areas (physiology of excitable tissues, physiology of the cardiovascular system, acid-base balance and digestive system, physiology of the endocrine system, physiology of the nervous system and senses), for which scores points from 1 to 10 for each exam question. A score of 0 on any question represents the end of the exam.

A student has the right to take an oral exam if he has achieved more than 50% of points in all pre-exam activities.

The final grade is formed as follows:

In order to pass the course, the student must pass the pre-exam activities and the oral exam.
The final grade is formed according to the attached table.

number of points won	**rating**
0 - 50	**5**
51 - 60	**6**
61 - 70	**7**
71 - 80	**8**
81-90	**9**
91 - 100	**10**

Commissions for oral examination:
Commission 1: Jovana Joksimović Jović, Vladimir Jakovljević, Marina Nikolić
Commission 2: Vladimir Živković, Ivan Srejović, Jasmina Sretenović

LITERATURE:

MODULE	TITLE OF THE TEXTBOOK	THE AUTHORS	PUBLISHER	THE LIBRARY
FUNDAMENTALS OF HUMAN PHYSIOLOGY	Ganong's Review of Medical Physiology, first edition in Serbian.	Ganong William.		Has
	MEDICAL PHYSIOLOGY	Guyton AC, Hall JE.		Has

All lectures and material for small group work are available on the website of the Faculty of Medical Sciences:www.medf.kg.ac.rs

THE PROGRAM:

TEACHING UNIT 1 (FIRST WEEK):

GENERAL PRINCIPLES OF HUMAN PHYSIOLOGY	
lectures - 4 classes	small groups activities - 2 classes
Review of Cell Physiology in Medical Physiology. Homeostasis. Transport through the cell membrane. Physiology of excitable tissues. Membrane potentials. Excitation and execution of action potentials.	Basic principles of work in the laboratory.

TEACHING UNIT 2 (SECOND WEEK):

EXCITABLE TISSUES: NERVE AND MUSCLE. TRANSMISSION AT SYNAPSES AND JOINTS	
lectures - 4 classes	small groups activities - 2 classes
Neuromuscular transmission. Excitation and contraction of skeletal and smooth muscle.	Disorders of neuromuscular transmission.

TEACHING UNIT 3 (THIRD WEEK):

PHYSIOLOGY OF THE HEART	
lectures - 4 classes	small groups activities - 2 classes
Physiology of the heart. Electrical activity of the heart and impulse conduction. Cardiac cycle. Regulation of the heart.	Electrocardiography

UNIT 4 (FOURTH WEEK):

PHYSIOLOGY OF THE CIRCULATORY SYSTEM	
lectures - 4 classes	small groups activities - 2 classes
Physiology of the circulatory system. Biophysical characteristics of circulation. Circulation in arteries, capillaries and veins. Lymph and lymphatic vessels. Regulation of circulation.	Arterial pulse. Arterial blood pressure.

UNIT 5 (FIFTH WEEK):

PHYSIOLOGY OF THE RESPIRATORY SYSTEM	
lectures - 4 classes	small groups activities - 2 classes
Physiology of the respiratory system. Breathing mechanics. Diffusion, exchange and transport of gases. Regulation of breathing.	Spirometry.

UNIT 6 (SIXTH WEEK):

BLOOD PHYSIOLOGY	
lectures - 4 classes	small groups activities - 2 classes
Blood physiology. Bone marrow. Erythrocytes. Leukocytes. Platelets. Blood groups. Plasma and plasma proteins. Hemostasis.	Determination of blood groups in the ABO system.

UNIT 7 (SEVENTH WEEK):

KIDNEY PHYSIOLOGY	
lectures - 4 classes	small groups activities - 2 classes
Kidney physiology. Functional morphology of the kidney. Renal circulation. Glomerular filtration. Tubule function. Counter current mechanism. Regulation of water and electrolyte excretion. Regulation of composition and volume of extracellular fluid. The role of the kidneys in the regulation of pH values.	Renal clearances.

UNIT 8 (EIGHTH WEEK):

PHYSIOLOGY OF THE GASTROINTESTINAL SYSTEM	
lectures - 4 classes	small groups activities - 2 classes
Physiology of the digestive system. Functional morphology of the gastrointestinal system. Basic types of movement of the gastrointestinal tract. Gastrointestinal secretion. Digestion and absorption of carbohydrates. Digestion and absorption of proteins and nucleic acids. Digestion and absorption of lipids.	Disorders of secretion in the digestive tract.

UNIT 9 (NINTH WEEK):

METABOLISM AND NUTRITION	
lectures - 4 classes	small groups activities - 2 classes
Basic principles of nutrition and metabolism. Liver function.	The basic principles of composing a daily meal.

UNIT 10 (TENTH WEEK):

BASIC PRINCIPLES OF ENDOCRINE REGULATION 1	
lectures - 4 classes	small groups activities - 2 classes
Basic principles of endocrine regulation. Hypothalamic hormones. Pituitary. Thyroid gland. Adrenal glands.	Tests to assess thyroid function.

UNIT 11 (ELEVENTH WEEK):

BASIC PRINCIPLES OF ENDOCRINE REGULATION 2	
lectures - 4 classes	small groups activities - 2 classes
Regulation of calcium and phosphorus metabolism. Hormones of the endocrine pancreas. Physiology of the female reproductive system. Physiology of the male reproductive system.	Tests for evaluation of glycoregulation. Tests for early diagnosis of pregnancy.

UNIT 12 (Twelfth Week):

PHYSIOLOGY OF THE NERVOUS SYSTEM 1	
lectures - 4 classes	small groups activities - 2 classes
Physiology of the sensory nervous system.	Examination of sensory functions.

UNIT 13 (THIRTEENTH WEEK):

PHYSIOLOGY OF THE NERVOUS SYSTEM 2	
lectures - 4 classes	small groups activities - 2 classes
Motor and integrative functions of the nervous system.	Examination of clinically important reflexes

UNIT 14 (FOURTEENTH WEEK):

PHYSIOLOGY OF THE NERVOUS SYSTEM 3	
lectures - 4 classes	small groups activities - 2 classes
Autonomic nervous system. The limbic system and higher brain functions. Wake-sleep cycle.	Autonomic reflexes.

UNIT 15 (FIFTEENTH WEEK):

PHYSIOLOGY OF THE SENSES	
lectures - 4 classes	small groups activities - 2 classes
Physiology of the senses. Eyesight. Sense of hearing. Sense of taste. Sense of smell.	Examination of the sense of sight: Determination of the nearest and farthest point of clear vision. Determination of visual acuity. Examination of the quality of color vision. Determining the width of the field of view using the perimeter. Proving the existence of the blind spot (Marriott's experiment).

LECTURE SCHEDULE

TUESDAY

08.00-12.00

HALL AT THE
PEDIATRIC CLINIC

SCHEDULE OF SMALL GROUP ACTIVITIES

WEDNESDAY

08.00-09.30

HALL AT THE
PEDIATRIC CLINIC

week	type	method unit name	a teacher
1	**L**	Review of Cell Physiology in Medical Physiology. Homeostasis. Transport through the cell membrane. Physiology of excitable tissues. Membrane potentials. Excitation and execution of action potentials.	Ivan Srejović
1	**SGA**	Basic principles of work in the laboratory.	Marina Nikolić Maja Murić
2	**L**	Neuromuscular transmission. Excitation and contraction of skeletal and smooth muscle.	Vladimir Živković
2	**SGA**	Disorders of neuromuscular transmission.	Jasmina Sretenović Maja Murić
3	**L**	Physiology of the heart. Electrical activity of the heart and impulse conduction. Cardiac cycle. Regulation of the heart.	Vladimir Jakovljević
3	**SGA**	Electrocardiography	Jovana Joksimović Jović Maja Murić
4	**L**	Physiology of the circulatory system. Biophysical characteristics of circulation. Circulation in arteries, capillaries and veins. Lymph and lymphatic vessels. Regulation of circulation.	Gvozden Rosić
4	**SGA**	Arterial pulse. Arterial blood pressure.	Marina Nikolić Maja Murić
5	**L**	Physiology of the respiratory system. Breathing mechanics. Diffusion, exchange and transport of gases. Regulation of breathing.	Jovana Joksimović Jović
5	**SGA**	Spirometry.	Jasmina Sretenović Maja Murić
6	**L**	Blood physiology. Bone marrow. Erythrocytes. Leukocytes. Platelets. Blood groups. Plasma and plasma proteins. Hemostasis.	Jasmina Sretenović
6	**SGA**	Determination of blood groups in the ABO system.	Jovana Joksimović Jović Maja Murić
7	**L**	Kidney physiology. Functional morphology of the kidney. Renal circulation. Glomerular filtration. Tubule function. Counter current mechanism. Regulation of water and electrolyte excretion. Regulation of composition and volume of extracellular fluid. The role of the kidneys in the regulation of rN values.	Marina Nikolić

week	type	method unit name	a teacher
7	**SGA**	Renal clearances.	Marina Nikolić Maja Murić
8	**L**	Physiology of the digestive system. Functional morphology of the gastrointestinal system. Basic types of movement of the gastrointestinal tract. Gastrointestinal secretion. Digestion and absorption of carbohydrates. Digestion and absorption of proteins and nucleic acids. Digestion and absorption of lipids.	Jovana Joksimović Jović
8	**SGA**	Disorders of secretion in the digestive tract.	Jasmina Sretenović Maja Murić
9	**L**	Basic principles of nutrition and metabolism. Liver function.	Jovana Joksimović Jović
9	**SGA**	The basic principles of composing a daily meal.	Jovana Joksimović Jović Maja Murić
10	**L**	Basic principles of endocrine regulation. Hypothalamic hormones. Pituitary. Thyroid gland. Adrenal glands.	Jasmina Sretenović
10	**SGA**	Tests to assess thyroid function.	Marina Nikolić Maja Murić
11	**L**	Regulation of calcium and phosphorus metabolism. Hormones of the endocrine pancreas. Physiology of the female reproductive system. Physiology of the male reproductive system.	Jasmina Sretenović
11	**SGA**	Tests for evaluation of glycoregulation. Tests for early diagnosis of pregnancy.	Jasmina Sretenović Maja Murić
12	**L**	Physiology of the sensory nervous system.	Jovana Joksimović Jović
12	**SGA**	Examination of sensory functions.	Jovana Joksimović Jović Maja Murić
13	**L**	Motor and integrative functions of the nervous system.	Marina Nikolić
13	**SGA**	Examination of clinically important reflexes.	Marina Nikolić Maja Murić

week	type	method unit name	a teacher
14	**L**	Autonomic nervous system. The limbic system and higher brain functions. Wake-sleep cycle.	Dragica Selaković
14	**SGA**	Autonomic reflexes.	Jasmina Sretenović Maja Murić
15	**L**	Physiology of the senses. Eyesight. Sense of hearing. Sense of taste. Sense of smell.	Marina Nikolić
15	**SGA**	Examination of the sense of sight: Determination of the nearest and farthest point of clear vision. Determination of visual acuity. Examination of the quality of color vision. Determining the width of the field of view using the perimeter. Proving the existence of the blind spot (Marriott's experiment).	Jovana Joksimović Jović Maja Murić
MODULE TEST			
E	**EXAM (JUNE DEADLINE)**		

Questions for oral exam.

The student answers 5 questions, which he draws from 3 groups of questions - A, B and C (he draws two questions from two groups, and one question from one, remaining group)

1. Content and distribution of water in the body
2. Morpho-functional characteristics of cells membrane
3. Types of transport through the cell membrane
4. Simple diffusion
5. Facilitated diffusion
6. Common characteristics of carrier-mediated transports
7. Primary active transport
8. Secondary active transport
9. Osmosis
10. The effect of solutions of different osmolarity on cells
11. Resting membrane potential
12. Action potential
13. Refractory periods
14. Neuromuscular junction
15. Correlation of end plate potential with skeletal muscle fiber excitation
16. Functional structure of skeletal muscle
17. Sarcomere as a functional unit of skeletal muscle. Effect of sarcomere length on muscle contraction
18. Propagation of action potentials in skeletal muscles
19. Sarcoplasmic reticulum and Ca^{2+} in skeletal muscles
20. Corss-bridge cycle
21. Motor unit. Summation of muscle contractions and mechanism of tetanization
22. Functional structure of smooth muscles
23. Excitation and contraction of smooth muscle
24. Cardiac conductive system
25. Action potentials of the heart - ventricles, atria and Purkinje system
26. Action potentials of the heart - SA node
27. Action potentials of the heart - AV node
28. The speed of impulse conduction in the heart
29. Specifics of the structure of the heart muscle
30. Connection between excitation and contraction of heart muscle
31. Cardiac cycle (phases)
32. Cardiac cycle (duration) – the effect of frequency on the cardiac cycle
33. Pressure-volume curve in chambers
34. Cardiac output and factors affecting cardiac output
35. Parasympathetic effects in the heart
36. Sympathetic effects in the heart
37. End-systolic and end-diastolic volume. Ejection fraction
38. Functional division of the circulatory system
39. Blood flow rate and pressures in different parts of the systemic circulation
40. Application of Ohm's law in the physiology of circulation
41. Types of blood flow
42. Differences in resistance between systemic and pulmonary circulation
43. Factors affecting conductance (Poiseuille's)
44. Vascular distensibility and vascular compliance
45. Volume-pressure curve in systemic circulation
46. Typical reactions of arterial and venous blood vessels to an increase in internal pressure (stretching)
47. Pulse pressure and factors that determine it
48. Mean arterial pressure

49. Hemodynamic characteristics of the venous part of the systemic circulation
50. Factors affecting the magnitude of venous pressure and flow
51. Functional significance of structural characteristics of capillaries
52. Transports through the capillary membrane
53. Forces that determine the direction of fluid movement in the exchange of matter through the capillary membrane
54. Roles and characteristics of the lymphatic system
55. The magnitude of local blood flow in certain tissues. Mechanisms of regulation of local blood flow
56. Acute and long-term control of local blood flow
57. Autoregulation of blood flow
58. Vasoactive substances originating from endothelium and blood
59. Humoral regulation of circulation
60. Nervous regulation of circulation
61. The role of the kidneys in the long-term regulation of arterial blood pressure
62. The importance of the renin-angiotensin-aldosterone system

B

1. Biomechanics of pulmonary ventilation
2. Pleural, alveolar and transpulmonary pressure
3. Anatomical dead space and minute alveolar ventilation. Physiological shunt and physiological dead space
4. Characteristics of pulmonary circulation. Capillary dynamics in the lungs and automatic control of blood distribution in the lungs
5. Blood flow zones in pulmonary capillaries
6. Factors affecting PO_2, PCO_2 in alveoli.
7. Size of net diffusion of gases through the respiratory membrane and diffusion coefficients
8. Effect of ventilation/perfusion ratio (VA/Q) on PAO_2 and $PACO_2$
9. Changes in circulating PO_2
10. Changes in circulating PCO2.
11. Factors affecting interstitial PO_2 and PCO_2
12. Transport of O_2 by blood
13. Oxyhemoglobin dissociation curve and factors that influence it
14. Transport of carbon dioxide by blood
15. Respiratory center. Chemosensitive area and direct control of respiratory center activity
16. Peripheral chemoreceptor system for respiratory control
17. Blood composition
18. Hematopoiesis
19. Erythrocytes (characteristics and number)
20. Synthesis, structure and functional characteristics of hemoglobin
21. Reticulocytes
22. Leukocytes (characteristics and number). Types of leukocytes and relative leukocyte formula
23. Neutrophiles
24. Eosinophils
25. Basophils
26. T and B lymphocytes
27. Antibodies
28. Procoagulants and anticoagulants
29. Immunity
30. Platelets

31. Phases of hemostasis
32. Coagulation factors
33. Fibrinolysis
34. Metabolism of iron in the body
35. Clinical tests for evaluation of hemostasis
36. Morpho-functional characteristics of kidneys and renal circulation
37. Nephron (types, roles and characteristics)
38. Basic processes in the formation of urine
39. Structure and function of glomeruli. Specificities of the glomerular membrane
40. Factors affecting the permeability of the glomerular membrane. Factors involved in the regulation of glomerular filtration
41. Tubular reabsorption
42. Transport maximum in the kidneys
43. Tubular secretion
44. Functions of the proximal tubule
45. Functions of the thin segment (descending and ascending) of Henle's loop
46. Functions of the thick segment of the Henle's loop
47. Functions of the final distal tubule and collecting ducts
48. Mechanisms of creation of concentrated urine
49. The role of vasa recta in concentrating urine
50. The mechanism of creation of dilute urine
51. The renin-angiotensin-aldosterone system
52. Renal clearance (definition, calculation)
53. Regulation of osmolarity in the body
54. Systems for controlling the acid-base balance in the body
55. The role of chemical buffers in maintaining acid-base balance
56. The role of the kidneys in maintaining acid-base balance
57. Electrical activity of the smooth muscles of the digestive tract
58. Enteric nervous system
59. The role of the autonomic nervous system in the control of GIT functions
60. Types of movements in the digestive tract
61. Swallowing and the neural control of swallowing
62. Stomach motor functions. Regulation of gastric emptying
63. Motor functions of the small intestine and their control. Control of emptying of the small intestine – the role of the ileocecal sphincter.
64. Colonic motor functions and defecation reflexes
65. Types of glands and daily secretion in the digestive tract
66. Saliva secretion and its regulation
67. Gastric secretion. Control of gastric secretion
68. Pancreatic secretion and its control
69. Bile (composition, roles, secretion and secretion control)
70. Secretion of the small intestine and its regulation
71. Carbohydrate digestion
72. Fat digestion
73. Protein digestion
74. Absorption of the final products of the breakdown of nutrients
75. Liver functions
76. Basic principles of nutrition and metabolism

C

1. Feedback system in the endocrine system
2. General principles of action of peptide hormones
3. General principles of action of steroid hormones
4. General principles of action of amino acid derivative hormones
5. Secondary messengers in the endocrine system
6. Functional anatomy of the pituitary gland
7. Vasopressin
8. Oxytocin
9. Physiological roles, mechanism of action and regulation of growth hormone secretion
10. Metabolic effects of growth hormone
11. Hormones of the adenohypophysis that participate in the regulation of the work of other endocrine glands
12. Synthesis, transport and mechanism of action and control of thyroid hormone secretion
13. Physiological actions and metabolic effects of thyroid hormones
14. Calcitonin
15. Functional anatomy of the adrenal gland
16. Secretion rhythms and transport of cortisol. The role of cortisol in stress and inflammation
17. Metabolic effects of cortisol
18. Control of glucocorticoid secretion
19. Aldosterone (physiological roles and control of secretion)
20. Hormonal regulation of glycemia
21. Synthesis, secretion, regulation of secretion and mechanism of action of insulin
22. The effect of insulin on carbohydrate metabolism
23. Effect of insulin on protein metabolism and growth
24. Effect of insulin on fat metabolism
25. Synthesis, secretion, regulation of secretion and mechanism of action of glucagon
26. Metabolic effects of glucagon
27. Hormonal regulation of calcium metabolism
28. Neuroendocrine regulation of reproductive system functions
29. Spermatogenesis and hormones that regulate spermatogenesis
30. Physiological roles of testosterone. Metabolic effects of testosterone
31. The rhythm of secretion of FSH and LH during the menstrual cycle
32. The rhythm of estrogen and progesterone secretion during the menstrual cycle
33. Stages of follicle growth in the ovary and formation of the corpus luteum.
34. Effects of estradiol
35. Effects of progesterone
36. Endometrial menstrual cycle
37. Hormonal control of lactation
38. Functional characteristics of individual parts of neurons
39. Synapse
40. Mechanisms of excitation and inhibition of neurons
41. Fast-acting and slow-acting transmitters
42. Control of functions at the level of the spinal cord
43. Control of functions at the subcortical level
44. Control of functions at the level of the cerebral cortex
45. Synaptic transmission in conditions of acidosis and alkalosis, synapse fatigue
46. Spatial and temporal summation
47. Classification of sensory receptors
48. Mechanisms of receptor potential generation (example of Pacini's corpuscle)

49. Receptor adaptation. Tonic and phasic receptors
50. Classification of nerve fibers
51. Somatic sensations
52. Functional anatomy of the anterolateral system
53. Functional anatomy of the medial lemniscus system
54. Somatosensory cortex map
55. Functions of somatosensory area 1 and somatosensory association area
56. Reflexes at the level of the spinal cord
57. Brain stem functions
58. Primary motor cortex
59. Premotor region. Supplementary motor region
60. Specialized regions of the motor cortex (Broca's area, Wernicke's region)
61. Corticospinal pathway
62. Extrapyramidal system
63. Higher intellectual functions of the prefrontal association region
64. Physiological balance control
65. Morpho-functional characteristics of the cerebellum. Roles of the cerebellum
66. Morpho-functional characteristics of the basal ganglia
67. Memory, definition and classification
68. Physiological significance of the limbic system
69. Physiological significance of the hypothalamus
70. Physiological significance of the hippocampus
71. Sleep - definition and classification
72. Functional organization of the sympathetic part of the ANS
73. Functional organization of the parasympathetic part of the ANS
74. Receptor function of the retina
75. Color vision
76. Mechanisms for the detection of sound signals
77. Sense of smell
78. Sense of taste