



**INTEGRATED ACADEMIC
STUDIES OF PHARMACY**

FIRST YEAR OF STUDIES

school year 2025/2026.

**FUNDAMENTALS OF HUMAN
PHYSIOLOGY**

Subject:

FUNDAMENTALS OF HUMAN PHYSIOLOGY

The course is evaluated with 8 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	drvladakbg@yahoo.com	Full professor
2.	Gvozden Rosic	grosic@medf.kg.ac.rs	Full professor
3.	Vladimir Zivkovic	vladimirziv@gmail.com	Full professor
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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.	Maja Murić	majanikolickg90@gmail.com	Assistant professor

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. Jovana Joksimović Jović

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, Maja Murić

Commission 2: Vladimir Živković, Ivan Srejšević, 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).

LECTURES AND PRACTICE

TUESDAY

GREEN HALL (H45)

13.10-16.40

[Schedule of lectures, practical classes and tests – academic calendar](#)

week	type	method unit name	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 Srežović
1	SGA	Basic principles of work in the laboratory.	Jovana Joksimović Jović Maja Murić
2	L	Neuromuscular transmission. Excitation and contraction of skeletal and smooth muscle.	Maja Murić
2	SGA	Disorders of neuromuscular transmission.	Jasmina Sretenović Ivan Srežović
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.	Jasmina Sretenović Ivan Srežović
5	L	Physiology of the respiratory system. Breathing mechanics. Diffusion, exchange and transport of gases. Regulation of breathing.	Jovana Joksimović Jović
5	SGA	Spirometry.	Jovana Joksimović Jović Maja Murić
6	L	Blood physiology. Bone marrow. Erythrocytes. Leukocytes. Platelets. Blood groups. Plasma and plasma proteins. Hemostasis.	Јасмина Сретеновић
6	SGA	Determination of blood groups in the ABO system.	Jasmina Sretenović Ivan Srežović
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.	Maja Murić

week	type	method unit name	teacher
7	SGA	Renal clearances.	Jovana Joksimović Jović 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 Ivan Srejšović
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.	Jasmina Sretenović Ivan Srejšović
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.	Jovana Joksimović Jović Maja Murić
12	L	Physiology of the sensory nervous system.	Jovana Joksimović Jović
12	SGA	Examination of sensory functions.	Jasmina Sretenović Ivan Srejšović
13	L	Motor and integrative functions of the nervous system.	Maja Murić
13	SGA	Examination of clinically important reflexes.	Jovana Joksimović Jović Maja Murić

week	type	method unit name	teacher
14	L	Autonomic nervous system. The limbic system and higher brain functions. Wake-sleep cycle.	Dragica Selaković
14	SGA	Autonomic reflexes.	Jasmina Sretenović Ivan Srežović
15	L	Physiology of the senses. Eyesight. Sense of hearing. Sense of taste. Sense of smell.	Maja Murić
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. Cross-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. Pulse pressure and factors that determine it
47. Mean arterial pressure

48. Hemodynamic characteristics of the venous part of the systemic circulation
49. Factors affecting the magnitude of venous pressure and flow
50. Functional significance of structural characteristics of capillaries
51. Transports through the capillary membrane
52. Forces that determine the direction of fluid movement in the exchange of matter through the capillary membrane
53. Roles and characteristics of the lymphatic system
54. The magnitude of local blood flow in certain tissues. Mechanisms of regulation of local blood flow
55. Acute and long-term control of local blood flow
56. Autoregulation of blood flow
57. Humoral regulation of circulation
58. Nervous regulation of circulation
59. The role of the kidneys in the long-term regulation of arterial blood pressure
60. 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 PCO_2 .
11. Factors affecting interstitial PO_2 and PCO_2
12. Transport of O_2 by blood
13. Transport of carbon dioxide by blood
14. Respiratory center. Chemosensitive area and direct control of respiratory center activity
15. Peripheral chemoreceptor system for respiratory control
16. Blood composition
17. Hematopoiesis
18. Erythrocytes (characteristics and number)

19. Synthesis, structure and functional characteristics of hemoglobin
20. Reticulocytes
21. Leukocytes (characteristics and number). Types of leukocytes and relative leukocyte formula
22. Neutrophils
23. Eosinophils
24. Basophils
25. T and B lymphocytes
26. Antibodies
27. Immunity
28. Platelets
29. Phases of hemostasis
30. Coagulation factors
31. Metabolism of iron in the body
32. Morpho-functional characteristics of kidneys and renal circulation
33. Nephron (types, roles and characteristics)
34. Basic processes in the formation of urine
35. Structure and function of glomeruli. Specificities of the glomerular membrane
36. Factors affecting the permeability of the glomerular membrane. Factors involved in the regulation of glomerular filtration
37. Tubular reabsorption
38. Transport maximum in the kidneys
39. Tubular secretion
40. Functions of the proximal tubule
41. Functions of the thin segment (descending and ascending) of Henle's loop
42. Functions of the thick segment of the Henle's loop
43. Functions of the final distal tubule and collecting ducts
44. Mechanisms of creation of concentrated urine
45. The role of vasa recta in concentrating urine
46. The mechanism of creation of dilute urine
47. The renin-angiotensin-aldosterone system
48. Renal clearance (definition, calculation)
49. Regulation of osmolarity in the body
50. Systems for controlling the acid-base balance in the body

51. The role of chemical buffers in maintaining acid-base balance
52. The role of the kidneys in maintaining acid-base balance
53. Electrical activity of the smooth muscles of the digestive tract
54. Enteric nervous system
55. The role of the autonomic nervous system in the control of GIT functions
56. Types of movements in the digestive tract
57. Swallowing and the neural control of swallowing
58. Types of glands and daily secretion in the digestive tract
59. Saliva secretion and its regulation
60. Gastric secretion. Control of gastric secretion
61. Pancreatic secretion and its control
62. Bile (composition, roles, secretion and secretion control)
63. Secretion of the small intestine and its regulation
64. Carbohydrate digestion
65. Fat digestion
66. Protein digestion
67. Absorption of the final products of the breakdown of nutrients
68. Liver functions
69. 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 level of the cerebral cortex

44. Classification of sensory receptors
45. Mechanisms of receptor potential generation (example of Pacini's corpuscle)
46. Receptor adaptation. Tonic and phasic receptors
47. Classification of nerve fibers
48. Somatic sensations
49. Functional anatomy of the anterolateral system
50. Functional anatomy of the medial lemniscus system
51. Somatosensory cortex map
52. Reflexes at the level of the spinal cord
53. Brain stem functions
54. Primary motor cortex
55. Premotor region. Supplementary motor region
56. Specialized regions of the motor cortex (Broca's area, Wernicke's region)
57. Corticospinal pathway
58. Extrapyrarnidal system
59. Higher intellectual functions of the prefrontal association region
60. Morpho-functional characteristics of the cerebellum. Roles of the cerebellum
61. Memory, definition and classification
62. Physiological significance of the limbic system
63. Physiological significance of the hypothalamus
64. Sleep - definition and classification
65. Functional organization of the sympathetic part of the ANS
66. Functional organization of the parasympathetic part of the ANS
67. Receptor function of the retina
68. Sense of smell
69. Sense of taste