Course: Physiology and Pathophysiology I
Course Coordinator: Ines Mrakovčić Šutić, MD, PhD, Full Professor
Department: Department of Physiology, Immunology, and Pathophysiology
Study: Integrated Undergraduate and Graduate University Study of Dental Medicine in English
Year of the study: the 1st
Academic year: 2023/2024
Number of ECTS credits: 5

COURSE SYLLABUS

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

The course Physiology and Pathophysiology I is a compulsory subject in the first year of the Integrated Undergraduate and Graduate University Study of Dental Medicine, which is held in the summer semester. Classes consist of 30 hours of lectures, 18 hours of seminars and 12 hours of exercises, a total of 60 hours (5 ECTS.)

The main goals of the course are to enable the student to apply previously acquired knowledge to acquire new knowledge about the basic physiological and pathophysiological aspects of the organism.

General physiology and pathophysiology: Functional organization of the human body. Homeostatic mechanisms. Concepts of health and disease. An integrative approach to disease. Principles of pathogenetic mechanisms and disease development. Etiological factors. **General disorders of the body**: Structure and function of macromolecules. Pathophysiological principles of inheritance of diseases and syndromes and hereditary metabolic diseases. Energetic homeostasis and Energy metabolic disorders. Hypoenergoses.

Cellular physiology and pathophysiology: The cell and its function. Biological membranes, compartments and composition of body fluids. Transfer of substance through cell membranes. Transmembrane signal transduction and signaling molecules. Disorders of the structure and function of macromolecules and subcellular formations. Disorders of structure and function of mitochondria. An integral reaction of the cells to the injuries. Cellular death. Malignant transformation and growth. **Physiology and pathophysiology of cell membranes**: transfer of substances through cell membranes. Membrane and action potential. Canalopathies and membrane transport disorders.

Physiology and pathophysiology of muscle cells: contraction of skeletal muscle. Skeletal muscle relaxant, neuro-muscular transmission, poaching, and contraction. Smooth muscle contraction.

Hematology and body fluids: Hematopoiesis. Erythrocytes: erythrocyte function. Iron turnover in the body. Erythropoiesis disorders: basic mechanisms and types of anemia. White blood cells: physiological roles of different types of leukocytes. Basic role of leukocytes in specific and nonspecific immunity. White blood cell disorders: quantitative and qualitative. Blood groups: Antigens of the AB0 system. Rh system antigens. Agglutinins. Basics of transfusion: reaction after giving mismatched blood. Platelets: Platelet physiology. Hemostasis. Platelet and coagulation disorders. Mechanism of thrombosis. Propensity to bleed. Basic laboratory methods for determining hemostasis disorders. Inflammation: definition, name, mechanism of origin and division of inflammation. Chemotaxis. Phagocytosis. The role of cytokines in the inflammatory process. Local and systemic consequences of inflammation. Etiological factors, and the body's response to noxa. Endogenous bioactive compounds. Inflammation, repair of damage and wound healing.

Integrative functions. The overall reaction of the organism to the noxa. Stress and adaptation. Homeostasis. Stress

Required textbooks:

1. Guyton A.C., Hall J.E. Textbook of Medical Physiology (13th edition), Elsevier, 2016.
2. Gamulin S, Marušić M, Kovač Z. Pathophysiology – Basic Mechanisms of disease - Textbook, Medicinska naklada, Zagreb, 2014.
3. Handbook for Practicals in Physiology, Neurophysiology, and Immunology, Department of Physiology, Immunology, and Pathological Physiology, Faculty of Medicine in Rijeka, October 2001. (can be downloaded from the SharePoint platform of the Department of Physiology)
4. 4. Kovač Z. et al. Clinical Pathophysiology – Etiopathogenetic Nodes – Third Book (I-IV part). Medicinska naklada Zagreb 2013.

All materials that are not included in the compulsory reading will be published on the course website.

Recommended for additional reading:

1. Alberts et al. Molecular biology of the Cell, Sixth Edition, Garland publ., New York, 2015.
2. Abbas A.K, Lichtman A.H., Pillai S. Basic Immunology. Functions and Disorders of the Immune System. Fifth edition. Elsevier, 2016.

Course teaching plan:

List of lectures (with titles and learning outcomes):

L1: Principles in physiology and pathophysiology; Homeostasis, control systems. Health and disease; Cell and its function; Transfer of substance through cell membranes

Learning outcomes: Explain the principles of physiological feedback and determine the homeostatic mechanisms of the main functional systems.

Explain functional tests in the assessment of the state of the organism, general principles of assessment of biological systems, the role of clinical laboratory tests, the concept of reference value, principles of interpretation of laboratory tests and assessment of the general condition of the organism.

Define health and disease and understand the principles of maintaining normal and disturbed homeostasis.

Explain genetic control over cell fate

Transfer of substance through cell membranes

Learning outcomes: Explain the processes and principles of diffusion through the cell membrane.

Explain the chemical composition of extracellular and intracellular fluid.

Explain the active transfer of substances across the membrane. Explain the process of endocytosis and exocytosis.

Understand the principles of signal transduction using signaling molecules that are soluble and insoluble in the lipid bilayer. Explain the function of other messengers and membrane receptors.

Explain the function of nuclear receptors.

L2: Cell growth control. Tumor growth

Learning Outcomes: Explain the cell cycle, checkpoints in the cell cycle of the major regulatory proteins in the cell cycle.

Understand ways to regulate the cell cycle by external and intracellular signals.

Understand the role of kinases, retinoblastoma protein (pRb), and the relationship between p53 and p21 proteins.

Explain the role of protooncogenes in cell growth control and the principles of transformation into oncogenes.

L3: Membrane and action potential

Learning outcomes: Explain the physical basis of membrane potentials.
Explain the formation of the resting membrane potential in nerves and calculate the membrane potential under conditions when the membrane permeability for Na, K or Cl ions changes.
Explain the emergence of action potential in a nerve cell.
Explain the action of voltage-regulated Na +, K + and Ca ++ channels (stimulus threshold, activation and inactivation), ways of exciting the action potential and spreading the action potential along the cell membrane.
Understand the principles of recording membrane and action potentials.
Explain the conduction of action potential in nerve fibers and the dependence of conduction velocity in nerve fibers (myelin sheath).
Explain the formation of plateaus in some action potentials, rhythmicity and repeated triggering.

L4: Contraction of skeletal and smooth muscles
Learning Outcomes: Explain neuromuscular transmission, synaptic transmission, nicotinic cholinergic receptor, skeletal muscle action potential, coupling stimulation and contractions.
Describe the formation and secretion of acetylcholine at the molecular level.
Explain the molecular mechanisms of muscle contraction.
Describe the structure of skeletal and smooth muscle and the mechanisms of muscle contraction.
Understand the energy of muscle contraction, the characteristics of whole muscle contraction.

L5: Hematopoiesis; Erythrocyte function
Learning outcomes: Explain the development of blood cells: the place and stages of blood cell differentiation.
Describe and list the basic growth factors.
Describe erythropoiesis, primary and secondary centers of hematopoiesis, stages of erythrocyte differentiation, growth and differentiation factors (vitamins and iron), and regulation of erythropoiesis by erythropoietin and the amount of oxygen in tissues, lymphopoiesis, myelopoiesis, and thrombocytopoiesis.
Describe the formation, shape, size and concentration of erythrocytes in the blood.
Explain hemoglobin formation and function in erythrocytes (O2, CO2 transfer).
Explain the mechanism of erythrocyte degradation in the spleen as well as hemoglobin degradation.

L6: Red blood cell disorders
Learning outcomes: Explain disorders in erythrocyte formation and function.
Explain the pathogenesis of anemia and polycythemia.
Understand the metabolism and pathophysiological consequences of iron transport disorders.
Understand the basic laboratory tests to assess the number and function of erythrocytes.

L7: White blod cells: division and function
Learning outcomes: Explain the concentration and division of leukocytes in the blood (granulocytes - neutrophils, eosinophils, basophils; and agranulocytes - lymphocytes, monocytes and plasma cells).
Describe the differential blood count and its clinical significance.
Explain the lifespan and recirculation of leukocytes in the body (leukodiapedesis, chemotaxis).
Defensive properties of neutrophils and macrophages (phagocytosis and bacterial killing, antigenic presentation and stimulation of immune response, cytokine secretion to stimulate inflammation).
Describe the role of eosinophils and basophils.

L8: White blood cell disorders
Learning outcomes: Clarify the etiology and characteristics of qualitative and quantitative leukocyte disorders.
Explain the division of leukemias and lymphomas, and the significance that arises from the division

L9: Platelets and clotting
Learning outcomes: To describe the process of hemostasis.
To describe the types of bleeding into the skin and mucosa – petechiae, ecchymoses, purpura.
To name and explain innate and acquired causes of bleeding tendency.
To name and describe qualitative and quantitative disorders in platelet function.
To name and describe conditions of excessive tendency for blood clotting.

L 10: Hemostasis disorders.
Learning outcomes:
To name and describe qualitative and quantitative disorders in platelet function.
To describe the pathophysiological states of bleeding tendency.
To name and describe conditions of excessive tendency for blood clotting.
To describe spleen function disorders.

L11: Blood groups and transfusion
Learning outcomes: Describe major erythrocyte antigens and know plasma agglutinin types.
Explain the antigen system of the AB0 and Rh systems.
Understand the onset of fetal erythroblastosis.
Understand the reaction after giving mismatched blood.
Understand the basic principles of transplantation response.
Explain the importance of blood products.

L12: Etiological factors
Learning outcomes: Understand the development of the pathological process, the influence of temporal factors in pathogenesis, heredity, environment and risk factors. Explain mechanical, chemical and biological factors.

L13: Inflammation
Learning Outcomes: Understand the basic properties of inflammation and explain the etiopathogenesis of acute and chronic inflammation.
Clarify the body's systemic response to inflammation.
Be able to assess the inflammatory reaction

L14: Heat control mechanisms; Thermoregulatory disorders
Learning outcomes: Explain the mechanisms for generating heat (metabolism, trembling), and the mechanisms for emitting heat from the body surface.
Explain the isolation system of the body.
Clarify the role of sympathetic innervation in the regulation of body heat.
Explain the thermostatic center in the hypothalamus - the "set point" in body temperature control.
Explain fever and pyrogens and features of febrile conditions

L15: Complete response of the organism to the noxa
Learning outcomes: Explain the concepts of etiology, pathogenesis and etiological factors. Stress reaction.

List of seminars (with titles and learning outcomes):

S1: Cell and its function; Health and disease
Learning outcomes: Explain the general organization of the cell, the physical structure of the cell and the

functional systems in the cells.
Explain the role of cellular organelles, membrane structures in the cell, cellular devices and microorganals, mobility of cellular components and cellular architecture.
Understands and is able to explain the limits of fluctuations in physiological values, the principles of adaptation and adaptation,
Explain the disease as a nosological entity and the characteristics of the disease. Define death.

S2: Disorders of macromolecules
Learning outcomes: Explain disorders of DNA structure and function, DNA damage, disorders of DNA repair mechanisms, changes in DNA structure, disorders of DNA quantity and disorders of DNA synthesis.
Understand the principles of chromosomal disorders.
Explain disorders of genetic expression.
Explain disorders of protein production and degradation (transcriptional and translational disorders, disorders of intracellular protein degradation).
Understands the pathophysiological principles of disease and syndrome inheritance.

S3: Disorders of subcellular formations
Learning outcomes: Explain disorders of cell membrane, structure and function of mitochondria, lysosomes and other intracellular organelles
Understands the integral response of a cell to injury
Explain cell death.
Explain methods for assessing the function of subcellular structures

S4: Tumor growth
Learning outcomes: Genome instability and cell cycle disorder in carcinogenesis. Chemical, physical and biological carcinogenesis. Oncogenes and antioncogenes. General properties of malignant cells and tumor growth kinetics. Intercellular relationship between tumor and host. Pathogenetic sequence of events during the growth and metastasis of malignant tumors.

S5: Anemia and polycythemia
Learning outcomes: Explain disorders in erythrocyte formation and function.
Explain the etiopathogenesis of anemia and polycythemia, and clinical consequences.

S6: Leukemias and lymphomas
Learning outcomes: Explain disorders in leukocyte formation and function.
Clarify the qualitative and quantitative disorders of the white vine.

S7. Platelets and blood clotting
Learning outcomes: Explain the process of blood clotting
Explain blood clotting disorders

S8. Blood groups and transfusion
Learning outcomes: Describe the major erythrocyte antigens and know the types of agglutinins in plasma.
Explain the antigen system of the AB0 and Rh systems.
Explain the occurrence of fetal erythroblastosis.
Understand the reaction after giving mismatched blood.
Explain the basic principles of the transplantation reaction.

S9: Thermoregulation and thermoregulatory disorder, Inflammation
Learning outcomes: Definition of inflammation, basic symptoms and etiology.

Explain the pathogenetic mechanisms of local inflammatory processes in acute inflammation, as well as the systemic reactions of the organism to inflammation. Describe and explain inflammatory mechanisms, kinetics and pathogenesis of the inflammatory process, and mediators of the inflammatory process. Clarify the pathophysiological outcomes of inflammatory reactions. Explain the basic pathophysiological changes in hypothermia, as well as in heat shock

	SEMINARS (seminar topic)	Number of teaching hours	The place
S1	**Cell and its function; Health and disease** Textbook Guyton AC, Hall JE. Medical physiology, Chapter 2. and Chapter 3. Health and disease Textbook Gamulin S. et al. Pathophysiology, Chapter 2	**2**	
S2	**Disorders of the structure and function of macromolecules** Textbook Gamulin S. et al. Pathophysiology, Chapter 3	**2**	
S3	**Disorders of subcellular formations** Textbook Gamulin S. et al. Pathophysiology, Chapter 4. Disorders of subcellular formations	**2**	
S4	**Tumor growth** Textbook Gamulin S. et al. Pathophysiology, Chapter 21. Malignant transformation and growth	**2**	
S5	**Anemia and polycythemia** Textbook Guyton AC, Hall JE. Chapter 32. Erythrocytes, anemia and polycythemia. Textbook Gamulin S. et al. Pathophysiology, Chapter 26. Disorders of the composition and function of blood and hematopoietic organs	**2**	
S6	**Leukemias and lymphomas** Textbook Guyton AC, Hall JE. Chapter 33. Resistance of an organism to infection Textbook Gamulin S. et al. Pathophysiology, Chapter 26. Disorders of the composition and function of blood and hematopoietic organs	**2**	
S7.	**Platelets and blood clotting** Textbook Guyton AC, Hall JE. Medical physiology, Chapter 36 Hemostasis and blood clotting. Textbook Gamulin S. et al. Pathophysiology, Chapter 26. Disorders of the composition and function of blood and hematopoietic organs	**2**	

S8	**Blood groups and transfusion** Textbook Guyton AC, Hall JE. Chapter 35. Blood groups and transfusions, tissue and organ transplants Textbook Gamulin S. et al. Pathophysiology, Chapter 15. 15.9 Transfusion reaction	**2**	
S9	**Thermoregulation and thermoregulatory disorder; Inflammation** Textbook Gamulin S. et al. Pathophysiology, Textbook Pathophysiology, Chapter 14. Thermoregulatory disorders Chapter 16. Inflammation	**2**	
	Total number of seminar hours	**18**	

List of practicals (with titles and learning outcomes):

EXERCISE 1: Erythrocytes I

Learning outcomes:

Describe the development, properties and functions of erythrocytes

Explain the causes and understand the mechanism of red blood cell and hematopoietic disorders.

The exercise includes:

- Taking blood from the fingertip
- Erythrocyte count
- Assessment of changes in erythrocyte number and quality
- Evaluation of erythrocyte lineage disorders based on stained blood and bone marrow preparations

EXERCISE 2: Erythrocytes II Hemoglobin; Hematological indices and their significance.

Learning outcomes:

Determination of hemoglobin

Determine hematological indices and their significance.

Determine the hematocrit and its significance

Understand the metabolism and pathophysiological consequences of iron turnover.

Understand the osmotic balance on biological membranes.

Describe quantitative and qualitative disorders in the composition of plasma proteins, and the properties of pathological proteins.

The exercise includes:

- Determination of hemoglobin
- Determination of hematological indices
- Determine hematocrit

EXERCISE 3: Leukocytes

Learning outcomes:

Describe the properties, functions and development of individual leukocyte subpopulations.

Explain the causes and understand the mechanism of white blood cell disorders.

The exercise includes:

- Leukocyte count
- Preparation of blood smear and staining by Pappenheim method

EXERCISE 4: Differential blood count

Learning outcomes:

Explain the percentage of individual subpopulations of leukocytes in the blood

To judge leukocyte lineage disorders based on stained blood and bone marrow preparations

The exercise includes:

- Determination of numerical ratios of various types of leukocytes

EXERCISE 5: Blood groups

Learning outcomes:

Describe the major erythrocyte antigens and know the types of plasma agglutinins.

Explain the antigen system of the AB0 and Rh systems.

Understands the onset of fetal erythroblastosis.

Understands the reaction after giving mismatched blood.

Understands the basic principles of transplantation response.

The exercise includes:

- Determination of blood group according to AB0 and Rh system.

EXERCISE 6: Hemostasis and blood clotting

Learning outcomes:

Describe the properties, functions and formation of platelets.

Explain the mechanism of blood clotting.

Understand the mechanisms of preventing blood clotting in the normal vascular system.

The exercise includes:

- Platelet count

	PRACTICALS	Number of teaching hours	Place
P1	Erythrocytes I	2	
P2	Erythrocytes II; Hemoglobin and hematological index	2	
P3	Leukocytes	2	
P4	Differential blood count; Inflammation	2	
P5	Blood groups	2	
P6	Hemostasis and blood clotting	2	
	Total number of hours of practicals	**12**	

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

ECTS grading system:
Student grading will be conducted according to the current **Ordinance on Studies of the University of Rijeka** and the **Ordinance on Student Grading at the Faculty of Medicine in Rijeka.**
Student work and achievement are assessed and graded during the course, which is the basis for the final grade. Student work and competencies are evaluated during classes with a maximum of **70 grade points** and up to **30 grade points** at the final exam, which totals **100 grade points**. Students are graded according to the ECTS (A-E) and numerical system (1-5). Grading according to the ECTS system is conducted according to the absolute redistribution, as well as according to the graduate grading criteria.

I. The following components are evaluated during the course (maximum of 70 grade points):
a) acquired knowledge (up to 66 grade points)
b) attendance at classes (up to 4 grade points)

a) acquired knowledge (up to 66 grade points)
During classes, acquired knowledge will be evaluated by **two midterm exams comprising 40 questions**, A student may obtain up to 17 grade points on each midterm exam:

Correct answers	Grade points		Correct answers	Grade points
39,40	33		28	23
38	32		27	22
37	31		26	21
36	30		25	20
35	29		24	19
34	28		23	18
33	27		21,22	17
32	26		<20	0
31	25			
29,30	24			

b) Attendance at classes:
A maximum of 4 points can be achieved by attending classes:
100% 4 points
90-99% 3 points
80-89% 2 points
70-79% 1 point

II. Final exam (up to 30 points)

The final exam examines the key, specific competencies that are determined for each unit, and consists of a written and an oral part.

a) The written test has 50 questions, and points (from a minimum of 7 to a maximum of 15) are obtained when the student solves more than 50% of the questions as shown in the table:

Correct answers	Grade points
48-50	**15**
46-47	**14**
43-45	**13**
40-42	**12**
37-39	**11**
34-36	**10**
31-33	**9**
28-30	**8**
25-27	**7**

a) The student can access the oral part of the final exam if he has achieved at least 7 points in the written part of the final

exam. In the oral part of the final exam, the student can earn points as shown in the table:

Grade achieved in the oral part of the exam	Number of grade points obtained at the oral part of the final exam
excellent A	**13-15**
very good B	**11-12**
good C	**11-10**
sufficient D	**1-8**
insufficient F	**0**

In order to pass the final exam, a student must achieve a minimum of 7 grade points at the written part and a minimum of 8 grade points at the oral part of the exam. The final exam is an integral part, therefore, if the student does not achieve a positive assessment of the oral part of the final exam, the results of the written part of the final exam are invalid in the following final exam terms.

III. The final grade (maximum of 100 grade points)

The final grade represents a sum of all grade points obtained during classes and at the final exam based on the absolute redistribution according to the following scale:

Final grade	
A (90-100%)	Excellent (5)
B (75-89,9%)	Very good (4)
C (60-74,9%)	Good (3)
D (50-59,9%)	Sufficient (2)
F (less than 50 grade points)	insufficient (1)

Other important information regarding the course:

Course content and all information regarding the course, including exam dates, can be found on the *SharePoint* platform of the Department of Physiology and Immunology on the following website: https://spp.uniri.hr/ss_medri/katedre/427 - accessed via an **AAI address.**

COURSE SCHEDULE for the academic year 2023/2024

Date	Lectures (time and place)	Seminars (time and place)	Practicals (time and place)	Lecturer
5.06.2024.	L1 (9,15-11,00)			Ines Mrakovčić Šutić, MD, PhD, Full Professor
5.06.2024.		S1 (11,15-13,00)		Ines Mrakovčić Šutić, MD, PhD, Full Professor
5.06.2024.		S2 (13,15-15,00)		Ines Mrakovčić Šutić, MD, PhD, Full Professor
6.06.2024.	L2 (10,15-12,00)			Pero Lučin, MD, PhD, Full Professor
6.06.2024.	L3 (12,15-14,00)			Pero Lučin, MD, PhD, Full Professor
7.06.2024.	L4 (9,15-11,00)			Pero Lučin, MD, PhD, Full Professor
10.06.2024.	L5 (9,15-11,00)			Ines Mrakovčić Šutić, MD, PhD, Full Professor
10.06.2024.	L6 (11,15-13,00)			Ines Mrakovčić Šutić, MD, PhD, Full Professor
10.06.2024.	L7 (13,15-15,00)			Ines Mrakovčić Šutić, MD, PhD, Full Professor
11.06.2024.		S3 (9,15-11,00)		Ines Mrakovčić Šutić, MD, PhD, Full Professor
11.06.2024.		S4 (11,15-13,00)		Silvija Lukanović Jurić, MD, PhD, Teaching Assistant
18.06.2024.	Midterm 1 (12,00-13,00)			
19.06.2024.	L8 (9,15-11,00)			Ines Mrakovčić Šutić, PhD, Full Professor
19.06.2024.		S5 (11,15-13,00)		Ines Mrakovčić Šutić, PhD, Full Professor
20.06. 2024.		S6 (9,15-11,00)		Ines Mrakovčić Šutić, PhD, Full Professor

20.06. 2024.	L9 (11,15-13,00)			Ines Mrakovčić Šutić, MD, PhD, Full Professor
20.06. 2024.	L10 (13,15-15,00)			Ines Mrakovčić Šutić, MD, PhD, Full Professor
21.06. 2024.		S7 (9,15-11,00)		Tamara Gulić, PhD, Assistent Professor
21.06. 2024.		S8 (11,15-13,00)		Ines Mrakovčić Šutić, MD, PhD, Full Professor
24.06. 2024.			P1 (9,15-11,00)	Mirna Jurković, mag. biol. exp. Teaching Assistant
24.06. 2024.			P2 (11,15-13,00)	Mirna Jurković, mag. biol. exp. Teaching Assistant
26.06. 2024.			P3 (9,15-11,00)	Mirna Jurković, mag. biol. exp. Teaching Assistant
27.06. 2024.		S9 (9,15-11,00)		Ines Mrakovčić Šutić, MD, PhD, Full Professor
27.06. 2024.	L11 (11,15-13,00)			Ines Mrakovčić Šutić, MD, PhD, Full Professor
27.06. 2024.	L12 (13,15-15,00)			Ines Mrakovčić Šutić, MD, PhD, Full Professor
28.06. 2024.	L13 (9,15-11,00)			Ines Mrakovčić Šutić, MD, PhD, Full Professor
28.06. 2024.	L14 (11,15-13,00)			Ines Mrakovčić Šutić, MD, PhD, Full Professor
28.06. 2024.	L15 (13,15-15,00)			Ines Mrakovčić Šutić, MD, PhD, Full Professor
1.07. 2024.			P4 (8,15-10,00)	Mirna Jurković, mag. biol. exp. Teaching Assistant
1.07. 2024.			P5 (10,15-12,00)	Mirna Jurković, mag. biol. exp. Teaching Assistant
1.07. 2024.			P6 (12,15-14,00)	Mirna Jurković, mag. biol. exp. Teaching Assistant
4.07. 2024.	Midterm 2			
11.07. 2024.	Final exam			
18.07.2024.	Final exam			

3.09.2024.	Final exam			
18.09.2024.	Final exam			