



Course: Physiology and Pathophysiology II

Course Coordinator: Professor Gordana Blagojević Zagorac, MD, PhD

Course Collaborators: Professor Jagoda Ravlić-Gulan, MD, PhD; Professor Hrvoje Jakovac, MD, PhD; Professor Zlatko Trobonjača, MD, PhD; Assistant professor Božena Ćurko-Cofek, MD, PhD; Silvija Lukanović Jurić, MD, PhD

Department: Department of Physiology, Immunology and Pathophysiology

Study program: University Integrated Undergraduate and Graduate Study of Dental Medicine (in English)

Study year: 2.

Academic year: 2026./27.

SYLLABUS

Course description (a brief description of the course, general instructions, where and in what form the lessons are organized, necessary equipment, instructions for attendance and preparation for classes, student obligations, etc.):

The course Physiology and Pathophysiology II is a compulsory course in the second year of the Integrated Undergraduate and Graduate University Study of Dental Medicine. Classes are organized in shifts and are performed in the winter semester. Classes are held in the form of lectures (30 hours), seminars (15 hours) and practicals (15 hours), which amounts to a total of 60 hours (7.5 ECTS).

The primary aim of this course is to provide students with the knowledge of normal function of cardiovascular, urinary and respiratory system, as well as with pathophysiological mechanisms that lead to development of diseases of those systems. Seminars and practicals will prepare students for independent problem-solving and integrated thinking about health and disease. The intention is to explain physiological and pathophysiological mechanisms at the molecular level, at the level of the organs and at the level of the organism as a whole. For enrollment in the course "Physiology and Pathophysiology II" students have to pass exam of course "Physiology and Pathophysiology I".

Class organization:

Classes are held in the form of lectures, seminars and practicals. During seminars and practicals, the student actively discusses with the teacher the physiological and pathophysiological mechanisms in order to prepare for independent problem solving and integrative thinking about health and disease. The practicals use animal models and computer programs (Biopac) that allow detailed analysis of the function of the cardiovascular, renal and respiratory systems, and simulate the pathological conditions of these organ systems. The student is required to prepare material that is discussed in seminars and practicals.

In accordance with the Law and the Statute of the Faculty of Medicine, all forms of teaching (lectures, practicals, seminars,) are mandatory. Justification of absences from seminars and practicals is proven by valid certificates.



Lectures, seminars and practicals are held according to the Program. The schedule of students by groups can be found on the Merlin as well as on the Share point portal of the Department of Physiology and Immunology at the following address: https://spp.uniri.hr/ss_medri/katedre/427na which is accessed with the AAI address.

Content of the course Physiology and Pathophysiology II:

Physiology and Pathophysiology of the Heart and the Circulation:

Heart – structure and function. Creating and spreading impulses. Creating a normal electrocardiogram. Cardiac arrhythmias and their electrocardiographic interpretation. Heart sounds. Overview of the circulation. Cardiac output regulation. Arterial pressure regulation. Arterial and venous pulse. Microcirculation and lymphatic system. Hypertension and hypotension. Coronary circulation and ischemic heart disease. Cardiac failure. Syncope. Circulatory shock and the basics of its treatment.

Physiology and Pathophysiology of Urinary system: Kidney – structure and function. Filtration and reabsorption. Creating concentrated and diluted urine. Prerenal, renal, and postrenal kidney disorders. Disorders of water and electrolytes turnover. Acute and chronic renal insufficiency.

Physiology and Pathophysiology of Respiration: Respiratory system – structure and function. Pressures and volumes. Pulmonary ventilation. Gas exchange through the respiratory membrane. Regulation of respiration. Pulmonary function tests. Obstructive and restrictive respiration disorders.

Acid-base Balance Regulation and Disorders: Pathophysiological factors of acid-base balance disorders. Metabolic and respiratory acidosis and alkalosis. Compensation mechanisms and consequences of acid-base balance disorders.

LEARNING OUTCOMES FOR THE COURSE:

Development of general competencies (knowledge and skills)

At the end of the course Physiology and Pathophysiology II it is expected that the student will be able to:

1. observe the cell and the organism as an integrated system, interpret and explain normal and disturbed physiological values, as well as basic physiological and pathophysiological tests.
2. critically normal functioning as well as disorders of individual organ systems.

Development of specific competencies (knowledge and skills)

At the end of the course Physiology and Pathophysiology II it is expected that the student will be able to:

1. explain the normal functioning and electrophysiology of the heart, the physical properties of the circulatory system and the mechanisms of regulation of arterial pressure, capillary dynamics, as well as the pathophysiological mechanisms of cardiovascular system disorders.
2. explain the function of the nephron, the mechanisms of urine production, the role of the kidney in the regulation of the composition and volume of extracellular fluid, as well as the pathophysiological mechanisms of renal diseases and renal failure.
3. explain the structure and function of the respiratory system, regulation of respiration, and the mechanisms of respiratory disorders.
4. explain the mechanisms of acid-base balance regulation, acid-base balance disorders and their consequences.



Assigned reading:

1. Hall, J.E. and Hall, M.E., 2025. *Guyton and Hall Textbook of Medical Physiology*. 15th ed. Philadelphia: Elsevier.
2. Gamulin, S., Marušić, M. and Kovač, Z. (eds.) (2014) *Pathophysiology: Basic Mechanisms of Disease. Book One: Volumes One and Two*. Zagreb: Medicinska naklada.
3. Ravlić-Gulan J. et al., 2018. Textbook „Practicals of Physiology and Pathophysiology II“. First edition. Rijeka: University of Rijeka, Faculty of Medicine, Department of Physiology, Immunology and Pathophysiology.

Optional/additional reading:

1. Sembulingam K, *Essentials of Physiology for Dental Students*, 2016, Elsevier

COURSE TEACHING PLAN:

The list of lectures (with topics and descriptions):

LECTURES: (15 x 2 hours)

Lecture 1: Heart structure, cardiac cycle, regulation of heart work.

Anatomical and functional characteristics of the cardiac muscle and the cardiovascular system. Core principles of cardiac function and the role of valves in the cardiac function. Cardiac muscle as a pump. Phases of systole and diastole. Importance of different mechanisms for regulating cardiac function.

Lecture 2: Generation of electrical impulses in the heart and basic principles of electrocardiography (ECG)

Membrane and action potential in the heart. Special system for creating and conducting impulses in the heart. Basic principles of electrocardiography and the principles of vector analysis. Features of a normal electrocardiogram.

Lecture 3: Disorders of the generation of electrical impulses in the heart and their ECG interpretation

Mechanisms that lead to impulse generation disorders. Effect of ions (sodium, potassium and calcium) on heart function. Normotopic and heterotopic disorders of pulse generation in the heart with ECG interpretation. Mechanisms that lead to impulse conduction disturbances. Supraventricular and ventricular blocks with ECG interpretation. Atrial and ventricular undulation and fibrillation with ECG interpretation. Hemodynamic consequences of heart rhythm disorders.

Lecture 4: Basic principles of circulation, pressure and blood flow

Functional features of the arterial and venous part of the circulatory system. Physical properties of circulation. Relationships between pressure, flow and resistance.

Lecture 5: Microcirculation and regulation of local tissue flow

Structure of microcirculation and the mechanisms of capillary exchange. Function of the lymphatic system. Principles of metabolic, humoral and neural regulation of blood flow.



Lecture 6: Regulation of cardiac minute volume and venous return

Parameters that affect venous return: central venous pressure, systemic filling pressure, and venous return resistance. Cardiac output curve and parameters that lead to its shift. Relationship between venous return and cardiac output (example of sympathetic stimulation).

Lecture 7: Regulation of blood pressure and blood pressure disorders

Mechanisms of blood pressure regulation: short-term, medium-term and long-term. Arterial hypertension and hypotension. Pathogenetic consequences of arterial hypertension.

Lecture 8: Pathophysiology of the cardiovascular system

Pathophysiological mechanisms of systolic and diastolic heart dysfunction, and their hemodynamic consequences. Valvular heart disease. Compensated and decompensated heart failure, and the mechanisms and pathophysiological consequences of unilateral and bilateral heart failure.

Lecture 9: Overview of physiology of renal system I

Physiological structure of the urinary system and kidneys. Glomerular function and renal tubule function. Renal blood flow, glomerular filtration, and processing of glomerular filtrate in renal tubules, as well as their regulation.

Lecture 10: Overview of physiology of renal system II

Secretion of individual ions. Mechanisms of concentration and dilution of urine.

Lecture 11: Pathophysiology of the urinary tract

Basic pathophysiological mechanisms in prerenal, renal (glomerular disorders and tubulointerstitial disorders) and postrenal renal disorders.

Compensatory mechanisms of maintaining normal glomerular filtration and blood flow through the kidney. Nephrotic and nephritic syndrome.

Lecture 12: Physiology of respiration I

Physiological structure of the respiratory system and its function. Mechanics of pulmonary ventilation and the physical principles of gas exchange. Anatomical and physiological dead space. pulmonary volumes and capacities, minute tidal volume, and alveolar ventilation.

Lecture 13: Physiology of respiration II

Transport of oxygen and carbon dioxide through the blood. Specifics of pulmonary circulation. Regulation of respiration. Static and dynamic pulmonary tests.

Lecture 14: Pathophysiology of respiratory system

Obstructive and restrictive ventilation disorders. Diffusion disorders. Pulmonary edema (cardiogenic and noncardiogenic), pulmonary hypertension and pulmonary embolism.

Lecture 15: Regulation of acid-base balance

Role of regulatory systems for monitoring acid-base balance: buffers, respiratory and renal system.



The list of seminars with descriptions:

SEMINARS: (5 x 3 hours)

Seminar 1: Events during the heart cycle

Changes of atrial pressure, ventricular volume, ventricular pressure, aretrial pressure, ECG and heart sounds during systole and diastole.

Seminar 2: Circulatory shock and other emergencies in ordination of dental medicine

Hypovolemic, cardiogenic and vaso hypotonic circulatory shock. Compensatory mechanisms during circulatory shock. Disorders of coronary blood flow and the pathogenesis of ischemic heart disease. Biochemical, mechanical and electrophysiological consequences of ischemia.

Seminar 3: Dental care for patients with renal diseases

Pathogenesis of acute and chronic renal failure.

Seminar 4: Oral health and pulmonary diseases

Pathogenetic mechanism of respiratory insufficiency, differences between hypoxemic and hypercapnic forms of respiratory insufficiency. **Respiratory rhythm disorders.**

Seminar 5: Acid-base disorders

Metabolic and respiratory acidosis and alkalosis. Pathophysiological consequences of acid-base imbalance and the principles of their assessment.

The list of practicals with descriptions:

PRACTICALS: (5 x 3 hours)

Practical 1: Electrocardiography (ECG)

Recording and interpretation of a normal electrocardiogram in humans.

Practical 2: ECG and pulse

Pulse pressure and its disorders and various pathophysiological conditions.

Practical 3: Blood pressure measurement

Measurement of arterial pressure by auscultation method. Blood pressure measurements by the direct method- video recording.

Practical 4: Urine analysis

Normal composition of urine and urine sediment. Analysis of kidney function based on a urine tests.

Practical 5: Spirometry

Measurement of lung volumes and capacities using a spirometer and Biopac. Spirogram analysis (lung volumes and capacities). Measurement of FVC, FEV1 and MVV.

Students' obligations:

The students are obliged to attend classes regularly (maximum 30% of teaching hours may be absent), and to prepare material that is discussed in seminars and practicals. To access the final



exam, it is necessary to collect at least 50% of the total ECTS points during classes (minimally 35 points), and at the final exam it is necessary to satisfy at least 50% of both the written and oral part of the exam.

Assessment (exams, description of written / oral / practical exam, the scoring 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 will be assessed and graded during the course and on the final exam. During the course, students may obtain a total of 100 grade points. Students may achieve up to 50 grade points during classes, and up to 50 grade points at the final exam.

I. Evaluation during the course (maximum of 50 grade points):

During classes, acquired knowledge will be evaluated on two tests: Test 1 (1st midterm exam): Heart and Circulation (lectures 1–8, seminars 1–2 and practicals 1–3) – a student may obtain a maximum of 25 grade points; Test 2 (2nd midterm exam): Kidney, Respiration, and Acid-base Balance (lectures 9–15, seminars 3–5 and practicals 4–5) – a student may obtain a maximum of 25 grade points.

A student may access the correction of the first and the second midterm exam if they did not obtain a minimum number of grade points for accessing the final exam, if they did not access the midterm exam, or if they are not satisfied with the obtained grade points. If a student retakes the midterm exam because they are not satisfied with the obtained grade points, only the grade points obtained from the retaken midterm will be considered.

Up to 25 points can be "earned" on each midterm exam as follows:

Correct answers	Grade points
39, 40	25
37, 38	24
35, 36	23
33, 34	22
31, 32	21
30	20
29	19
28	18
27	17
26	16
24, 25	15
22, 23	14
20, 21	13

Midterm exams:

- I. **10.12.2026.**
- II. **21.12.2026.**



II. Final exam (up to 50 grade points)

Students who have earned 25-50 points during the course must take the final exam where they receive additional points. Students who achieved less than 25 points during classes or missed more than 30% of classes are not eligible to take the final exam (unsuccessful/failed F). The final exam evaluates specific competencies that are established for each section, and it consists of a written and an oral part. The student is required to demonstrate at least 50% of knowledge, skills and competencies in written and at least 50% of knowledge, skills and competencies in the oral part of the exam.

A) Written part consists of 50 questions, and grade points (minimum of 20 – maximum of 40) are obtained if the student solves correctly more than 50% of questions as shown in the table:

Correct answers	Grade points
49, 50	40
47, 48	39
45, 46	38
44	37
43	36
42	35
41	34
40	33
39	32
38	31
37	30
36	29
35	28
34	27
33	26
32	25
31	24
30	23
29	22
27, 28	21
25, 26	20

B) A student may access the oral part of the final exam if they obtained a minimum of 20 grade points at the written part of the final exam. At the oral part of the final exam, a student may obtain grade points as shown in the Table:

ORAL EXAM GRADE	GRADE POINTS
5	9, 10
4	8
3	7



2	5, 6
1	0

In order to pass the final exam, a student must achieve a minimum of 20 grade points at the written part and a minimum of 5 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 represents a sum of all grade points (ECTS credits) obtained during classes and at the final exam:

FINAL GRADE		
90-100 pints	A	excellent (5)
75-89,99 points	B	very good (4)
60-74,99 points	C	good (3)
50-59,99 points	D	sufficient (2)
less than 50 points	F	failed (1)

Other important information regarding to the course:

Course content and all the notifications regarding the course may be found on the Share-portal for internal communication of the Department of Physiology and Immunology as well as on the Merlin.

COURSE SCHEDULE (for the academic year 2026/2027)

Date	Lectures (time and place)	Seminars (time and place)	Practicals (time and place)	Instructor
30.11.2026.	L1 (12:00-13:30) S			Prof. G. Blagojević Zagorac, MD
	L2 (13:45-15:15) S			Prof. G. Blagojević Zagorac, MD
01.12.2026.	L3 (10:00-11:30) S			Prof. J. Ravlić-Gulan, MD
		S1 (11:45-14:00) S		Prof. G. Blagojević Zagorac, MD
02.12.2026.			P1 (08:00-10:15) V	Prof. G. Blagojević Zagorac, MD
	L4 (10:30-12:00) S			Prof. J. Ravlić-Gulan, MD
03.12.2026.	L5 (15:00-16:30) S			Prof. G. Blagojević Zagorac, MD
	L6 (16:45-18:15) S			Prof. G. Blagojević Zagorac, MD



04.12.2026.	L7 (11:00-12:30) S			Assistant professor, B. Ćurko-Cofek, MD
		S2 (12:45-15:00) S		Prof. G. Blagojević Zagorac, MD
07.12.2026.	L8 (15:15-16:45) S			Prof. J. Ravlić-Gulan, MD
			P2 (12:30-14:15) V	Prof. H. Jakovac, MD
08.12.2026.			P3 (08:00-10:15) V	S. Lukanović Jurić, MD, PhD
09.12.2026.				
10.12.2026.	PARTIAL EXAM I			
11.12.2026.	L9 (11:00-12:30) S			Prof. G. Blagojević Zagorac, MD
	L10 (12:45-14:15) S			Prof. G. Blagojević Zagorac, MD
14.12.2026.	L11 (12:30-14:00) S			Prof. H. Jakovac, MD
		S3 (14:15-16:30) S		Prof. G. Blagojević Zagorac, MD
15.12.2026.			P4 (08:15-10:30) V	S. Lukanović Jurić, MD, PhD
	L12 (10:45-12:15) S			Prof. G. Blagojević Zagorac, MD
16.12.2026.	L13 (8:15-9:45) S			Prof. G. Blagojević Zagorac, MD
	L14 (10:00-11:30) S			Prof. G. Blagojević Zagorac, MD
17. 12. 2026.			P5 (10:15-12:30) S	Prof. G. Blagojević Zagorac, MD
		S4 (8:00-10:15) S		Assistant professor, B. Ćurko-Cofek, MD
18.12.2026.	L15 (8:15-09:45) S			Prof. Z. Trobonjača, MD
		S5 (10:00-12:15) S		Prof. Z. Trobonjača, MD
21.12.2026.	PARTIAL EXAM II			
22.12.2026.	FINAL EXAM			



List of lectures, seminars and practicals:

	LECTURES (Topics)	Teaching hours	Location/Lecture room
1.	Heart structure, cardiac cycle, regulation of heart work.	2	Seminar room
2.	Generation of electrical impulses in the heart and basic principles of electrocardiography (ECG)	2	Seminar room
3.	Disorders of the generation of electrical impulses in the heart and their ECG interpretation	2	Seminar room
4.	Basic principles of circulation, pressure and blood flow	2	Seminar room
5.	Microcirculation and regulation of local tissue flow	2	Seminar room
6.	Regulation of cardiac minute volume and venous return	2	Seminar room
7.	Regulation of blood pressure and blood pressure disorders	2	Seminar room
8.	Pathophysiology of the cardiovascular system	2	Seminar room
9.	Overview of physiology of renal system I	2	Seminar room
10.	Overview of physiology of renal system II	2	Seminar room
11.	Pathophysiology of the urinary tract	2	Seminar room
12.	Physiology of respiration I	2	Seminar room
13.	Physiology of respiration II	2	Seminar room
14.	Pathophysiology of respiratory system	2	Seminar room
15.	Regulation of acid-base balance	2	Seminar room
	TOTAL TEACHING HOURS	30	

	SEMINARS (Topics)	Teaching hours	Location/Lecture room
1.	Events during the heart cycle	3	Seminar room
2.	Circulatory shock and other emergencies in ordination of dental medicine	3	Seminar room
3.	Dental care for patients with renal diseases	3	Seminar room
4.	Oral health and pulmonary diseases	3	Seminar room
5.	Acid-base disorders	3	Seminar room
	TOTAL TEACHING HOURS	15	



	PRACTICALS (Topics)	Teaching hours	Location/Lecture room
1.	Electrocardiography (ECG)	3	Practical room
2.	ECG and pulse	3	Practical room
3.	Blood pressure measurement	3	Practical room
4.	Urine analysis	3	Practical room
5.	Spirometry	3	Seminar room
	TOTAL TEACHING HOURS	15	

	FINAL EXAM DATES
1.	22.12.2026.
2.	
3.	



Sveučilište u Rijeci
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	Lectures	Seminars	Practicals	Total
Total number	30	15	15	60
On-line				
Percentage				