MEDICINAL CHEMISTRY 1

PHARMACY
INTEGRATED ACADEMIC STUDIES

THE SECOND YEAR OF STUDIES

2025/2026

Course Name:

MEDICINAL CHEMISTRY 1

Medicinal chemistry 7 ECTS. There are 4 hours of active classes per week (2 hours of lectures and 2 hours of work in a small group)

TEACHERS AND ASSOCIATES WHO PERFORM TEACHING:

	Name and surname	Email	
1.	Slobodan Novokmet	slobodan.novokmet@fmn.kg.ac.rs	Full Professor
2.	Isidora Milosavljevic	isidora.milosavljevic@fmn.kg.ac.rs	Associate Professor
3.	Jovana Novakovic	jovana.novakovic@fmn.kg.ac.rs	Assistant Professor
4.	Maja Savic	maja.savic@fmn.kg.ac.rs	Assistant Professor
5.	Nevena Lazarevic	nevena.lazarevic@fmn.kg.ac.rs	Assistant Professor
6.	Jelena Terzic	jelena.terzic@fmn.kg.ac.rs	Junior Teaching Assistant

COURSE STRUCTURE:

Title	Week	Lectures	Small group work	Teachers
Medicinal chemistry 1	15	2	2	Assoc. Prof. Isidora Milosavljevic Ass. Prof. Jovana Novakovic
				Σ 30+30=60

GRADING SYSTEM:

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

PRE-EXAM OBLIGATIONS:
Activity during class - maximum 20 points
2 tests that include material covered in lectures 30 points

FINAL EXAM:
Final written exam - maximum 50 points.

Medicinal chemistry 1	**MAXIMUM POINTS**			
	Activity during class	**Test**	**Final written exam**	**Σ**
	4 x 5	30	50	
Σ	**20**	**30**	**50**	**100**

The final grade is formed as follows:

In order to pass the course, the student must obtain a minimum of 51 points.
In order to pass the course, the student must:
1. acquires more than 50% of the points (25.5 points) provided for the pre-exam activity (Activity during class and Test)
2. acquires more than 50% of the points (25.5 points) provided for the written final exam

Points	**grade**
0 - 50	**5**
51 - 60	**6**
61 - 70	**7**
71 - 80	**8**
81 - 90	**9**
91 - 100	**10**

LITERATURE:

TEXTBOOKS	THE AUTHORS	PUBLISHER	THE LIBRARY
Introduction to Medicinal Chemistry, 4th Edition.	Patrick GL (Ed)	Oxford: University Press; 2009	**Yes**
Essentials of Pharmaceutical Chemistry, 3rd Edition.	Cairns D (Ed)	London, Chicago: Pharmaceutical Press; 2008	**Yes**
Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry, 12th Edition.	Beale JM, Block JH (Eds)	Philadelphia: Lippincott Williams & Wilkins; 2011	**Yes**
Fundamentals of Medicinal Chemistry	Thomas G (Ed)	London, United Kingdom, 2003	**Yes**
All lectures and material for group work are available on the website of the Faculty of Medical Sciences: www.medf.kg.ac.rs			

THE PROGRAM

TEACHING UNIT 1:

INTRODUCTION TO MEDICINAL CHEMISTRY

Lectures - 2 hours	Work in a small group - 2 hours
This lesson provides an overview of medicinal chemistry as a discipline at the intersection of chemistry, biology, and pharmacology. It introduces basic concepts such as the role of drug molecules, their interaction with biological targets, and the importance of chemical structure in drug action and design.	Discussion: What is medicinal chemistry and how does it differ from pharmacology? Analyzing the structure of a simple drug and identifying key functional groups. Matching drug names with their therapeutic classes and general mechanisms of action.

TEACHING UNIT 2:

FUNCTIONAL GROUPS

Lectures - 2 hours	Work in a small group - 2 hours
This lesson introduces the basic functional groups commonly found in drug molecules. Understanding functional groups is essential for predicting chemical reactivity, solubility, acid-base properties, and the interaction of drugs with biological targets.	Identifying functional groups in the structures of common drugs. Classifying functional groups as acidic, basic, or neutral. Drawing and naming simple organic compounds containing key functional groups (e.g. alcohols, amines, carboxylic acids, esters, amides).

TEACHING UNIT 3:

PHYSICO-CHEMICAL PROPERTIES OF DRUGS: ACIDITY AND BASICITY OF FUNCTIONAL GROUPS

Lectures - 2 hours	Work in a small group - 2 hours
This lesson focuses on the acidic and basic behavior of functional groups commonly found in drug molecules. Understanding the acid-base properties is essential for predicting drug ionization, solubility, absorption, and interaction with biological targets at physiological pH.	Identifying acidic and basic functional groups in drug structures. Estimating pKa values and predicting ionization at physiological pH. Comparing drug molecules based on their acid-base properties and discussing their influence on pharmacokinetics.

TEACHING UNIT 4:

PHYSICO-CHEMICAL PROPERTIES OF DRUGS: IONIZATION

Lectures - 2 hours	Work in a small group - 2 hours
This lesson covers the concept of ionization of drug molecules, explaining how drugs can exist in ionized or non-ionized forms depending on the pH of the environment and their pKa values. Ionization influences drug solubility, absorption, distribution, and interaction with targets.	Calculating the degree of ionization of acidic and basic drugs at different pH values using the Henderson-Hasselbalch equation. Predicting the ionization state of given drugs in various body compartments (stomach, blood, intestine). Discussing how ionization affects drug absorption and distribution.

TEACHING UNIT 5:

PHYSICO-CHEMICAL PROPERTIES OF DRUGS: LIPOPHILICITY

Lectures - 2 hours	Work in a small group - 2 hours
This lesson introduces lipophilicity as a key property that influences a drug's ability to cross biological membranes. Lipophilicity affects absorption, distribution, metabolism, and excretion. Concepts such as partition coefficient (log P) and distribution coefficient (log D) are explained, along with their relevance in drug design.	Calculating or interpreting log P and log D values for different drug molecules. Comparing the lipophilicity of drug pairs and predicting their membrane permeability. Discussing how lipophilicity impacts drug pharmacokinetics and pharmacodynamics.

TEACHING UNIT 6:

PHYSICO-CHEMICAL PROPERTIES OF DRUGS: SOLUBILITY

Lectures - 2 hours	Work in a small group - 2 hours
This lesson covers the importance of solubility in drug absorption and bioavailability. It explains the factors affecting solubility, such as temperature, pH, and the chemical nature of the drug, and discusses how solubility influences drug formulation and delivery.	Classifying drugs based on their water solubility. Predicting the effect of pH changes on solubility for acidic and basic drugs. Designing simple experiments to compare solubility of different compounds in water and organic solvents.

TEACHING UNIT 7:

BIOTRANSFORMATION OF DRUG MOLECULES: BIOACTIVATION AND PRODRUGS

Lectures - 2 hours	Work in a small group - 2 hours
This lesson introduces the concept of bioactivation, where drugs are metabolically converted into active forms, and prodrugs, which are administered in an inactive form and require metabolic transformation to exert their therapeutic effect. The mechanisms, advantages, and examples of prodrugs are discussed, emphasizing their role in improving drug properties such as solubility, stability, and targeted delivery.	Analyzing metabolic pathways of selected prodrugs and identifying enzymes involved in their activation. Case studies: comparing the pharmacokinetics of a prodrug and its active metabolite. Discussing clinical scenarios where prodrugs offer therapeutic advantages.

TEACHING UNIT 8:

BIOTRANSFORMATION OF DRUG MOLECULES: BIO-OXIDATION

Lectures - 2 hours	Work in a small group - 2 hours
This lesson focuses on Phase I biotransformation reactions, specifically bio-oxidation processes where enzymes like cytochrome P450 oxidases introduce or expose functional groups in drug molecules. These oxidative reactions often prepare drugs for further metabolism or excretion by increasing their polarity.	Identifying common oxidative reactions such as hydroxylation, N-oxidation, and dealkylation. Mapping metabolic pathways of drugs undergoing bio-oxidation. Predicting sites of oxidation on given drug structures.

TEACHING UNIT 9:

BIOTRANSFORMATION OF DRUG MOLECULES: BIOREDUCTION, BIOHYDROLYSIS AND BIOHYDRATION

Lectures - 2 hours	Work in a small group - 2 hours
This lesson covers Phase I metabolic reactions including bioreduction, biohydrolysis, and biohydration. Bioreduction involves the enzymatic reduction of drug molecules, often under low oxygen conditions. Biohydrolysis refers to the enzymatic cleavage of ester and amide bonds, while biohydration involves the enzymatic addition of water to double bonds. These reactions modify drug molecules to alter their activity or prepare them for Phase II conjugation.	Identifying drug structures susceptible to bioreduction, hydrolysis, or hydration. Analyzing enzyme types responsible for these reactions. Case studies on drugs metabolized through these pathways.

TEACHING UNIT 10:

PHASE II DRUG BIOTRANSFORMATION – CONJUGATION REACTIONS

Lectures - 2 hours	Work in a small group - 2 hours
This lesson introduces Phase II biotransformation, where drug molecules or their Phase I metabolites undergo conjugation with endogenous substrates such as glucuronic acid, sulfate, acetyl groups, methyl groups, amino acids, or glutathione. These reactions increase drug water solubility, facilitating elimination.	Identifying functional groups suitable for conjugation. Classifying examples of drugs according to the type of conjugation they undergo. Diagram completion: match conjugation reactions with enzymes and co-substrates.

TEACHING UNIT 11:

ENZYMES AND CO-SUBSTRATES IN CONJUGATION REACTIONS

Lectures - 2 hours	Work in a small group - 2 hours
This lesson focuses on the main enzymes involved in Phase II conjugation reactions, such as UGTs, SULTs, NATs, and methyltransferases. It explains the role of co-substrates like UDP-glucuronic acid, PAPS, acetyl-CoA, and SAM in forming water-soluble drug metabolites.	Matching enzymes with their conjugation reactions and co-substrates. Predicting which conjugation pathway a drug will follow based on its structure. Discussion: why certain drugs undergo glucuronidation vs. sulfation.

TEACHING UNIT 12:

MOLECULAR-CHEMICAL BASIS OF THE MECHANISM OF DRUG ACTION: RECEPTORS

Lectures - 2 hours	Work in a small group - 2 hours
This lesson explores how drugs exert their effects by interacting with specific biological receptors. It covers receptor types, binding sites, and the molecular interactions involved, such as hydrogen bonding, ionic interactions, and hydrophobic forces. The concept of agonists, antagonists, and receptor selectivity is introduced to explain drug efficacy and potency.	Identifying different receptor types and their ligands. Analyzing drug-receptor binding interactions using molecular models or diagrams. Comparing agonists and antagonists based on their chemical structures and effects.

TEACHING UNIT 13:

MOLECULAR-CHEMICAL BASIS OF THE MECHANISM OF DRUG ACTION: ENZYMES, NUCLEIC ACIDS

Lectures - 2 hours	Lectures - 2 hours
This lesson focuses on how drugs interact with enzymes and nucleic acids to produce therapeutic effects. It explains enzyme inhibition (competitive, non-competitive) and activation, as well as drug interactions with DNA and RNA that affect replication and transcription. Key molecular interactions and examples of drugs targeting enzymes or nucleic acids are discussed.	Classifying drugs based on their mechanism of enzyme inhibition. Exploring examples of nucleic acid-targeting drugs and their modes of action. Analyzing molecular structures to predict potential enzyme or nucleic acid interactions.

TEACHING UNIT 14:

NATURAL REMEDIES

Lectures - 2 hours	Work in a small group - 2 hours
This lesson introduces natural remedies derived from plants, animals, and minerals used for therapeutic purposes. It covers the chemical constituents responsible for biological activity, their mechanisms of action, and the challenges in standardization and quality control. The role of natural remedies in modern medicine and their integration with conventional therapies is also discussed.	Identifying active compounds in common medicinal plants. Discussing advantages and limitations of natural remedies compared to synthetic drugs. Case studies analyzing the pharmacological effects of selected herbal extracts.

TEACHING UNIT 15:

RECAPITULATION

Lectures - 2 hours	Work in a small group - 2 hours
This lesson serves as a comprehensive review of the key concepts covered throughout the course. It summarizes fundamental principles of medicinal chemistry, drug biotransformation, mechanisms of drug action, and physico-chemical properties of drugs, reinforcing student understanding and preparing them for exams..	Quiz covering major topics from the course. Group discussions and problem-solving sessions to integrate knowledge. Case studies applying multiple concepts to drug design and metabolism.

LECTURE SCHEDULE						
Week	**Date**	**Time**	**Place**	**Type**	**Teaching Unit 1**	**Teacher**
1				**L**	Introduction to Medicinal Chemistry	Ass. Prof. Jovana Novakovic
				WSG	Introduction to Medicinal Chemistry	Ass. Prof. Jovana Novakovic Assoc. Prof. Isidora Milosavljevic
2				**L**	Functional groups	Ass. Prof. Jovana Novakovic
				WSG	Functional groups	Ass. Prof. Jovana Novakovic Assoc. Prof. Isidora Milosavljevic
3				**L**	Physico-chemical properties of drugs: acidity and basicity of functional groups.	Assoc. Prof. Isidora Milosavljevic
				WSG	Physico-chemical properties of drugs: acidity and basicity of functional groups.	Assoc. Prof. Isidora Milosavljevic Ass. Prof. Jovana Novakovic
4				**L**	Physico-chemical properties of drugs: ionization.	Assoc. Prof. Isidora Milosavljevic
				WSG	Physico-chemical properties of drugs: ionization.	Assoc. Prof. Isidora Milosavljevic Ass. Prof. Jovana Novakovic
5				**L**	Physico-chemical properties of drugs: lipophilicity.	Ass. Prof. Jovana Novakovic
				WSG	Physico-chemical properties of drugs: lipophilicity.	Ass. Prof. Jovana Novakovic Assoc. Prof. Isidora Milosavljevic
6				**L**	Physico-chemical properties of drugs: solubility.	Ass. Prof. Jovana Novakovic

LECTURE SCHEDULE						
Week	**Date**	**Time**	**Place**	**Type**	**Teaching Unit 1**	**Teacher**
				WSG	Physico-chemical properties of drugs: solubility.	Ass. Prof. Jovana Novakovic Assoc. Prof. Isidora Milosavljevic
7				**L**	Biotransformation of drug molecules	Assoc. Prof. Isidora Milosavljevic
				WSG	Biotransformation of drug molecules: biooxidation and prodrugs	Assoc. Prof. Isidora Milosavljevic Ass. Prof. Jovana Novakovic
8				**L**	Biotransformation of drug molecules: biooxidation and prodrugs	Assoc. Prof. Isidora Milosavljevic
				WSG	Biotransformation of drug molecules: biooxidation.	Assoc. Prof. Isidora Milosavljevic Ass. Prof. Jovana Novakovic
Test						
9				**L**	Biotransformation of drug molecules: bioreduction, biohydrolysis and biohydration.	Ass. Prof. Jovana Novakovic
				WSG	Biotransformation of drug molecules: bioreduction, biohydrolysis and biohydration.	Ass. Prof. Jovana Novakovic Assoc. Prof. Isidora Milosavljevic
10				**L**	Phase II Drug Biotransformation – Conjugation Reactions	Ass. Prof. Jovana Novakovic

LECTURE SCHEDULE						
Week	**Date**	**Time**	**Place**	**Type**	**Teaching Unit 1**	**Teacher**
				WSG	Phase II Drug Biotransformation – Conjugation Reactions	Ass. Prof. Jovana Novakovic Assoc. Prof. Isidora Milosavljevic
11				**L**	Enzymes and Co-substrates in Conjugation Reactions	Assoc. Prof. Isidora Milosavljevic
				WSG	Enzymes and Co-substrates in Conjugation Reactions	Assoc. Prof. Isidora Milosavljevic Ass. Prof. Jovana Novakovic
12				**L**	Molecular-chemical basis of the mechanism of drug action: receptors	Ass. Prof. Nevena Lazarevic
				WSG	Molecular-chemical basis of the mechanism of drug action: receptors	Assoc. Prof. Isidora Milosavljevic Ass. Prof. Jovana Novakovic Ass. Prof. Nevena Lazarevic
13				**L**	Molecular-chemical basis of the mechanism of drug action: enzymes, nucleic acids	Assoc. Prof. Isidora Milosavljevic
				WSG	Molecular-chemical basis of the mechanism of drug action: enzymes, nucleic acids	Ass. Prof. Jovana Novakovic Assoc. Prof. Isidora Milosavljevic
14				**L**	Natural remedies	Ass. Prof. Nevena Lazarevic
				WSG	Natural remedies	Ass. Prof. Jovana Novakovic Assoc. Prof. Isidora Milosavljevic Ass. Prof. Nevena Lazarevic

LECTURE SCHEDULE						
Week	**Date**	**Time**	**Place**	**Type**	**Teaching Unit 1**	**Teacher**
15				**L**	Recapitulation	Assoc. Prof. Isidora Milosavljevic
				WSG	Recapitulation	Assoc. Prof. Isidora Milosavljevic Ass. Prof. Jovana Novakovic
					Final written exam	