



**INTEGRATED ACADEMIC STUDIES OF  
PHARMACY**

**SECOND YEAR OF STUDY**

2023/2024.

**PHARMACEUTICAL CHEMISTRY 1**

Course:

## **PHARMACEUTICAL CHEMISTRY 1**

The course is evaluated with 5 ECTS. There are 5 classes of active teaching per week (2 classes of lectures, 1 class of seminar and 2 classes of work in a small group)

## TEACHING STAFF:

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	Name and surname	Email addresses	Title
1.	Miloš V. Nikolić	milos.nikolic@medf.kg.ac.rs	Associate Professor - Course chief
2.	Nevena S. Jeremić	nbarudzic@hotmail.com	Associate Professor
3.	Marina Ž. Vesović	marina.mijajlovic@medf.kg.ac.rs	Associate Professor
4.	Nikola Nedeljković	nikola.nedeljkovic@medf.kg.ac.rs	Teaching Assistant
5.	Ana Živanović	ana.zivanovic@medf.kg.ac.rs	Teaching Associate

## COURSE STRUCTURE:

Module	Name of module	Week	Lectures weekly	Seminars weekly	Work in small group	Teacher-module supervisor
1	Introduction to pharmaceutical chemistry and its importance. Strategies in drug design. Computer-aided design and detection of molecules. Relationship between functional groups and pharmacological activity of drugs. Membrane drug transporters. Receptors. Enzymes. Steroid hormones. Women's health. Men's health. Corticosteroids. Peptide hormones. Insulin and drugs for the regulation of diabetes. Thyroid function. Thyroid drugs. Calcium homeostasis. $\beta$ -lactam antibiotics.	7	2	1	2	Nevena S. Jeremić
2	Aminoglycoside and macrolide antibiotics. Tetracyclines. Antibiotics of peptide and other structures. Sulfonamides. Quinolones and oxazolidinones. Antimycobacterial drugs. Antimycotics and antiparasitics. Antiseptics and disinfectants. Nutrition and obesity. Pharmaceutical chemistry of plants.	8	2	1	2	Miloš V. Nikolić
						$\Sigma$ 30+15+30=75

## EVALUATION:

The student overcomes the subject by modules. The grade is equivalent to the number of points earned (see tables). Points are earned in three ways:

**ACTIVITY DURING EXERCISES:** In this way, the student can gain up to 15 points during exercises that will be evaluated weekly on an oral examination in a scale of 0 to 1 point (the minimum for a passed activity is 3.75 points within the first module and 4.25 points within the second module).

**FINAL TESTS BY MODULES:** In this way, the student can gain up to 55 points, according to the attached table. In accordance with the demonstrated knowledge, the tasks on the module tests are scored from 0-2 points.

**FINAL EXAM:** In this way, the student can earn up to 30 points, according to the attached table. In accordance with the demonstrated knowledge, the tasks on the final exam are scored from 0-2 points.

MODULE		MAXIMUM OF POINTS		
		activity during exercises	final test	Σ
1	Introduction to pharmaceutical chemistry and its importance. Strategies in drug design. Computer-aided design and detection of molecules. Relationship between functional groups and pharmacological activity of drugs. Membrane drug transporters. Receptors. Enzymes. Steroid hormones. Women's health. Men's health. Corticosteroids. Peptide hormones. Insulin and drugs for the regulation of diabetes. Thyroid function. Thyroid drugs. Calcium homeostasis. β-lactam antibiotics.	7 (minimum 3.75 points)	26 (minimum 13.5 points)	<b>33</b>
2	Aminoglycoside and macrolide antibiotics. Tetracyclines. Antibiotics of peptide and other structures. Sulfonamides. Quinolones and oxazolidinones. Antimycobacterial drugs. Antimycotics and antiparasitics. Antiseptics and disinfectants. Nutrition and obesity. Pharmaceutical chemistry of plants.	8 (minimum 4.25 points)	29 (minimum 15 points)	<b>37</b>
<b>FINAL EXAM</b>			30 (minimum 15.5 points)	<b>30</b>
<b>Σ</b>		15	85	<b>100</b>

**Note:**

**If the student did not pass the module activity during exercises he will pass it on the day of the exam. Only students who have previously passed all module activities and module tests can take the final exam.**

**The final grade is formed as follows:**

To pass the course, the student has to obtain a minimum of 51 points and pass all modules as well as the final exam.

To pass the module the student has to:

1. obtain more than 50% points in that module
2. obtain more than 50% of the points predicted for the activity during exercises in each module
3. pass the module test, i.e. has more than 50% correct answers.

To pass the final exam, the student has to:

1. Obtain more than 50% points in that final exam

<b>Number of points</b>	<b>Grade</b>
0 - 50	<b>5</b>
51 - 60	<b>6</b>
61 - 70	<b>7</b>
71 - 80	<b>8</b>
81 - 90	<b>9</b>
91 - 100	<b>10</b>

## **TESTS BY MODULES**

### **MODULE 1.**

**FINAL TEST of module 1  
0-26 POINTS**

#### **EVALUATION OF THE FINAL TEST**

Each question is scored 0-2 points

### **MODULE 2.**

**FINAL TEST of module 2  
0-29 POINTS**

#### **EVALUATION OF THE FINAL TEST**

Each question is scored 0-2 points

## LITERATURE:

Module	Module name	Textbook title	Authors	Publisher	Library
1	Introduction to pharmaceutical chemistry and its importance. Strategies in drug design. Computer-aided design and detection of molecules. Relationship between functional groups and pharmacological activity of drugs. Membrane drug transporters. Receptors. Enzymes. Steroid hormones. Women's health. Men's health. Corticosteroids. Peptide hormones. Insulin and drugs for the regulation of diabetes. Thyroid function. Thyroid drugs. Calcium homeostasis. $\beta$ -lactam antibiotics.	Wilson and Gisvold's textbook of organic medicinal and pharmaceutical chemistry.	John M. Beale John H. Block	Lippincott Williams & Wilkins; 2011.	
		Foye's Principles of Medicinal Chemistry	Thomas Lemke	Wolters Kluwer. 2013.	
		Pharmaceutical and medicinal chemistry.	David G. Watson	Churchill Livingstone; 2011.	
2	Aminoglycoside and macrolide antibiotics. Tetracyclines. Antibiotics of peptide and other structures. Sulfonamides. Quinolones and oxazolidinones. Antimycobacterial drugs. Antimycotics and antiparasitics. Antiseptics and disinfectants. Nutrition and obesity. Pharmaceutical chemistry of plants.	Wilson and Gisvold's textbook of organic medicinal and pharmaceutical chemistry	John M. Beale John H. Block	Lippincott Williams & Wilkins; 2011.	
		Foye's Principles of Medicinal Chemistry	Thomas Lemke	Wolters Kluwer. 2013	
		Pharmaceutical and medicinal chemistry	David G. Watson	Churchill Livingstone; 2011.	

All lectures can be found on the website of the Faculty of Medicine: [www.medf.kg.ac.rs](http://www.medf.kg.ac.rs)

# THE PROGRAM

**FIRST MODULE: Introduction to pharmaceutical chemistry and its importance. Strategies in drug design. Computer-aided design and detection of molecules. Relationship between functional groups and pharmacological activity of drugs. Membrane drug transporters. Receptors. Enzymes. Steroid hormones. Women's health. Men's health. Corticosteroids. Peptide hormones. Insulin and drugs for the regulation of diabetes. Thyroid function. Thyroid drugs. Calcium homeostasis.  $\beta$ -lactam antibiotics.**

## TEACHING UNIT 1 (FIRST WEEK):

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**INTRODUCTION TO PHARMACEUTICAL CHEMISTRY AND ITS IMPORTANCE. RELATIONSHIP BETWEEN FUNCTIONAL GROUPS AND PHARMACOLOGICAL ACTIVITY OF DRUGS. STRATEGIES IN DRUG DESIGN.**

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Lectures: 2 classes

Seminar: 1 class

Exercises: 2 classes

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- Introduction to pharmaceutical chemistry and its importance
  - Strategies in drug design
  - Computer-aided design and detection of molecules
  - Relationship between functional groups and pharmacological activity of drugs
  - General overview of the most important functional groups
  - pH values of body fluids
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## TEACHING UNIT 2 (SECOND WEEK):

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**MEMBRANE DRUG TRANSPORTERS. RECEPTORS. ENZYMES.**

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Lectures: 2 classes

Seminar: 1 class

Exercises: 2 classes

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- Types of membrane transporters
  - Receptors.
  - Covalent and ionic bonding
  - Hydrophobic interactions
  - Hydrogen bonding
  - The role of conformational changes
  - The role of stereochemistry
  - The most important classes of receptors
  - Enzymes
  - Reversible and irreversible enzyme inhibition
  - Antimetabolites
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## TEACHING UNIT 3 (THIRD WEEK):

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**STEROID HORMONES. WOMEN'S HEALTH.**

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Lectures: 2 classes

Seminar: 1 class

Exercises: 2 classes

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- Nomenclature of steroids (steroidal hydrocarbons)
  - Steroid hormones (biosynthesis of steroid hormones)
  - Female sex hormones
  - Aromatase inhibitors
  - Sterility therapy
  - Progesterone antagonists
  - Progestins
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**TEACHING UNIT 4 (FOURTH WEEK):****MEN'S HEALTH. CORTICOSTEROIDS.**

Lectures: 2 classes	Seminar: 1 class	Exercises: 2 classes
<ul style="list-style-type: none"><li>• Male sex hormones</li><li>• Biosynthesis of androgens</li><li>• Androgen metabolism</li><li>• Steroidal androgens</li><li>• Non-steroidal androgens</li><li>• Anabolics</li><li>• Antiandrogens</li><li>• Medicines in the therapy of erectile dysfunction</li><li>• Corticosteroids (connection between structure and action, structural modifications, oxidation and reduction reactions)</li><li>• Adrenocorticosteroids</li></ul>		

**TEACHING UNIT 5 (FIFTH WEEK):****PEPTIDE HORMONES. ANTIHYPERGLYCEMICS AND THYROSTATICS.**

Lectures: 2 classes	Seminar: 1 class	Exercises: 2 classes
<ul style="list-style-type: none"><li>• Peptide hormones and synthetic analogues</li><li>• Hypothalamic hormones</li><li>• Pituitary hormones</li><li>• Placental hormones</li><li>• Pancreatic hormones</li><li>• Biguanidine derivatives</li><li>• Sulphonylurea derivatives</li><li>• Newer sulfonamides and carboxamide derivatives</li><li>• Thiazolidinedione derivatives</li><li>• Artificial sweeteners</li><li>• Peptide hormones in calcium homeostasis</li><li>• Thyroid hormones (connection between structure and action, thyrostatics)</li></ul>		

**TEACHING UNIT 6 (SIXTH WEEK):** **$\beta$ -LACTAM ANTIBIOTICS (FIRST PART).**

Lectures: 2 classes	Seminar: 1 class	Exercises: 2 classes
<ul style="list-style-type: none"><li>• <math>\beta</math>-lactam antibiotics</li><li>• Penicillins</li><li>• <math>\beta</math>-lactamase inhibitors</li></ul>		

**TEACHING UNIT 7 (SEVENTH WEEK):** **$\beta$ -LACTAM ANTIBIOTICS (SECOND PART).**

Lectures: 2 classes	Seminar: 1 class	Exercises: 2 classes
<ul style="list-style-type: none"><li>• Cephalosporins</li><li>• Carbapenem and monobactam antibiotic derivatives</li></ul>		



**SECOND MODULE: Aminoglycoside and macrolide antibiotics. Tetracyclines. Antibiotics of peptide and other structures. Sulfonamides. Quinolones and oxazolidinones. Antimycobacterial drugs. Antimycotics and antiparasitics. Antiseptics and disinfectants. Nutrition and obesity. Pharmaceutical chemistry of plants.**

**TEACHING UNIT 8 (EIGHTH WEEK):**

**AMINOGLYCOSIDE AND MACROLIDE ANTIBIOTICS.**

Lectures: 2 classes	Seminar: 1 class	Exercises: 2 classes
<ul style="list-style-type: none"> <li>• 2-deoxystreptamine derivatives</li> <li>• 4,6-disubstituted aminoglycosides of 2-deoxystreptamine</li> <li>• 4,5-disubstituted aminoglycosides of 2-deoxystreptamine</li> <li>• Chemical structure and properties of erythromycin</li> <li>• Semi-synthetic analogues of erythromycin A</li> <li>• Lincosamides</li> <li>• Polyene macrolides</li> </ul>		

**TEACHING UNIT 9 (NINTH WEEK):**

**TETRACYCLINES AND ANTIBIOTICS OF PEPTIDE AND OTHER STRUCTURES.**

Lectures: 2 classes	Seminar: 1 class	Exercises: 2 classes
<ul style="list-style-type: none"> <li>• General structure of tetracycline</li> <li>• Chemical properties and stability of tetracycline</li> <li>• Relationship between structure and antimicrobial activity of tetracycline</li> <li>• Mechanism of action</li> <li>• Natural tetracyclines</li> <li>• Semi-synthetic tetracyclines</li> <li>• Anthracyclines</li> <li>• Newer anthracyclines</li> <li>• Mitomycins</li> <li>• Antibiotics with a peptide structure</li> <li>• Bleomycins</li> <li>• Streptocins</li> <li>• Chloramphenicol</li> <li>• Antibiotics of different structure</li> </ul>		

**TEACHING UNIT 10 (TENTH WEEK):**

**SULFONAMIDES. QUINOLONES AND OXAZOLIDINONES.**

Lectures: 2 classes	Seminar: 1 class	Exercises: 2 classes
<ul style="list-style-type: none"> <li>• Chemical properties of sulfonamides</li> <li>• Mechanism of action</li> <li>• Resorption and biotransformation</li> <li>• Relationship between chemical properties and biological activity</li> <li>• Fluoroquinolones</li> <li>• Relationship between structure and action</li> <li>• Basic chemical properties of quinolones</li> <li>• Mechanism of action</li> <li>• Antibacterial activity</li> <li>• Oxazolidinones</li> </ul>		

**TEACHING UNIT 11 (ELEVENTH WEEK):****ANTIMYCOBACTERIAL DRUGS.**

Lectures: 2 classes

Seminar: 1 class

Exercises: 2 classes

- Antimycobacterial drugs

**TEACHING UNIT 12 (ELEVENTH WEEK):****ANTIMYCOTICS AND ANTIPARASITICS.**

Lectures: 2 classes

Seminar: 1 class

Exercises: 2 classes

- Antimycotics (azoles, allylamine derivatives, various structures)
- Antiprotozoans
- Anthelmintics
- Pediculocides, scabicides and insecticides

**TEACHING UNIT 13 (THIRTEENTH WEEK)****ANTISEPTICS AND DISINFECTANTS.**

Lectures: 2 classes

Seminar: 1 class

Exercises: 2 classes

- Alcohols, epoxides, and aldehydes
- Phenols
- Preservatives and antioxidants
- Organic oxidizing agents
- Organic halogen compounds
- Organic chlorine compounds
- Organic compounds of mercury
- Surfactants
- Diamidines and guanidine derivatives
- Organic colors
- Derivatives of 5-nitrofurfural
- Uroantiseptics

**TEACHING UNIT 14 (FOURTEENTH WEEK)****NUTRITION AND OBESITY.**

Lectures: 2 classes

Seminar: 1 class

Exercises: 2 classes

- Medicines in obesity therapy
- Micronutrients
- Macronutrients

**TEACHING UNIT 15 (FIFTEENTH WEEK)****PHARMACEUTICAL CHEMISTRY OF PLANTS.**

Lectures: 2 classes

Seminar: 1 class

Exercises: 2 classes

- Medicinally and clinically important plants
- Chemistry of clinically important plants

## **SCHEDULE OF LECTURES AND SEMINARS**

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## **SCHEDULE OF EXERCISES**


## LESSON SCHEDULE FOR THE COURSE PHARMACEUTICAL CHEMISTRY 1

module	week	type	name of the teaching unit	teacher
1	1	L	Introduction to pharmaceutical chemistry and its importance. relationship between functional groups and pharmacological activity of drugs. strategies in drug design.	Nevena Jeremić Miloš Nikolić Marina Vesović
	1	S	Introduction to pharmaceutical chemistry and its importance. relationship between functional groups and pharmacological activity of drugs. strategies in drug design.	Nevena Jeremić Miloš Nikolić Marina Vesović
	1	E	Introduction with the most important tools in drug design.	Nevena Jeremić Miloš Nikolić Marina Vesović Ana Živanović Nikola Nedeljković
	2	L	Membrane drug transporters. Receptors. Enzymes.	Nevena Jeremić Miloš Nikolić Marina Vesović
	2	S	Membrane drug transporters. Receptors. Enzymes.	Nevena Jeremić Miloš Nikolić Marina Vesović
	2	E	Introduction with the most important tools in drug design.	Nevena Jeremić Miloš Nikolić Marina Vesović Ana Živanović Nikola Nedeljković
	3	L	Steroid hormones. Women's health.	Nevena Jeremić Miloš Nikolić Marina Vesović
	3	S	Steroid hormones. Women's health.	Nevena Jeremić Miloš Nikolić Marina Vesović
	3	E	Molecular modeling of drugs with steroid structure.	Nevena Jeremić Miloš Nikolić Marina Vesović Ana Živanović Nikola Nedeljković
	4	L	Men's health. Corticosteroids.	Nevena Jeremić Miloš Nikolić Marina Vesović
	4	S	Men's health. Corticosteroids.	Nevena Jeremić Miloš Nikolić Marina Vesović

## LESSON SCHEDULE FOR THE COURSE PHARMACEUTICAL CHEMISTRY 1

module	week	type	name of the teaching unit	teacher
<b>1</b>	4	<b>E</b>	Molecular modeling of the corticosteroid drugs.	Nevena Jeremić Miloš Nikolić Marina Vesović Ana Živanović Nikola Nedeljković
	5	<b>L</b>	Peptide hormones. antihyperglycemics and thyrostatics.	Nevena Jeremić Miloš Nikolić Marina Vesović
	5	<b>S</b>	Peptide hormones. antihyperglycemics and thyrostatics.	Nevena Jeremić Miloš Nikolić Marina Vesović
	5	<b>E</b>	Molecular modeling of drugs with peptide structure.	Nevena Jeremić Miloš Nikolić Marina Vesović Ana Živanović Nikola Nedeljković
	6	<b>L</b>	β-lactam antibiotics (first part)	Nevena Jeremić Miloš Nikolić Marina Vesović
	6	<b>S</b>	β-lactam antibiotics (first part)	Nevena Jeremić Miloš Nikolić Marina Vesović
	6	<b>E</b>	Molecular modeling of the β-lactam antibiotics.	Nevena Jeremić Miloš Nikolić Marina Vesović Ana Živanović Nikola Nedeljković
	7	<b>L</b>	β-lactam antibiotics (second part)	Nevena Jeremić Miloš Nikolić Marina Vesović
	7	<b>S</b>	β-lactam antibiotics (second part)	Nevena Jeremić Miloš Nikolić Marina Vesović
	7	<b>E</b>	Molecular modeling of the β-lactam antibiotics.	Nevena Jeremić Miloš Nikolić Marina Vesović Ana Živanović Nikola Nedeljković
		<b>FTM</b>	<b>FINAL TEST OF MODULE 1</b>	

## LESSON SCHEDULE FOR THE COURSE PHARMACEUTICAL CHEMISTRY 1

module	week	type	name of the teaching unit	teacher
2	8	L	Aminoglycoside and macrolide antibiotics.	Nevena Jeremić Miloš Nikolić Marina Vesović
	8	S	Aminoglycoside and macrolide antibiotics.	Nevena Jeremić Miloš Nikolić Marina Vesović
	8	E	Molecular modeling of aminoglycosides and macrolides.	Nevena Jeremić Miloš Nikolić Marina Vesović Ana Živanović Nikola Nedeljković
	9	L	Tetracyclines. Antibiotics of peptide and other structures.	Nevena Jeremić Miloš Nikolić Marina Vesović
	9	S	Tetracyclines. Antibiotics of peptide and other structures.	Nevena Jeremić Miloš Nikolić Marina Vesović
	9	E	Molecular modeling of tetracyclines and peptide antibiotics.	Nevena Jeremić Miloš Nikolić Marina Vesović Ana Živanović Nikola Nedeljković
	10	L	Sulfonamides. Quinolones and oxazolidinones.	Nevena Jeremić Miloš Nikolić Marina Vesović
	10	S	Sulfonamides. Quinolones and oxazolidinones.	Nevena Jeremić Miloš Nikolić Marina Vesović
	10	E	Molecular modeling of sulfonamides and quinolones.	Nevena Jeremić Miloš Nikolić Marina Vesović Ana Živanović Nikola Nedeljković
	11	L	Antimycobacterial drugs.	Nevena Jeremić Miloš Nikolić Marina Vesović
	11	S	Antimycobacterial drugs.	Nevena Jeremić Miloš Nikolić Marina Vesović

## LESSON SCHEDULE FOR THE COURSE PHARMACEUTICAL CHEMISTRY 1

module	week	type	name of the teaching unit	teacher
2	11	E	Molecular modeling of antimycobacterial drugs.	Nevena Jeremić Miloš Nikolić Marina Vesović Ana Živanović Nikola Nedeljković
	12	L	Antimycotics and antiparasitics.	Nevena Jeremić Miloš Nikolić Marina Vesović
	12	S	Antimycotics and antiparasitics.	Nevena Jeremić Miloš Nikolić Marina Vesović
	12	E	Molecular modeling of antiparasitic and antimycotic drugs.	Nevena Jeremić Miloš Nikolić Marina Vesović Ana Živanović Nikola Nedeljković
	13	L	Antiseptics and disinfectants.	Nevena Jeremić Miloš Nikolić Marina Vesović
	13	S	Antiseptics and disinfectants.	Nevena Jeremić Miloš Nikolić Marina Vesović
	13	E	Molecular modeling of antiseptics.	Nevena Jeremić Miloš Nikolić Marina Vesović Ana Živanović Nikola Nedeljković
	14	L	Nutrition and obesity.	Nevena Jeremić Miloš Nikolić Marina Vesović
	14	S	Nutrition and obesity.	Nevena Jeremić Miloš Nikolić Marina Vesović
	14	E	Molecular modeling of obesity treatment drugs.	Nevena Jeremić Miloš Nikolić Marina Vesović Ana Živanović Nikola Nedeljković
	15	L	Pharmaceutical chemistry of plants.	Nevena Jeremić Miloš Nikolić Marina Vesović

## LESSON SCHEDULE FOR THE COURSE PHARMACEUTICAL CHEMISTRY 1

module	week	type	name of the teaching unit	teacher
2	15	S	Pharmaceutical chemistry of plants.	Nevena Jeremić Miloš Nikolić Marina Vesović
	15	E	Molecular modeling of cardiotonic glycosides.	Nevena Jeremić Miloš Nikolić Marina Vesović Ana Živanović Nikola Nedeljković
		<b>FTM</b>	<b>FINAL TEST OF MODULE 2</b>	
		<b>FE</b>	<b>FINAL EXAM</b>	