

PHARMACOLOGY	
GENERAL INFORMATION	
Course coordinator	Associate Professor Ines Bilić-Ćurčić, MD, PhD
Assistant/Associate	Professor Martina Smolić, MD, PhD Assoc. Prof. Željko Debeljak, PhD Hrvoje Roguljić, MD, PhD Nikola Raguž Lučić, MD, PhD Tea Omanović Kolarić, MD, PhD Aurora Antolović-Amidžić, MSc Ana Petrović, MD
Study Programme	Integrated undergraduate and graduate university study of Medicine
Status of the course	Mandatory
Year of study, semester	3 rd year, 6 th semester
ECTS	11
Workload (hours)	Lectures (35), seminars (52), exercises (28)
Expected number of students	70
COURSE DESCRIPTION	
Course objectives	
<p>Within the Pharmacology course, students should gain knowledge of general pharmacology, and learn the mechanisms of drug action (pharmacodynamics) and their effects, as well as the fate of drugs in the body (pharmacokinetics). The student will be able to interpret the mechanisms of action, methods of administration, indications, therapeutic effects, side effects and contraindications of the most important groups of drugs. The student will also be trained to recognize side effects and interactions and correctly write prescriptions for different forms of medication. Through the lectures, the student will be familiar with the basic concepts of toxicology and the principles of procedures for poisoning and the application of specific antidotes.</p>	
Enrolment requirements and entry competencies	
There are no special requirements for this course except those defined by the curriculum of the entire study program.	
Learning outcomes at the Programme level	
1.1. 1.2. 2.1. 3.1. 3.2. 3.3. 3.5. 4.1. 4.2.	
Learning outcomes (5-10)	
<ol style="list-style-type: none"> 1. Critically evaluate the general principles and principles of pharmacodynamics and pharmacokinetics and determine and assess the factors modifying drug actions 2. To determine the types and to review the mechanisms of drug actions when drugs are used simultaneously and to link them to clinically significant drug interactions 3. Classify drugs into individual groups/subgroups and describe and explain methods of administration, mechanism of action at the molecular and cellular level, and predict pharmacological effects on various organ systems, main indications, contraindications, side effects and toxicity of individual drugs that are an illustrative example of pharmacotherapeutic groups and subgroup 4. Predict pharmacological effects and valorize side effects, indications and contraindications among drugs from different subgroups within the same drug class and compare them with each other 	

5. Determine and evaluate dose-dependent and independent adverse effects of drugs and associate them with the most clinically significant drug poisonings and treatment of poisoned patients
6. Determine and select the dose of medicines required for prescribing recipes
7. Apply prescribing skills for different forms of medicine
8. Demonstrate the skill of using the Register of Medicines in the Republic of Croatia
9. Present the process of development and research of new medicines

Course content

Lectures (35 hours):

P1: General principles of pharmacology

General principles of pharmacology. The nature of the drugs. Drug-organism interactions - principles of pharmacokinetics and pharmacodynamics.

P2: Research of new drugs

The development process and phases of research of new drugs. Drug screening. Non-clinical safety and toxicity studies. Evaluation in humans. Drug clinical trials.

P3: Fate of the drug in the body

Pharmacological receptors and pharmacodynamics. Macromolecular nature of pharmacological receptors. Signaling mechanisms of physiological receptors and drug action. Relationship between drug concentration and effect. Relationship between drug dose and clinical response.

P4: Mechanism of drug action

Pharmacokinetics – volume of distribution, clearance, half-life, drug accumulation, bioavailability, rate of absorption, extraction ratio and first-pass effect. Time course of drug effect. The concept of target concentration in the design of a rational dosing regimen - maintenance dose, shock dose. Achieving the target concentration: application of pharmacokinetics and pharmacodynamics in individual dosing.

P5: Introduction to the pharmacology of the autonomic nervous system

Structure of the autonomic nervous system. Neurochemistry of the autonomic nervous system - cholinergic and adrenergic neurotransmission. Receptors in the autonomic nervous system. Neurons that are neither adrenergic nor cholinergic (NANC). Functional organization of the activity of the autonomic nervous system. Changing the function of the autonomic nervous system.

P6: Medicines with an effect on the heart

Vasodilators and treatment of angina pectoris – nitrates and nitrites, other nitro-vasodilators, calcium channel blockers, beta-blockers, newer anti-anginal drugs. Basic pharmacology of drugs for heart failure – positive inotropic drugs, drugs without positive inotropic effect. Medicines for the treatment of cardiac arrhythmias – sodium channel blockers, beta-adrenergic receptor blockers, medicines that prolong the effective refractory period by prolonging the action potential, calcium channel blockers.

P7: Antihypertensives

Arterial hypertension and blood pressure regulation. Basic pharmacology of antihypertensive drugs. Medicines that alter sodium and water balance. Medicines that change the function of the sympathetic nervous system. Vasodilators. RAAS inhibitors. Diuretics.

P8: Pharmacology of the central nervous system

Organization of SŽS. Ion channels and neurotransmitter receptors. Synapse and synaptic potentials. Sites of action of drugs. Cellular organization of the brain. Central neurotransmitters.

P9: Pain, analgesics, anesthetics

Basic pharmacology of drugs for the treatment of pain. Non-opioid analgesics – nonsteroidal anti-inflammatory drugs (NSAIDs), disease-modifying antirheumatic drugs (DMARDs), other analgesics.

Opioid analgesics and antagonists. General anesthetics – inhalation and intravenous anesthetics. Local anesthetics.

P10: Pharmacology of the digestive system

Medicines for the treatment of peptic diseases. Agents that reduce the acidity of stomach contents. Gastric mucosa protectors. Medicines that stimulate the motility of the digestive tract. Laxatives. Antidiarrheals. Medicines for the treatment of irritable bowel syndrome. Antiemetics. Medicines for the treatment of inflammatory bowel disease. Medicines to replace pancreatic enzymes. Glucagon-like peptide 2 analogue in the treatment of short bowel syndrome. Bile acids for the treatment of gallstones. Medicines for the treatment of bleeding from varicose veins.

P11: Pancreatic hormones and treatment of diabetes

Endocrine pancreas – insulin, glucagon. Diabetes mellitus (type 1, type 2, gestational diabetes). Medicines for the treatment of hyperglycemia. Medicines for the treatment of type 2 diabetes. Treatment plan for patients with diabetes.

P12: Antimicrobial drugs and chemotherapy of infectious diseases

Introduction to antimicrobial drugs. Beta-lactam and other antibiotics that act on the cell wall and membrane. Tetracyclines, macrolides, clindamycin, chloramphenicol, streptogramins, oxazolidinones. Aminoglycosides and spectinomycin. Sulfonamides, trimethoprim and quinolones. Medicines that act against mycobacteria. Medicines against fungal infections. Antiviral drugs. Drugs against protozoa. Antimicrobial agents; disinfectants, antiseptics and sterilization agents.

P13: Introduction to toxicology

Occupational and environmental toxicology. Toxicological terms and definitions (harm and risk, routes of exposure, quantity, duration and intensity of exposure). Environmental problems. Specific chemical substances - air pollutants, solvents, pesticides, herbicides, environmental pollutants.

Seminars (52 hours)

S1: How drugs work

Basic principles of drug action, nature of drugs (the concept of agonists/antagonists), binding reaction of drug and target molecules, duration of drug effect, unwanted side effects and orphan drugs

S2: Pharmacokinetics

Basic terms and principles of pharmacokinetics, knowledge about distribution of drugs in blood and tissues, reactions involved in the biotransformation process of drugs, pathways of drug elimination

S3: Pharmacodynamics

Division and peculiarities of certain types of receptors, effects that arise as a result of stimulation of certain types of receptors; knowledge of basic pharmacodynamic laws, terms and principles.

S4: Drug formulation

Development of drugs throughout history, medicinal forms, types of oral forms (tablets, capsules, effervescent tablets, extended-release tablets, film tablets. Medicinal forms for parenteral administration, local administration. Development of drugs, patent protection, generic drugs, monoclonal antibodies, biological drugs, biosimilars. Development of antineoplastic drugs. Preparation of drugs, application of drugs according to instructions. Summary of the description of drug properties. Same generic name of the drug, new forms that are more accessible to the patient. Development of local forms, patches with nanotechnology. Availability of drugs on the Croatian market, List of drugs of the Croatian Health Insurance organization, expensive drugs, off-label use of drugs.

S5: Autonomic nervous system, cholinergic

Activity of the autonomic nervous system and action on cholinergic receptors, methods of administration of drugs and their action on receptors, pharmacological effects, main indications, contraindications, side effects and toxicity of individual drugs that are an illustrative example of pharmacotherapeutic groups and subgroups. Pharmacological effects, pharmacokinetic profile, adverse effects, indications and contraindications among drugs from different subgroups within the same drug group, and mutual comparison

S6: Autonomic nervous system, adrenergic

Activity of adrenergic receptors and associated neurotransmitters, pharmacological effects, main indications, contraindications, side effects and toxicity of certain drugs that act on the adrenergic nervous system. Pharmacological effects, pharmacokinetic profile, adverse effects, indications and contraindications among drugs from different subgroups within the same drug class, and mutual comparison

S7: Diuretics, RAAS inhibitors

Subgroups of diuretics and inhibitors of the RAAS system, and the mechanism of action and methods of administration of drugs of the above-mentioned groups, pharmacological effects, main indications and contraindications of the above-mentioned groups of drugs with regard to their action, side effects and toxicity of individual drugs. Pharmacological effects, pharmacokinetic profile, adverse effects, indications and contraindications among drugs from different subgroups within the same drug class, and mutual comparison

S8: Calcium channel blockers, vasodilators, cardioactive glycosides

Methods of application of calcium channel blockers, vasodilators and cardioactive glycosides, their mechanism of action, pharmacological effects, main indications, contraindications, side effects and toxicity of certain drugs. Pharmacological effects, pharmacokinetic profile, adverse effects, indications and contraindications among drugs from different subgroups within the same drug group

S9: Antiepileptics

Differences in the subgroups of the mentioned drugs, methods of administration of antiepileptic drugs, mechanism of their action, pharmacological effects, main indications, contraindications, side effects and toxicity of individual drugs. Pharmacological effects, pharmacokinetic profile, adverse effects, indications and contraindications among drugs from different subgroups within the same drug group

S10: Antipsychotics and drugs for affective disorders, sedatives and hypnotics

Differences in subgroups of the mentioned drugs and indications for their use, methods of administration of antipsychotics, drugs for affective disorders, sedatives and hypnotics. Mechanism of their action, pharmacological effects, main indications, contraindications, side effects and toxicity of certain drugs. Pharmacological effects, pharmacokinetic profile, adverse effects, indications and contraindications among drugs from different subgroups within the same drug group.

S11: Substances of addiction and drug abuse

Subgroups of addictive substances, mechanism of addiction development. Pharmacological effects, pharmacokinetic profile, adverse effects, indications and contraindications among addictive substances from different subgroups. Associated antidotes for certain agents and drugs, mechanism of action, indications and contraindications in use. Explain the possible and available ways of treating addiction.

S12: Theories about the origin of depression, antidepressants

Current theories of the origin of depression and the biological etiology of depression as a disorder of the nervous system. Subgroups of antidepressants, mechanism of action of subgroups.

Pharmacological effects, pharmacokinetic profile, adverse effects, indications and

contraindications among drugs from different subgroups within the same drug group

S13: Medicines for the treatment of movement disorders (antiparkinsonian drugs)

Methods of application and principles of action of drugs for the treatment of movement disorders, pharmacological effects, main indications, contraindications, side effects of individual drugs, which are an illustrative example of pharmacotherapeutic groups and subgroups. Pharmacological effects, pharmacokinetic profile, adverse effects, indications and contraindications among drugs from different subgroups within the same drug group

S14: Local anesthetics and skeletal muscle relaxants

Ways of applying drugs of the above-mentioned groups, their mechanism of action, pharmacological effects, main indications, contraindications, side effects and toxicity of individual drugs, which are an illustrative example of pharmacotherapeutic groups and subgroups.

Pharmacological effects, pharmacokinetic profile, adverse effects, indications and contraindications among drugs from different subgroups within the same group of drugs

S15: Medicines for the treatment of coagulation disorders and dyslipidemia

Coagulation cascade, methods of administration of drugs for the treatment of coagulation disorders, mechanism and place of their action, pharmacological effects, main indications, contraindications, side effects and toxicity of certain drugs. Pharmacological effects, pharmacokinetic profile, adverse effects, indications and contraindications to intermediate drugs from different subgroups within the same group of drugs. The pathophysiology of dyslipidemia, lipoprotein and triglyceride disorders, ways of using drugs for the treatment of dyslipidemia, mechanism and site of their action, pharmacological effects, main indications, contraindications, side effects and toxicity of individual drugs, pharmacokinetic profile, adverse effects, indications and contraindications among drugs from different subgroups within the same group of drugs

S16: Medicines with an important effect on smooth muscles

Administration and pharmacodynamics of histamine and antagonists of histamine receptors, serotonin and serotonin agonists, basic pharmacology of ergot alkaloids, mechanism of action, pharmacological effects, main indications, contraindications, side effects and toxicity of certain drugs. Pharmacological effects, pharmacokinetic profile, adverse effects, indications and contraindications among drugs from different subgroups within the same drug group

S17: Medicines for the treatment of asthma

Administration of sympathomimetics, methylxanthines, antimuscarinic drugs, corticosteroids and leukotriene inhibitors in the treatment of asthma, mechanism of action, pharmacological effects, main indications, contraindications, side effects and toxicity. The possibility of treating asthma with monoclonal antibodies. Pharmacokinetic profile, adverse effects, indications and contraindications among drugs from different subgroups within the same drug group

S18: Non-steroidal anti-inflammatory drugs

Pharmacokinetics and pharmacodynamics of certain non-steroidal anti-inflammatory drugs, mechanism of action, pharmacological effects, main indications, contraindications, side effects and toxicity. Pharmacokinetics and pharmacodynamics of drugs that modify the course of the disease, mechanism and site of their action, pharmacological effects, main indications, contraindications, side effects and toxicity of individual drugs.

S19: Hormones of the hypothalamus, pituitary gland and adrenal glands

Pituitary hormones and associated hypothalamic regulators, pharmacokinetics and pharmacodynamics of hormones, clinical application of hormones in the treatment of disorders. Route of administration of hormone agonists and antagonists, mechanism of action, pharmacological effects, main indications, contraindications, side effects and toxicity of individual drugs, analyze pharmacological effects, pharmacokinetic profile, adverse effects, indications and contraindications among drugs from different subgroups within the same group of drugs.

Pharmacokinetics, pharmacodynamics and systemic effects of adrenal hormones, synthetic glucocorticoids and antagonists of adrenal hormones, indications and contraindications for their use, side effects and toxicity in clinical use.

S20: Biology of tumors and drugs for the treatment of neoplasms, Immunopharmacology
Administration of drugs of the above-mentioned drug groups, mechanism of action, pharmacological effects, main indications, contraindications, side effects and toxicity of individual drugs, which are an illustrative example of pharmacotherapeutic groups and subgroups. Pharmacokinetic profile, adverse effects, indications and contraindications among drugs from different subgroups within the same drug group

S21: Treatment of thyroid disease and bone metabolism

Hormonal principles of maintaining bone homeostasis, the role of PTH, vitamin D, FGF 23 and their interaction, the role of calcitonin, estrogen and glucocorticoids. Principles of action of non-hormonal drugs in the treatment of bone mineralization disorders. Pharmacological effects, pharmacokinetic profile, adverse effects, indications and contraindications among drugs from different subgroups within the same drug group

S22: Antibiotics acting on the cell wall and membrane

Classification of antibiotics that act on the cell wall and membrane, methods of administration, mechanism of their action, pharmacological effects, main indications, contraindications, side effects and toxicity of individual drugs. Pharmacokinetic profile, adverse effects, indications and contraindications among drugs from different subgroups within the same drug group

S23: Tetracyclines, macrolides, streptogramins, oxazolidinones, aminoglycosides

Methods of administration, mechanism of their action, pharmacological effects, main indications, contraindications, side effects and toxicity of individual drugs. Pharmacological effects, pharmacokinetic profile, adverse effects, indications and contraindications among drugs from different subgroups within the same drug group

S24: Sulfonamides, trimethoprim, quinolones, drugs against mycobacteria and fungi

Methods of administration, mechanism of their action, pharmacological effects, main indications, contraindications, side effects and toxicity of certain drugs. Pharmacokinetic profile, adverse effects, indications and contraindications among drugs from different subgroups within the same drug group

S25: Antiviral drugs

The basic principles of the action of antiviral drugs, with an emphasis on drugs for the treatment of infections with herpes simplex virus and varicella zoster virus, cytomegalovirus, and antiretroviral drugs. Pharmacological effects, pharmacokinetic profile, adverse effects, indications and contraindications among drugs from different subgroups within the same drug group

S26: Side effects and drug interactions of clinical significance

The concept of polypharmacy, important drug interactions that are of clinical significance, the mechanisms of interaction of individual drugs when they are used simultaneously (polypharmacy), the influence of the chemical structure, dose, method and time of drug administration on its activity, adverse effects, indications and contraindications among drugs.

Exercises (28 hours)

E1: Pharmacography I

Prescribing recipes for different types and forms of preparations (Part 1).

E2: Pharmacography II

Prescribing recipes for different types and forms of preparations (Part 2).

E3: Case clinical presentation

Presentation and analysis of clinical cases from the materials of the first partial collocation

<p>(pharmacokinetics, pharmacodynamics, autonomic nervous system), and the influence of pharmacogenetics on the effect and side effects of the drug.</p> <p>E4: Final exercise in pharmacography with colloquium Repetition of material for the colloquium in pharmacography and writing the colloquium.</p> <p>E5: Pharmacodynamic characterization of agonists and antagonists Interpretation and analysis of terms from pharmacodynamics (full and partial agonist, competitive and non-competitive antagonist, EC50, Kd, etc.), and study of the concentration-effect curve.</p> <p>E6: Monitoring therapy (e.g. antiepileptics, immunosuppressants) Repetition of antiepileptic material and theoretical introduction to therapeutic monitoring of drug concentration, and practical part with sample preparation (pipetting), processing and analysis of results related to drug concentration monitoring.</p> <p>E7: Analgesics-psychopharmaceuticals Presentation and analysis of clinical cases .</p> <p>E8: Anesthetic effect (computer exercise, Microlabs computer program) Using the Microlabs software package, the calculation of the basic pharmacodynamic parameters: EC50 and Emax will be shown on the example of anesthetics.</p> <p>E9: Analgesics Presentation and analysis of clinical cases.</p>
<p>Mode of teaching</p>
<p>Lectures; Seminars; Exercises</p>
<p>Student obligations</p>
<p>Students are expected to attend all class sessions, as well as to take all the examinations. However, they are allowed for excused absences, totalling 30% of all classes.</p>
<p>Monitoring student work (<i>alignment of learning outcomes, teaching methods, and grading</i>)</p>

Teaching activity	ECTS	Learning outcome	Student activity	Assessment methods	Grade points	
					Min.	Max.
Class attendance	0	1-9	Class attendance;	Evidence sheet;	0	0
Practical exams	0,33	1-9	Studying for the practical exam	Grading of the practical exam	0	3
Seminars	1,65	1-9	Preparation of a seminar presentation	Seminar presentation	0	15
Partial exams	6,6	1-9	Continuous learning during lectures	Grading of thhe partial exams	0	20
Written exam	6,6	1-9	Continuous learning during lectures	Grading of the written exam	0	60
Oral exam	2,42	1-9	Continuous learning during lectures	Grading of the oral exam	0	22
Total	11				0	100

Lectures: The student is expected to listen attentively to the lecture.

Seminars: Students will actively present a part of the seminar during class. The student is expected to prepare the topic of the seminar in advance from the given mandatory literature.

Each student will actively present two topics of the seminar, for which he will be evaluated with a maximum of 3 evaluation points. Each student will take the entrance exam, which can earn 0.5 points per exam. In accordance with the above, during the seminar students can achieve a maximum of 15 evaluation points based on the presentation of their seminar topics and successfully passed exit colloquiums. Students who are absent from the seminar or fail to pass the corresponding entrance exam are required to pass the same in a repeated exam, but do not receive grade points. All additional colloquia must be passed before taking the partial exam I, II, or III.

Exercises: During the exercises, which include learning how to write prescriptions, an exercise in the biochemical laboratory where the concentration of medicine in body fluids is measured, and clinical presentations of cases, students can gain a maximum of 3 evaluation points, based on active participation and demonstrated knowledge. The student is expected to have theoretical knowledge for the assigned topic of the exercise.

Evaluation of partial tests I, II and III.

Partial test I includes the material of general pharmacology and the autonomic nervous system, partial test II includes the material of pharmacology of the cardiovascular and central nervous system, while partial test III includes the rest of the material of special pharmacology. Partial tests

are composed of 40 questions. The minimum criterion for obtaining evaluation points is 55% of correctly solved questions. The points obtained on the partial test are converted into grade points.

Oral part of the final exam

On the oral part of the exam, students can achieve a maximum of 22 evaluation points based on the demonstrated knowledge of the entire pharmacology material.

The final grade represents the sum of the grade points achieved during the class and on the final exam.

Calculation of final grade:

Based on the total sum of the points awarded during the course and the final exam, the final grade is determined according to the following distribution:

A – excellent (5): 90-100 grade points; B – very good (4): 70-79,99 grade points; C – good (3): 60-69,99 grade points; D – sufficient (2): 50-59,99 grade points

Required reading (available in the library and through other media)

Title	Number of copies in the library	Availability through other media
Katzung B.G., Trevor A.J. et al. Temeljna i klinička farmakologija, 14. izdanje. Medicinska naklada. Zagreb, 2020	18	

Additional reading

Trevor A.J., Katzung B.G. et al. Pharmacology (examination and board review), 13th Edition. The Mc-Graw-Hill Companies, Inc., 2021.

Course evaluation procedures

Anonymous, quantitative, standardized student survey providing feedback on the course as well as on the work of course coordinators and their assistants/associates is being conducted by the QA Office of the Faculty of medicine Osijek.

Note /Other

E-learning does not count towards course contact hours, but is being used in teaching and comprises links to various web pages, as well as video and audio materials available on web pages.