1. COURSE DECRIPTION – GENERAL INFORMATION			
1.1. Course teacher	Professor BrankaZorc, PhD	1.6. Year of study	4th
1.2. Name of the course	**Drug Metabolism**	1.7. Credit value (ECTS)	8
1.3. Associate teachers	Assistant Professor Monika Barbarić, PhD Assistant Professor Zrinka Rajić Džolić, PhD Ivana Perković, PhD Mirza Bojić, PhD Hrvoje Rimac, MPharm	1.8. Type of instruction (number of hours L+E+S+e-learning)	45+30+15
1.4. Study programme (undergraduate, graduate, integrated)	Integrated study of Pharmacy	1.9. Expected enrolment in the course	120
1.5. Status of the course	Compulsory	1.10. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2nd

2. COURSE DESCRIPTION	
2.1. Course objectives	Students will gain knowledge about enzymes, biological and chemical changes and their effect on drugs, other xenobiotics and endobiotics in human organism that are related to metabolic processes.
2.2. Enrolment requirements and required entry competences for the course	Enrolment requirements: completed course of Pharmaceutical Chemistry 2 and Pharmacology
2.3. Learning outcomes at the level of the study programme to which the course contributes	• Relating drug structure to the metabolic processes and specific enzymes involved in metabolism. • Understand mode of action and side-effects of drugs as a consequence of metabolism. • Applying the professional knowledge and competences obtained in consolations about mechanism of action, side effects and drug-drug interactions.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After completing the course student should be able to: 1. Identify major metabolic pathways of representative endogenous substances and drugs; 2. Describe metabolic reactions of first and second phase; 3. List major enzymatic system and their roles in biotransformation reactions; 4. Explain specific forms of activation and/or toxicity, side effects and interactions;

	5. Describe pharmacodynamics and pharmacokinetic properties of selected drugs and xenobiotics based their biotransformation; 6. Predict potential of drug interactions based on metabolic pathways and enzymes susceptible to inductions and inhibition; 7. Relate drug structure with metabolic processes and specific enzymes involved in metabolism; 8. Calculate molecular descriptors and optimize molecular geometry; 9. Describe formation and detection of major products of biotransformation of selected drugs.
2.5. Course content broken down in detail by weekly class schedule(syllabus)	LECTURES: • Introduction to drug biochemistry and principles of biotransformation processes. Metabolism and biotransformation of xenobiotics and endobiotics. Overview of phase I and phase II reactions. • Bio-oxidations. Alcohols, aldehydes, ketones. Hydroxylations (monooxidations). Examples of monooxygenations in drug metabolism. • Hydroxylations of aromatic compounds. NIH-shift. Hydrolysis (amides, esters). Cyclization. • Oxidation of N-C bond system without bond cleavage. Oxidations of N-C bond system with bond cleavage (N-dealkylation, deamination). Bickel's triangle.Enzymes MAO, DAO, PAO. S-oxidations. S- and O-dealkylations. Aromatization of steroids and cyclohexane. • Bioreductions of carbonyls.Bioreductions of N-containing groups. Oxido-reductions of steroids. Oxido-reductive dehalogenations. Oxido-reductions of other functional groups. • CYP, FMO, molybdo-oxidases, peroxidases. Mono-oxygenations systems. Substrate, ligand binding.Mechanism of activation of molecular oxygen. Overview of CYP catalyzed reactions. • Peroxidase. Peroxidation of unsaturated fatty acids. Molybdo-hydroxylases. Aldehyde oxidase (AO), xanthineoxidase(XO).Flavinmonooxygenases (FMO), mechanism of oxygenation. Oxidation of nicotine, cimetidine. Hydrolysis. Biotransformation of adrenalin and noradrenalin. Biosynthesis of folic acid. Metabolism of purine basis. • Toxicity of chemicals. Examples of drug toxicity. Tricyclic systems. Estrogens. Pahse II reactions. Biomethylations. Bioacethylations. Amino acids conjugations. Metabolism of selected drugs. • Sulfo-conjugations. Glucuronidations. Glycine conjugations. • Prodrugs (esters, amides).Stereoselectivity of drug metabolism. Biosynthesis of steroid hormones. Transport proteins. • Substrates, inhibitors and activators of P-gp. Binding to human serum proteins. Enzyme inhibition. Enzyme induction. (CYP) • Drug-drug and drug-xenobiotic interactions, Drug toxicity. Metabolic reactions of selected drugs. SEMINARS: • ADMET databases. • Introduction to QSAR. Graph theory. Topology indices. • Molecular descriptors calculations.

	• Geometry optimization and QSAR modeling. • Application of bioinformatics in synthesis of new antibiotics. • Quantochemical approach in drug design. • Computational analysis of antiaggregatory effect of flavonoids. LABORATORY EXERCISES: • QSAR and lipophilicity of sulphonamides. • Biotransformation of salicylamide. • Biotransformation of active substances in cough syrup (ephedrine, codeine). • Binding of benzodiazepines to the human serum albumin (gel filtration method). • Biotransformation of acetylsalicylic acid.					
2.6. Type of instruction	**lectures** **seminars and workshops** exercises online in entirety mixed e-learning field work		independent study multimedia and the internet **laboratory** work with the mentor (other)		2.7. Comments:	
2.8. Student responsibilities	Lectures, seminars and laboratory attendance. Laboratory exercises exam					
2.9. Screening of student's work (specify the proportion of ECTS credits for each activity so that the total number of CTS credits is equal to the credit value of the course)	Class attendance	2.5	Research		Practical training	
	Experimental work		Report			
	Essay		Seminar essay	0.5	(Other--describe)	
	Tests	1	Oral exam	2	(Other—describe)	
	Written exam	2	Project		(Other—describe)	
2.10. Grading and evaluation of student work over the course of instruction and at a final exam	Written and oral exam					
2.11. Required literature (available at the library and via other media)	**Title**					
	1. Slobodan Rendić and MaricaMedić-Šarić, Metabolizam lijekova i odabranih ksenobiotika, Medicinska naklada, 2012.					
2.12. Optional literature	Bernard Testa and Stefanie D. Krämer, The Biochemistry of Drug Metabolism, Wilay-VCH, 2010. PavelAnzenbacher and Ulrich M. Zanger (Eds.), Metabolism of Drugs and Other Xenobiotics, Wiley-VCH, 2012					
2.13. Methods of monitoring quality that ensure acquisition of exit competences	Learning outcomes 1 to 7 are assessed with written and oral exam, learning outcome 8 within seminars and learning outcome 9 within laboratory exercises and with laboratory exercises exam.					