ANALYTICS OF THE DEVELOPMENT OF PHARMACEUTICAL PRODUCTS

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Ana Mornar Turk, associated professor
1.2. Associate teachers	Miranda Sertić, assistant professor
1.3. Graduate programme	pharmacy
1.4. Status of the course	elective
1.5. Year of study, Semester	4th year
1.6. Credit value (ECTS)	2.5
1.7. Type of instruction (number of hours L+E+S+e-learning)	15+0+15
1.8. Expected enrolment in the course	60
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2.
2. COURSE DESCRIPTION	
2.1. Course objectives	Student will be introduced in fundamentals of sample preparation techniques: solid-phase extraction and head space sampling. Analytical techniques used in ADME (adsorption, distribution, metabolism and elimination) investigation will be defined and compared. Student will be introduced in fundamentals of chiral chromatography and bioanalytical methods. Student will understand development of stability indicating high performance liquid chromatographic (HPLC) methods. Student will be introduced in implementation of capillary electrophoresis in analytics of active pharmaceutical ingredients and medicinal products.
2.2. Enrolment requirements and required entry competences for the course	Pharmaceutical analysis – course attended Required entry competences: liquid and gas chromatography, mass spectrometry, basics of capillary electrophoresis
2.3. Learning outcomes at the level of the study programme to which the course contributes	* Proposing procedures related to the analysis and quality control of pharmaceuticals. * Applying analytical methods to ensure the quality of medicines in accordance with good laboratory practice and the relevant European directives.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After passing final exam student will be able to: 1. describe and propose the sample preparation procedure for analyzing formulated pharmaceutical products and biosamples 2. develop stability indicating HPLC methods 3. define and explain application of capillary electrophoresis in development and quality control of pharmaceuticals 4. apply analytical methods for ADME investigation of active pharmaceutical ingredients 5. develop bioanalitical methods 6. define and explain analytical techniques used in quality control of biopharmaceuticals (proteins and peptids) 7. define and explain chiral HPLC method used in quality control of active pharmaceutical ingredients, impurities' investigation and drug metabolite profiling
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES: • Sample preparation techniques (Head Space Sampler – HSS, Solid Phase Extraction – SPE i Solid Phase Microextraction – SPME). • ADME investigation of active pharmaceutical ingredients. • Bioanalytical methods and their application in pharmacokinetics. • Chiral high performance liquid chromatography. • Development of stability indicating HPLC methods. • Analytical techniques (LC/MS^n) used in quality control of biopharmaceuticals (peptids and proteins). • Capillary electrphoresis in development of pharmaceuticals.

<table>
<tr><td></td><td colspan="4">LABORATORY EXCERCISES:
• Determination of methanol content in liquid pharmaceutical products by headspace sampling and gas chromatography (HSS-GC-FID).
• Determination of mitotan and its main metabolites in plasma samples by solid phase extraction and high performance liquid chromatography (SPE-HPLC).
• Investigation of atorvastatin's impurities by high performance liquid chromatography and tandem mass spectrometry (LC/MS^n).
• Simultaneous analysis of statins by capillary electrophoresis in pharmaceuticals.</td></tr>
<tr><td>2.6. Type of instruction</td><td colspan="2"><u>lectures</u>
seminars
workshops
<u>exercises</u>
online in entirety
mixed m-learning</td><td colspan="2">field work
<u>independent study</u>
<u>multimedia and the internet</u>
<u>laboratory</u>
work with the mentor
(other)</td></tr>
<tr><td>2.7. Student responsibilities</td><td colspan="4">Lectures and laboratory work attendance and taking written exam.</td></tr>
<tr><td rowspan="8">2.8. 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)</td><td>Class attendance</td><td>0.5</td><td>Seminar essay</td><td></td></tr>
<tr><td>Experimental work</td><td>0.5</td><td>Oral exam</td><td></td></tr>
<tr><td>Essay</td><td></td><td>Project</td><td></td></tr>
<tr><td>Tests</td><td></td><td>Practical training</td><td></td></tr>
<tr><td>Written exam</td><td>1.5</td><td>(Other--describe)</td><td></td></tr>
<tr><td>Research</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>Report</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>2.9. Grading and evaluation of student work over the course of instruction and at a final exam</td><td colspan="4">Written exam</td></tr>
<tr><td rowspan="2">2.10. Required literature (available at the library and via other media)</td><td>Title</td><td colspan="2">Number of copies at the library</td><td>Availability via other media</td></tr>
<tr><td>A. Mornar, M. Sertić i B. Nigović: Analitika u razvoju farmaceutskih proizvoda – praktikum. Faculty of Pharmacy and Biochemistry University of Zagreb, Zagreb, Croatia 2013</td><td colspan="2">5</td><td></td></tr>
<tr><td>2.11. Optional literature</td><td colspan="4"></td></tr>
<tr><td>2.12. Methods of monitoring quality that ensure acquisition of exit competences</td><td colspan="4">Outcomes 1-7 are checked by written exam.</td></tr>
<tr><td>2.13. Comments</td><td colspan="4"></td></tr>
</table>

APPLIED MICROBIOLOGY

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Assoc. Prof. Maja Šegvić Klarić, PhD
1.2. Associate teachers	Assoc. Prof. Ivan Kosalec, PhD
1.3. Graduate programme	Pharmacy integrated study programme
1.4. Status of the course	Elective
1.5. Year of study, Semester	4th year, VII semester
1.6. Credit value (ECTS)	2.5
1.7. Type of instruction (number of hours L+E+S+e-learning)	20+0+10+0
1.8. Expected enrolment in the course	30 students
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2nd level of e-learning (not included in standard hours, but it is used in teaching)
2. COURSE DESCRIPTION	
2.1. Course objectives	The student will learn: the application of microbes in the pharmaceutical industry and biotechnology, the food industry and ecology; the properties of antimicrobial agents and vaccines, methods for the production of antibiotics, vaccines, human proteins and enzymes using microbes as well as control of sterility and quality control of such products; microbiological control in the pharmaceutical industry (GMP); microbial indicators of fecal contamination of drinking water and water used for pharmaceutical products; the microbes and their products that represent biological or chemical hazard in food and food supplements.
2.2. Enrolment requirements and required entry competences for the course	Enrolled 7th semester, the attended Molecular Biology with Genetic Engineering, passed exam of of the course Microbiology and Parasitology
2.3. Learning outcomes at the level of the study programme to which the course contributes	• The use of expertise and capabilities in the development, production, analysis and quality control of pharmaceutical products. • Information and consulting patients about prevention of infectious diseases, antimicrobial therapy and rational use of antibiotics.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	At the end of the course students will be able to: 1. List microbes applied in the production of antibiotics, vaccines, enzymes and human proteins; 2. Describe the production processes of pharmaceutical products which are produced by microbes; 3. Relate the specific stages of the production of pharmaceutical products with the processes of quality control and safety of such products; 4. Determine microbiological control points in the pharmaceutical industry (GMP); 5. Analyze validity of sterilization procedures; 6. Analyze the effectiveness and content of antibiotics in the pharmaceutical product microbiological methods; 7. Identify indicators of faecal contamination of water as well as microbes and their products which are biological or chemical hazard in food and/or food supplements.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES: • Introduction to Applied Microbiology; development of microbiology at different discipline (pharmaceutical, industrial, sanitary, agricultural, microbial ecology). Taxonomy of microbes according to their application. • Antimicrobial drugs: classification, producers, mechanism of action, resistance mechanisms, biosynthetic processes, production, application. • Vaccines, immunization and production of immunological products: types of vaccines, routine vaccination, vaccination of risk groups, the development of new vaccines, production of vaccines, serum immunoglobulin and preparations for diagnostics, in vivo quality control of immunological

<table>
<tr><td></td><td colspan="4">products.
• Microbes in the pharmaceutical biotechnology: recombinant insulin, somatostatin, somatotropin, vaccines, antibiotics. The production of amino acids, enzymes, proteins, polysaccharides, and a microbial pesticide.
• Microbial control in the pharmaceutical industry (GMP).
• Disinfection and sterilization: effectiveness and application of disinfectants and preservatives, sterilization methods and control of sterilization procedure, pyrogens and their removal.
• Microbiological tests in the Pharmacopoeia: microbiological quality of non-sterile pharmaceutical products, demand for the absence of certain microbes, control of preservative effectiveness.
• Microbiological methods and antibiotics; determine antibiotic activity-antagonistic microbes; methods of determining the concentration of antibiotics in the pharmaceutical product.
• Sanitary microbiology: indicators of faecal contamination of water, food spoilage, bacterial and fungal toxins.
SEMINARS:
• Microbial control in the pharmaceutical industry: the microbiological control of water and air. Challenge test for preservatives.
• Determination of antibiotic concentration in pharmaceuticals by diffusion method
• Qualitative and quantitative methods for the detection of bacteria, which are indicators of faecal contamination of water.
• The use of bacteriophages: treatment of bacterial infections, bioreporters and biocontrollers.
• Microbes in bioremediation: examples of participation microbes to break down organic chlorine compounds, oil pollution, PAH compounds, pesticides, heavy metals and radioactive waste.
• Misuse of microbes: microbes as biological weapons.</td></tr>
<tr><td>2.6. Type of instruction</td><td colspan="2">lectures
seminars
workshops
exercises
online in entirety
mixed e-learning
mixed m-learning</td><td colspan="2">field work
independent study
multimedia and the internet
work with the mentor
(other)</td></tr>
<tr><td>2.7. Student responsibilities</td><td colspan="4">Students are obligate to attend the lectures and seminars and to actively participate in the course activity.</td></tr>
<tr><td rowspan="8">2.8. 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)</td><td>Class attendance</td><td>0.5</td><td>Seminar essay</td><td>0.5</td></tr>
<tr><td>Experimental work</td><td></td><td>Oral exam</td><td>1</td></tr>
<tr><td>Essay</td><td></td><td>Project</td><td></td></tr>
<tr><td>Tests</td><td></td><td>Practical training</td><td></td></tr>
<tr><td>Written exam</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>Research</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>Report</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>2.9. Grading and evaluation of student work over the course of instruction and at a final exam</td><td colspan="4">In grading and evaluation of student work class attendance and active participation in the course activity and results of oral exam are taken into account.</td></tr>
<tr><td rowspan="3">2.10. Required literature (available at the library and via other media)</td><td colspan="2">Title</td><td>Number of copies at the library</td><td>Availability via other media</td></tr>
<tr><td colspan="2">Hugo and Russell: Pharmaceutical Microbiology 8th Edition, Blackwell Publishing, 2011.</td><td></td><td>eBook-PDF</td></tr>
<tr><td colspan="2">European Pharmacopoeia 8th Ed, EDQM,</td><td>1</td><td></td></tr>
</table>

	Strasbourg		
	Denyer and Baird. Guide to Microbiological Control in Pharmaceuticals and Medical Devices 2nd Edition, CRS Press, Taylor & Francis Froup, 2007.		eBook-PDF
2.11. Optional literature	J. Šušković, B. Kos: Mikrobiološke metode za određivanje antibiotika, U: Metode u molekularnoj biologiji , A. Ambriović Ristov ur., Institut Ruđer Bošković, Zagreb, 2008. e-articles are provided by e-learning system.		
2.12. Methods of monitoring quality that ensure acquisition of exit competences	Learning outcomes 1-7 are evaluated by oral exam.		
2.13. Comments			

BASICS OF PHARMACY BUSINESS

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Assistant Professor Ivan Pepić, PhD
1.2. Associate teachers	Practice associates
1.3. Graduate programme	Pharmacy
1.4. Status of the course	Elective course
1.5. Year of study, Semester	5th year, 9th semester
1.6. Credit value (ECTS)	
1.7. Type of instruction (number of hours L+E+S+e-learning)	13+0+7+0
1.8. Expected enrolment in the course	50
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2nd level
2. COURSE DESCRIPTION	
2.1. Course objectives	Students will be able to explain the basic principles of retail pharmacy and wholesale markets. Students will be able to explain of basic structure of revenues (e.g., prescription and non-prescription revenue; dispensing fees, revenues from additional services and insurance) and expenses (e.g., payroll expenses; expenses for rent, utilities, licences fees, insurance and other overhead) of pharmacies classified in the pharmacies and pharmacy chains. Students will learn how to calculate the price at wholesale (manufacturer price, wholesale acquisition cost) and retail pharmacy (maximum allowable price; gross margins; dispensing fee added to the price) level. Students will be able to define and explain the external (business conditions which are determined by national policy as well as various para-fiscal charges) and internal (business conditions which are determined by pharmacy business strategy - payment terms, rebates, bulk order discounts, allowance, cash and early payment discounts) determinants of pharmacy business. Students will be able to design an annual business plan. Students will learn how to control purchase orders and how to assess accurate inventory management. Students will be able to explain the basics of modern pharmacy marketing in terms of appearance, arrangement, assortment and product positioning.
2.2. Enrolment requirements and required entry competences for the course	Enrolled 9th semester.
2.3. Learning outcomes at the level of the study programme to which the course contributes	1. Efficiently implement financial, marketing and organisational principles important for autonomous work and teamwork; participate in and supervise the distribution of pharmaceuticals; plan and implement pharmaceutical care. 2. Demonstrate autonomy in organisation, coordination and management, as well as in the development of strategies and business plans relevant to the profession.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After completing the course students will be able to: 1. Explain the structure of revenues and expenses in pharmacy business. 2. Analyze the retail pharmacy and wholesale market conditions. 3. Explain the basic principles of price calculation at wholesale and retail pharmacy level. 4. Explain the wholesalers´ pricing and discount models to pharmacies. 5. Explain the basic principles of accurate inventory management and purchase order control. 6. Analyze the advantage of additional incentives offered by suppliers in ensuring sustainable pharmacy business. 7. Explain the financial statements and projections that are usually included in retail pharmacy business plan.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	<u>Lectures:</u> • Basic structure and organization in retail pharmacies (2L)

	• Basic structure of revenue and expense in retail pharmacy (2L) • Market conditions in retail pharmacy (2L) • Wholesalers´ pricing and discount models to pharmacies (1L) • Relationships between pharmacies and wholesalers (1L) • Pharmacy retail pricing (1L) • Proper inventory management in retail pharmacy (1L) • Drafting a one-year retail pharmacy business plan (1L) • Pharmacy marketing (2L) <u>Seminars:</u> • Wholesale price calculation (1S) • Negotiation on wholesalers-pharmacy relation (1S) • Retail pharmacy price calculation (1S) • Procedures of monitoring retail pharmacy inventory turns (1S) • Core components of a typical business plan considering pharmacy and pharmacy chains (1S) • Invoicing of prescription and remittances to Croatian Health Insurance Fund (1S) • The use of information systems in retail pharmacy (1S)

2.6. Type of instruction	**lectures** **seminars** workshops exercises online in entirety mixed *e*-learning mixed *m*-learning	field work independent study multimedia and the internet work with the mentor (other)
2.7. Student responsibilities	Regular attendance of lectures and seminars.	

2.8. 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		Seminar essay	
	Experimental work		Oral exam	
	Essay		Project	
	Tests		Practical training	
	Written exam		(Other--describe)	
	Research		(Other--describe)	
	Report		(Other--describe)	

2.9. Grading and evaluation of student work over the course of instruction and at a final exam	Written final exam.

2.10. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	PDFs of lectures and seminars.		Merlin e-learning system

2.11. Optional literature	Maja Vehovec et al. (2014) About health from an economic perspective. Institute of Economics, Zagreb.
2.12. Methods of monitoring quality that ensure acquisition of exit competences	Assessment of learning outcomes through final examination. Analysis of assessment results to improve the quality of teaching.
2.13. Comments	

BIOCHEMICAL BASIS OF TOXICITY OF ENDOBIOTICS AND XENOBIOTICS

1. COURSE DESCRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Assistant Professor Mirza Bojić, PhD
1.2. Associate teachers	Hrvoje Rimac, MPharm
1.3. Graduate programme	Integrated
1.4. Status of the course	Elective
1.5. Year of study, Semester	5th year, 9th semestar
1.6. Credit value (ECTS)	2.5
1.7. Type of instruction (number of hours L+E+S+e-learning)	15+0+15
1.8. Expected enrolment in the course	20
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2
2. COURSE DESCRIPTION	
2.1. Course objectives	Students will get to know biochemical mechanism of toxicity of endobiotics and xenobiotics with special emphasis on enzymes, enzymatic and transport systems, and reactive species that are involved in toxicity.
2.2. Enrolment requirements and required entry competences for the course	Enrolment requirements: audited Biochemistry of Drugs
2.3. Learning outcomes at the level of the study programme to which the course contributes	• Assess metabolism and enzymes involved in metabolism of drugs based on their structural features • Relate the mechanism of action and side effects to the metabolism of drugs • Apply knowledge and competences in advising about mode of action, side effects and interactions of drugs
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After completing the course students will be able to 1. List major xenobiotics whose metabolism is basis of their toxicity 2. State major reactions, enzymes, transporters and mechanism if/how they contribute to the toxicity 3. Explain how polymorphism of enzymes and transporters contributes to the side effects of drugs and other xenobiotics 4. Understand the role of reactive oxygen and nitrogen species in reactions of biotransformation 5. Describe the role of endogenous and exogenous antioxidants
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES: • Toxicity of xenobiotics as a consequence of metabolic reactions; idiosyncratic drug reactions • Reactions, enzymes, transporters and their involvement to the toxicity • Genetic polymorphism • Metabolic activation, toxicophores and models of toxicity • Free radicals in reactions of biotransformation (examples and mechanism of toxicity of selected drugs and other xenobiotics) • Antioxidant system of defence – the role of endogenous and exogenous antioxidants • Reactive oxygen and nitrogen species in reactions of biotransformation SEMINARS: Individual seminars on • Pathogenesis and prophylaxis of diseases that are attributed to the generation of free radicals and other reactive species • Examples of toxicity of drugs and other xenobiotics that is mediated by biotransformation reactions EXPERIMENTAL-INDEPENDENT STUDY: Interactions and assessment of drug toxicity on the level of cytochromes P450

2.6. Type of instruction	lectures seminars research independent study			
2.7. Student responsibilities	Attendance and active participation in classes. Writing and presenting a seminar. Individual study on assessment of clinical significance of in vitro dana that includes experimental part.			
2.8. 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	0,5	Seminar essay	0,5
	Experimental work	0,5	Oral exam	0,5
	Essay		Project	0,5
	Tests		Practical training	
	Written exam		(Other--describe)	
	Research		(Other--describe)	
	Report		(Other--describe)	
2.9. Grading and evaluation of student work over the course of instruction and at a final exam	Seminar includes written part, oral presentation and discussion (25% grade ea). Individual study contributes to 25% of the grade. If student is not satisfied with a grade, one can take written and oral exam (60+40% of the grade).			

2.10. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	Bernard Testa and Stefanie D. Krämer The Biochemistry of Drug Metabolism. Wilay-VCH, 2010	3	
	Pavel Anzenbacher and Ulrich M. Zanger (urednici), Metabolism of Drugs and Other Xenobiotics,Wiley-VCH, 2012	3	
	Slobodan Rendić and Marica Medić-Šarić, Metabolizam lijekova i odabranih ksenobiotika, Medicinska naklada, 2012	30	
	Andrew Parkinson, Brian W. Ogilvie, David B. Buckley, Faraz Kazmi, Maciej Czerwinski and Oliver Parkinson. Chapter 6: Biotransformation of Xenobiotics. In: Casarett & Doull's Toxicology, The Basic Science of Poisons, 8th edition, Curtis Klaassen (ed.)		Available from Xenotech (https://www.xenotech.com/zcontent-tree/chapter-6)

2.11. Optional literature	
2.12. Methods of monitoring quality that ensure acquisition of exit competences	Learning outcomes 1 to 3 are assessed through written seminars. Outcomes 4 and 5 are assessed through seminar presentation and discussion.
2.13. Comments	

BIOCHEMISTRY

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Prof Karmela Barišić Prof Lada Rumora
1.2. Associate teachers	Assistant Prof Marija Grdić Rajković Anita Somborac Bačura, PhD Andrea Hulina, mag. med. biochem.
1.3. Graduate programme	Medical Biochemistry
1.4. Status of the course	compulsory
1.5. Year of study, Semester	2, 4
1.6. Credit value (ECTS)	10.5
1.7. Type of instruction (number of hours L+E+S+e-learning)	60 + 45 + 15
1.8. Expected enrolment in the course	30
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2
2. COURSE DESCRIPTION	
2.1. Course objectives	Student will acquire fundamental knowledge necessary to understand molecular logics of biochemical processes in living organisms; recognise dynamics in the synthesis and degradation of the natural biomacromolecules: proteins, polysaccharides, lipids and nucleic acids, and will be able to analyse and identify important factors that are influencing dynamics, control and regulation of cellular metabolism. Biochemical knowledge and skills acquired are compulsory basis for the further studies, especially in clinical biochemistry, haematology, pharmacology, biochemistry of drug metabolism, nutrition, molecular biology and genetic engineering, molecular diagnostics, identify molecular basis of diseases and therapy and other lessons dealing with metabolism of endogenic macromolecules, drugs and other xenobiotic in health and disease.
2.2. Enrolment requirements and required entry competences for the course	Enrolment requirements: completed study course Biological Chemistry
2.3. Learning outcomes at the level of the study programme to which the course contributes	1. Students will be able to apply fundamental biochemical knowledge to explain, analyse and evaluate procedures related to the research, development and quality control of diagnostic reagents and diagnostic methods in general. 2. Implementation of the optimal solutions for practical and everyday problems in monitoring progress of the disease or drug therapy (research and application of new laboratory diagnostic procedures for therapeutic drug monitoring). 3. Critical evaluation and application of the scientific data and expert knowledge for the problem solving in biochemical systems.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	1. Apply expert knowledge of biochemistry, chemistry and biology in biochemical problem solving. 2. Describe and apply basic biochemical principles for relating structure and function of the protein macromolecules. 3. Determine key enzymes regulating reaction rate in the metabolic pathways and asses what diagnostically measurable biochemical changes might indicate disorders in the particular enzyme systems. Estimate what genetic factors might be relevant to diseases and relate enzyme kinetics to regulatory enzyme characteristics. 4. Explain biochemical mechanism of the DNA replication, generation and repair of the DNA mutations, recognise role of all elements in the process of transcription and protein synthesis, in prokaryotes and eukaryotes. 5. Review basic principles of acquiring and processing of data in pharmacogenetics, transcriptomics and proteomics. 6. Designing and performing biochemical experiments based on grasped

	experimental and technical skills. 7. Analyse scientific data bases for the interpretation of the personal results and presentation to the professional audience.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES AND SEMINARS: • Dynamic aspects of structure and function of specific proteins: haemoglobin, myoglobin, collagen, elastin, proteins of the extracellular matrix • Structure and function of cell membranes in various tissues, transport of ions, amino acids, sugars • Methods for exploring proteins and protein sorting • Generation, transforming and storing of metabolic energy: basic concepts of metabolism • Glycolysis • Oxidative decarboxylation of pyruvate, citric acid cycle • Cellular bioenergetics and role of ATP generation and expenditure, respiratory chain and oxidative phosphorylation • Gluconeogenesis and pentose phosphate pathway • Glycogen metabolism, glycogenesis and glycogenolysis, reactions and hormone regulation • Biochemistry of hormones: insulin, epinephrine and cortisol • Fatty acid metabolism, degradation and synthesis of triglycerides, biosynthesis and β-oxidation of fatty acid, biosynthesis of ketone bodies • Protein turnover and amino acid catabolism, urea cycle • Biosynthesis of macromolecular precursors, amino acids, ribonucleotides and deoxyribonucleotides • Information in biological systems: DNA - structure and genetic role, genome organisation, chromosomes and genes • Methods for exploring genome • Histones and DNA packing, conformation of DNA molecule, DNA replication, fidelity of replication • DNA mutations and repair • RNA in translation of genetic message • Synthesis and modification of functional RNA molecules: mRNA and transcription, t-RNA, activation and role in protein synthesis, structure of ribosomes and rRNA • Genetic code and relation of genes and proteins, protein synthesis • Control of gene expression in prokaryotes: Lac-operon and Trp-operon • Chromosomes in eukaryotes and control of gene expression in eukaryotes, introns and exons • Integration of biochemical processes in the cell - basic concepts and design, strategy, control and regulation of metabolism LABORATORY PRACTICALS: • Determination of initial velocity v_o in acetylcholine reaction • Alkaline phosphatase • Homogenisation, differential centrifugation, determination of DNA and lactate in cellular fractions • Isolation of plasmid DNA from the transformed bacteria • Rate of glycolysis in various tissues • Electrophoresis of haemoglobin • Evaluation of cytotoxicity with MTT test • Determination of thiols group and glutathione concentration

<table>
<tr><td>2.6. Type of instruction</td><td colspan="2">lectures
seminars
workshops
exercises
online in entirety
mixed e-learning
mixed m-learning</td><td colspan="2">field work
independent study
multimedia and the internet
work with the mentor
laboratory</td></tr>
<tr><td>2.7. Student responsibilities</td><td colspan="4">Regular attendance at the lectures, obligatory attendance at the seminars and laboratory practicals, active participation in seminars with individual presentations.</td></tr>
<tr><td rowspan="7">2.8. 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)</td><td>Class attendance</td><td>0.5</td><td>Seminar essay</td><td>1.0</td></tr>
<tr><td>Experimental work</td><td>2.0</td><td>Oral exam</td><td>2.5</td></tr>
<tr><td>Essay</td><td></td><td>Project</td><td></td></tr>
<tr><td>Tests</td><td>1.0</td><td>Practical training</td><td></td></tr>
<tr><td>Written exam</td><td>2.0</td><td>Semestral written tests)</td><td>1.5</td></tr>
<tr><td>Research</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>Report</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>2.9. Grading and evaluation of student work over the course of instruction and at a final exam</td><td colspan="4">Seminars are organised as a problem solving practice, teachers are guiding the discussion and evaluating student achievements. During the lecture course two tests are organised, and marked for the final grade. Two additional tests are organised for laboratory practicals, before and after completing exercises. At the end of the complete lecture program written and oral exam are organised for the whole program and final grade is decided.</td></tr>
<tr><td rowspan="4">2.10. Required literature (available at the library and via other media)</td><td>Title</td><td colspan="2">Number of copies at the library</td><td>Availability via other media</td></tr>
<tr><td>JM Berg, JL Tymoczko, L. Stryer: Biochemistry, 7th edition, Školska knjiga, Zagreb, 2013.</td><td colspan="2">30</td><td></td></tr>
<tr><td>TM Devlin: Texbook of Biochemistry with Clinical Correlation, J. Wiley & sons, New York, 2011.</td><td colspan="2">15</td><td></td></tr>
<tr><td></td><td colspan="2"></td><td></td></tr>
<tr><td>2.11. Optional literature</td><td colspan="4">C. Smith, AD Marks: MMarks' basic Medical Biochemistry, A Clinical Approach. Lippincott Williams & Wilkins, Philadelphia, 2005.</td></tr>
<tr><td>2.12. Methods of monitoring quality that ensure acquisition of exit competences</td><td colspan="4">Learning outcomes 1 and 6 are tested during experimental work in laboratory practicals and tests, outcome 7 during seminars, and outcomes 2-5 with written and oral exam.</td></tr>
<tr><td>2.13. Comments</td><td colspan="4"></td></tr>
</table>

BIOCHEMISTRY OF DRUGS

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Assoc. Professor Milena Jadrijević-Mladar Takac, PhD Assist. Profesor Mirza Bojić, PhD
1.2. Associate teachers	Assist. Professor Monika Barbarić, PhD, Hrvoje Rimac, mag. pharm., Kristina Pavić, mag. pharm., Maja Beus, mag. pharm.
1.3. Graduate programme	Pharmacy
1.4. Status of the course	Obligatory
1.5. Year of study, Semester	4th Year, 8th Semester
1.6. Credit value (ECTS)	8 ECTS
1.7. Type of instruction (number of hours L+E+S+e-learning)	45 + 15 + 30 + e-learning
1.8. Expected enrolment in the course	130
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2nd level
2. COURSE DESCRIPTION	
2.1. Course objectives	Students will gain knowledge about enzymes, biological and chemical changes and the effects of medicinal substances, other xenobiotics and endobiotics on the human body that occur as a result of metabolic processes.
2.2. Enrolment requirements and required entry competences for the course	Attended Pharmaceutical Chemistry 2 and the attended Pharmacology
2.3. Learning outcomes at the level of the study programme to which the course contributes	Learning outcomes are better understanding the relationship between chemical structure of drugs and their metabolic processes as well as specific enzymes that are involved in their metabolism. Students will be also able to understand the pharmacological and side effects as a result of metbolic processes. Acquired knowledge and skills regarding the mechanism of drug activity, side effects and drug-drug interactions can be successfully applied in patients counseling in health care system, but also in drug discovery and development of new drugs, as well as in clarifying the mechanisms of side effects of medicines already present in clinical use.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After passing the course the student will be able to: o Identify the main metabolic pathways of certain endogenous substances and drugs; o Describe the metabolic reactions of Phase I and Phase II o Know the main enzymatic systems and their role in the biotransformation reactions; o Explain the specific pathway of biochemical activation and/or toxicity and adverse effects as well as interactions; o Describe the pharmacodynamic and pharmacokinetic properties of certain drugs and other xenobiotics regarding to specificities of their biotransformations; o Predict the potential of interactions of a drug based on the metabolic pathways as well as the potential of enzyme inhibition or induction; o Understand the relationship between drug structure and metabolic process as well as specific enzymes involved in its metabolism; o Calculate the molecular descriptors and optimize the geometry of the molecule; o Describe the formation and to identify the main metabolites of certain drugs.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	PREDAVANJA: o Introduction to biochemistry of drugs and the importance of drug metabolism research; o *In vitro* and *in silico* tools in the study of metabolism in the discovery and

	early drug development. Introduction to the seminar and practical training; o Biological oxidation; o Reactions of monooxygenation in drug biotransformation. Hydroxylation of aromatic compounds. NIH-shift; o Dehydrogenases/reductases; o *N*-oxidation catalyzed by CYP and FMO o Oxidation of *S* atom catalyzed by CYP and FMO o Other reactions catalyzed by CYP enzymes o Aromatization, cyclization and other less common reactions catalyzed by CYP enzymes o Other oxidoreductases and their reactions. Monoamine oxidase (MAO) inhibitors and other aminooxidases; Molibdenoxidases, Aldehyde oxidases (AO) and Xanthine oxidoreductases, XOR (XDH and XO); o Biological reduction; o Biotransformation of endogenous substances; o Reactions of hydrolysis and their enzymes (Part I and Part II). Pro-drugs; o Phase II Reactions – Reactions of conjugation and their enzymes: methylations, sulfonations and phosphorylations of xenobiotics and endobiotics; o Phase II Reactions – Reactions of conjugation and their enzymes – Reactions of glucuronidation and other glycosidations in the biotransformation of drugs and other xenobiotics; o Phase II Reactions - Reactions of conjugation and their enzymes - Glutathione and its reactions; o Enzyme induction and inhibition; o Metabolism and bioactivity; o Metabolism and toxicity (reactive intermediates of biotransformation, toxicophore moieties – quinones, electrophyle species, etc.); o *Inter*- and *intra*-individual factors affecting drug metabolism. SEMINARS: o Mathematical modeling, SAR, QSAR and QSPR, graph theory; o Lipophilicity, experimental and computational methods for logP assessment; o Plasma protein binding of drugs; o Evaluation of cytochrome P450 enzymes responsible for metabolism of xenobiotics; o Drug-drug interactions; o The role of the CYP enzymes in the biosynthesis of steroids; o The basic principles of biotransformation - Repetitorium EXCERCISES: o Investigation of the relationship between the chemical structure, physical-chemical properties, drug-likeness scores and biological activity (QSAR) o Prediction of the metabolic reactions of antimicrobe sulfonamides catalyzed by CYP enzymes using MedChem Studio and ADMET Predictor™ software packages o Study of the drug plasma protein binding - Binding of drugs to human serum albumin (HSA) o Biotransformation of acetylsalicylic acid and salicylamide o Evaluation of potential drug-drug interactions based on predicted metabolic reactions catalyzed by CYP enzymes

<table>
<tr><td>2.6. Type of instruction</td><td colspan="2">lectures
seminars
workshops
exercises
online in entirety
mixed e-learning
mixed m-learning</td><td colspan="2">field work
independent study
multimedia and the internet
work with the mentor
(other)</td></tr>
<tr><td>2.7. Student responsibilities</td><td colspan="4"></td></tr>
<tr><td rowspan="7">2.8. 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)</td><td>Class attendance</td><td>1</td><td>Seminar essay</td><td>0.5</td></tr>
<tr><td>Experimental work</td><td>0.5</td><td>Oral exam</td><td>2.5</td></tr>
<tr><td>Essay</td><td></td><td>Project</td><td></td></tr>
<tr><td>Tests</td><td>1</td><td>Practical training</td><td></td></tr>
<tr><td>Written exam</td><td>2</td><td>(Other--describe)</td><td></td></tr>
<tr><td>Research</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>Report</td><td>0.5</td><td>(Other--describe)</td><td></td></tr>
<tr><td>2.9. Grading and evaluation of student work over the course of instruction and at a final exam</td><td colspan="4">After completing practicum students take colloquium.
Preliminary exam is a prerequisite for taking the written examination.
Passing the written exam is a prerequisite for taking the oral exam.</td></tr>
<tr><td rowspan="6">2.10. Required literature (available at the library and via other media)</td><td>Title</td><td>Number of copies at the library</td><td colspan="2">Availability via other media</td></tr>
<tr><td>Milena Jadrijević-Mladar Takač, Mirza Bojić, handouts of lecture and seminar presentations</td><td></td><td colspan="2">available at Merlin system</td></tr>
<tr><td>S.Rendić i M.Medić-Šarić, Metabolizam lijekova i odabranih ksenobiotika, Medicinska naklada, Zagreb, 2013./ ISBN 978-953-176-587-9).</td><td>30</td><td colspan="2"></td></tr>
<tr><td>B. Testa, S.D. Krämer, The Biochemistry of Drug Metabolism: Volume 1: Principles, Redox Reactions, Hydrolyses, Wiley-VCH, Verlag GmbH, Weinheim, 2008.</td><td>1</td><td colspan="2"></td></tr>
<tr><td>B. Testa, S.D. Krämer, The Biochemistry of Drug Metabolism: Volume 2: Conjugations, Consequences of Metabolism, Influencing Factors, Wiley-VCH, Verlag GmbH, Weinheim, 2010.</td><td>1</td><td colspan="2"></td></tr>
<tr><td>M. Jadrijević-Mladar Takač, Exercises in Drug Biochemistry. FBF 2015 (ISBN 978-953-6256-84-6)</td><td>1</td><td colspan="2">available at Merlin system</td></tr>
<tr><td>2.11. Optional literature</td><td colspan="4"></td></tr>
<tr><td>2.12. Methods of monitoring quality that ensure acquisition of exit competences</td><td colspan="4">Outcomes 1st - 7th are checked by written and oral examination, the outcome 8th is checked during seminars while the outcome 9th by colloquium after exercises.</td></tr>
<tr><td>2.13. Comments</td><td colspan="4"></td></tr>
</table>

BIOCHEMISTRY OF DRUGS

1. COURSE DECRIPTION – GENERAL INFORMATION	
Course teacher	Assoc. Prof. Milena Jadrijević-Mladar Takač Assist. Prof. Monika Barbarić
Associate teachers	-
Graduate programme	Integrated
Status of the course	Compulsory
Year of study, Semester	4th Year/8th Semester
Credit value (ECTS)	5
Type of instruction (number of hours L+E+S+e-learning)	30 + 30 + 0 + e-learning
Expected enrolment in the course	25
Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2
2. COURSE DESCRIPTION	
Course objectives	Students will gain knowledge about biochemical changes of drugs, other chemical substances and endobiotics, and the effects of these metabolic changes in the body. Furthermore, students will gain insights into biochemical processes that involve drugs, mechanisms and the relationships between drug structure and biotransformation process and biological effect, as well as the features of enzymes and enzyme systems relevant for toxic effects, and the drug-drug and drug-other chemical substance interactions, as well.
Enrolment requirements and required entry competences for the course	The required entry competence are Medicinal Chemistry and Pharmacology.
Learning outcomes at the level of the study programme to which the course contributes	Students will be able to: • Define, analyse and to propose the procedures relevant to research and implementation of new laboratory tests in disease discovery and disease monitoring, as well as in monitoring of therapeutic outcomes and the effectiveness of the therapy, using the knowledge of xenobiotics biotransformation in the body; • Apply an acquired knowledge of metabolic pathways and enzymes involved in xenobiotics biotransformation in diagnostic tests and laboratory procedures, in assessment of clinical significance of biochemical and molecular biology indicators, in detecting the source of errors and variability of the results of laboratory analysis and the interpretation of results by biochemical and clinical aspects.
Expected learning outcomes at the level of the course (4-10 learning outcomes)	After completing the course students will be able to: 1. Identify the main metabolic pathways for particular endogenous substances and drugs, 2. List the major enzyme systems and their role in biotransformation reactions, 3. Explain the specific pathway of biochemical activation and/or toxicity occurrence, as well as side effects and interactions, 4. Describe the pharmacodynamic and pharmacokinetic properties of certain drugs and xenobiotics regarding the specificity of their biotransformation, 5. Link the drug structure with metabolic pathways and specific enzymes involved in biotransformation, 6. Predict the major biotransformation products (metabolites) of certain drugs and to describe their formation.
Course content broken down in detail by weekly class schedule (syllabus)	**LECTURES:** o Introduction to Biochemistry of drugs and the importance of drug metabolism research o Phase I Reactions – Oxidoreduction reactions and oxidoreductases (EC1) playing a major or secondary role in xenobiotic and endobiotic metabolism

- Catalytic mechanism of cytochrome P450 (CYP) enzymes and flavin monooxygenases (FMOs).
- Phase I Reactions – Oxidations (biooxidations): CYP-catalyzed sp^3-C-, sp^2-C- and sp-C-oxidation of the examples of drugs. Mechanisms of olefine and aromatic monooxygenation of C=C bond. Regioselectivity and substrate and product stereoselectivity in monooxygenase-mediated drug activation and inactivation.
- Phase I Reactions - Oxidation of *N*- and *S*-atoms catalyzed by CYPs and FMOs. *N*-oxygenation of basic or weakly basic tertiary, secondary and primary amines, aromatic amides and toxicity of *N*-aryl-*N*-hydroxyamides, as well as *S*-oxidation of thiols and disulfides. Other reactions catalyzed by CYPs – Peroxidase reactions
- Phase I Reactions - Reductions (bioreductions) – Reactions of reductive dehalogenation catalyzed by CYPs – catalytic mechanism and examples of xenobiotic biotransformations. Other reductions catalyzed by CYPs and/or NADPH-CYP reductase (drug examples). Other oxidoreductases and their reactions: monoamine oxidase (MAO), diamineoxidase (DAO) and semicarbazide-sensitive amaine oxidases (SSAO), as well as aldehyde oxisidase (AO) and xanthine oxidoreductase, XOR (XDH and XO) involved in biotransformation of drugs.
- Phase I Reactions – Drug biotransformations catalyzed by peroxidases and prostaglandin G/H synthase (PGHS). Dehydrogenases/reductases important in the drug metabolism: alcohol dehydrogenase (ADH), aldehyde dehydrogenase (ALDH), aldo-keto reductase (AKR), short-chain dehydrogenase/reductase (SDR), carbonyl reductase (CR) and quinine reductase (NQO), as well as catalytic mechanism and bioactivation of antitumor drugs by NQO.
- Reactions of hydrolysis and their enzymes (Part I and Part II). Pro-drugs.
- Phase II Reactions – Reactions of conjugation and their enzymes: methylations, sulfonations and phosphorylations of xenobiotics and endobiotics.
- Phase II Reactions – Reactions of conjugation and their enzymes – Reactions of glucuronidation and other glycosidations in the biotransformation of drugs and other xenobiotics.
- Phase II Reactions - Reactions of conjugation and their enzymes - Glutathione and its reactions.
- Enzyme induction and inhibition
- Metabolism and bioactivity
- Metabolism and toxicity (reactive intermediates of biotransformation, toxicophore moieties – quinones, electrophyle species, etc.)
- *Inter*- and *intra*-individual factors affecting drug metabolism

EXCERCISES:

- Investigation of the relationship between the chemical structure, physical-chemical properties, drug-likeness scores and biological activity (QSAR)
- Prediction of the metabolic reactions of antimicrobe sulfonamides catalyzed by CYP enzymes using MedChem Studio and ADMET Predictor™ software packages
- Study of the drug plasma protein binding - Binding of drugs to human serum albumin (HSA)
- Biotransformation of acetylsalicylic acid and salicylamide
- Evaluation of potential drug-drug interactions based on predicted metabolic reactions catalyzed by CYP enzymes

<table>
<tr><td>Type of instruction</td><td colspan="3">lectures
seminars
workshops
exercises
online in entirety
mixed e-learning
mixed m-learning</td><td colspan="2">field work
independent study
multimedia and the internet
work with the mentor
(other)</td></tr>
<tr><td>2.7. Student responsibilities</td><td colspan="5">Class attendance and active participation in theoretical part (lectures), practical part (exercises), and passed preliminary exam.</td></tr>
<tr><td rowspan="7">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)</td><td>Class attendance</td><td>1.0</td><td>Seminar essay</td><td></td></tr>
<tr><td>Experimental work</td><td>0.5</td><td>Oral exam</td><td>2.0</td></tr>
<tr><td>Essay</td><td></td><td>Project</td><td></td></tr>
<tr><td>Tests</td><td>0.5</td><td>Practical training</td><td></td></tr>
<tr><td>Written exam</td><td>1.0</td><td>(Other--describe)</td><td></td></tr>
<tr><td>Research</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>Report</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>2.9. Grading and evaluation of student work over the course of instruction and at a final exam</td><td colspan="5">The student's activity is evaluated during the teaching process. The final assessment is made on the basis of the success achieved in the written and oral exam. After completing the excersises students must take colloquium which is a prerequisite for written exam and the passed written exam is a prerequisite for taking the oral exam.</td></tr>
<tr><td rowspan="4">2.10. Required literature (available at the library and via other media)</td><td colspan="2">Title</td><td>Number of copies at the library</td><td>Availability via other media</td></tr>
<tr><td colspan="2">Milena Jadrijević-Mladar Takač, Monika Barbarić, handouts are available through the Merlin e-learning system</td><td></td><td>available at Merlin system</td></tr>
<tr><td colspan="2">S.Rendić i M.Medić-Šarić, Metabolizam lijekova i odabranih ksenobiotika, Medicinska naklada, Zagreb, 2013./ ISBN 978-953-176-587-9).</td><td>30</td><td></td></tr>
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B. Testa, S.D. Krämer, The Biochemistry of Drug Metabolism: Volume 2: Conjugations, Consequences of Metabolism, Influencing Factors, Wiley-VCH, Verlag GmbH, Weinheim, 2010.
M. Jadrijević-Mladar Takač, Exercises in Drug Biochemistry. FBF 2015 (ISBN 978-953-6256-84-6)</td><td>1

1

1</td><td>

available at Merlin system</td></tr>
<tr><td>2.11. Optional literature</td><td colspan="4"></td></tr>
<tr><td>Methods of monitoring quality that ensure acquisition of exit competences</td><td colspan="4"></td></tr>
<tr><td>Comments</td><td colspan="4">Outcomes 1-5 are checked by written and oral exams, while the outcome 6 during the exercise by final colloquium.</td></tr>
</table>

BIOCHEMISTRY

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Prof Karmela Barišić Prof Lada Rumora
1.2. Associate teachers	Assistant Prof Marija Grdić Rajković Anita Somborac Bačura, PhD Andrea Hulina, mag. med. biochem.
1.3. Graduate programme	Pharmacy
1.4. Status of the course	compulsory
1.5. Year of study, Semester	2, 4
1.6. Credit value (ECTS)	8.5
1.7. Type of instruction (number of hours L+E+S+e-learning)	60 + 30 + 10
1.8. Expected enrolment in the course	130
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2
2. COURSE DESCRIPTION	
2.1. Course objectives	Student will acquire fundamental knowledge necessary to understand molecular logics of biochemical processes in living organisms; recognise dynamics in the synthesis and degradation of the natural biomacromolecules: proteins, polysaccharides, lipids and nucleic acids, and will be able to analyse and identify important factors that are influencing dynamics, control and regulation of cellular metabolism. Biochemical knowledge and skills acquired are compulsory basis for the further studies, especially in clinical biochemistry, haematology, pharmacology, biochemistry of drug metabolism, nutrition, molecular biology and genetic engineering, molecular diagnostics, identify molecular basis of diseases and therapy and other lessons dealing with metabolism of endogenic macromolecules, drugs and other xenobiotic in health and disease.
2.2. Enrolment requirements and required entry competences for the course	Enrolment requirements: completed study course Biological Chemistry
2.3. Learning outcomes at the level of the study programme to which the course contributes	1. Students will be able to apply fundamental biochemical knowledge to explain, analyse and evaluate procedures related to the research, development and production of drugs. 2. Development and implementation of the optimal solutions for practical and everyday problems in monitoring progress of the drug therapy (research and application of new laboratory diagnostic procedures for therapeutic drug monitoring). 3. Critical evaluation and application of the scientific data and expert knowledge for the problem solving in biochemical systems.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	1. Apply expert knowledge of biochemistry, chemistry and biology in biochemical problem solving. 2. Describe and apply basic biochemical principles for relating structure and function of the protein macromolecules. 3. Determine key enzymes regulating reaction rate in the metabolic pathways and asses what diagnostically measurable biochemical changes might indicate disorders in the particular enzyme systems. Estimate what genetic factors might be relevant to diseases and relate enzyme kinetics to regulatory enzyme characteristics.

	4. Explain biochemical mechanism of the DNA replication, generation and repair of the DNA mutations, recognise role of all elements in the process of transcription and protein synthesis, in prokaryotes and eukaryotes. 5. Review basic principles of acquiring and processing of data in pharmacogenetics, transcriptomics and proteomics 6. Designing and performing biochemical experiments based on grasped experimental and technical skills. 7. Analyse scientific data bases for the interpretation of the personal results and presentation to the professional audience.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES AND SEMINARS: • Dynamic aspects of structure and function of specific proteins: haemoglobin, myoglobin, collagen, elastin, proteins of the extracellular matrix • Structure and function of cell membranes in various tissues, transport of ions, amino acids, sugars • Methods for exploring proteins and protein sorting • Generation, transforming and storing of metabolic energy: basic concepts of metabolism • Glycolysis • Oxidative decarboxylation of pyruvate, citric acid cycle • Cellular bioenergetics and role of ATP generation and expenditure, respiratory chain and oxidative phosphorylation • Gluconeogenesis and pentose phosphate pathway • Glycogen metabolism, glycogenesis and glycogenolysis, reactions and hormone regulation • Biochemistry of hormones: insulin, epinephrine and cortisol • Fatty acid metabolism, degradation and synthesis of triglycerides, biosynthesis and β-oxidation of fatty acid, biosynthesis of ketone bodies • Protein turnover and amino acid catabolism, urea cycle • Biosynthesis of macromolecular precursors, amino acids, ribonucleotides and deoxyribonucleotides • Information in biological systems: DNA - structure and genetic role, genome organisation, chromosomes and genes • Methods for exploring genome • Histones and DNA packing, conformation of DNA molecule, DNA replication, fidelity of replication • DNA mutations and repair • RNA in translation of genetic message • Synthesis and modification of functional RNA molecules: mRNA and transcription, t-RNA, activation and role in protein synthesis, structure of ribosomes and rRNA • Genetic code and relation of genes and proteins, protein synthesis • Control of gene expression in prokaryotes: Lac-operon and Trp-operon • Chromosomes in eukaryotes and control of gene expression in eukaryotes, introns and exons • Integration of biochemical processes in the cell - basic concepts and design, strategy, control and regulation of metabolism LABORATORY PRACTICALS: • Determination of initial velocity v_o in acetylcholine reaction • Alkaline phosphatase • Homogenisation, differential centrifugation, determination of DNA and lactate in cellular fractions • Isolation of plasmid DNA from the transformed bacteria • Rate of glycolysis in various tissues

<table>
<tr><td></td><td colspan="4">• Electrophoresis of haemoglobin</td></tr>
<tr><td>2.6. Type of instruction</td><td colspan="2">lectures
seminars
workshops
exercises
online in entirety
mixed e-learning
mixed m-learning</td><td colspan="2">field work
independent study
multimedia and the internet
work with the mentor
laboratory</td></tr>
<tr><td>2.7. Student responsibilities</td><td colspan="4"></td></tr>
<tr><td rowspan="7">2.8. 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)</td><td>Class attendance</td><td>0.5</td><td>Seminar essay</td><td></td></tr>
<tr><td>Experimental work</td><td>1.5</td><td>Oral exam</td><td>2.5</td></tr>
<tr><td>Essay</td><td></td><td>Project</td><td></td></tr>
<tr><td>Tests</td><td>0.5</td><td>Practical training</td><td></td></tr>
<tr><td>Written exam</td><td>2.0</td><td>Semestral written tests</td><td>1.5</td></tr>
<tr><td>Research</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>Report</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>2.9. Grading and evaluation of student work over the course of instruction and at a final exam</td><td colspan="4">Seminars are organised as a problem solving practice, teachers are guiding the discussion and evaluating student achievements. During the lecture course two tests are organised, and marked for the final grade. Two additional tests are organised for laboratory practicals, before and after completing exercises. At the end of the complete lecture program written and oral exam are organised for the whole program and final grade is decided.</td></tr>
<tr><td rowspan="4">2.10. Required literature (available at the library and via other media)</td><td colspan="2">Title</td><td>Number of copies at the library</td><td>Availability via other media</td></tr>
<tr><td colspan="2">JM Berg, JL Tymoczko, L. Stryer: Biochemistry, 7th edition, Školska knjiga, Zagreb, 2013.</td><td>30</td><td></td></tr>
<tr><td colspan="2">TM Devlin: Texbook of Biochemistry with Clinical Correlation, J. Wiley & sons, New York, 2011.</td><td>15</td><td></td></tr>
<tr><td colspan="2"></td><td></td><td></td></tr>
<tr><td>2.11. Optional literature</td><td colspan="4">C. Smith, AD Marks: MMarks' basic Medical Biochemistry, A Clinical Approach.
Lippincott Williams & Wilkins, Philadelphia, 2005.</td></tr>
<tr><td>2.12. Methods of monitoring quality that ensure acquisition of exit competences</td><td colspan="4">Learning outcomes 1 and 6 are tested during experimental work in laboratory practicals and tests, outcome 7 during seminars, and outcomes 2-5 with written and oral exam.</td></tr>
<tr><td>2.13. Comments</td><td colspan="4"></td></tr>
</table>

BIOETHICS

1. COURSE DECRIPTION – GENERAL INFORMATION				
1.1. Course teacher	Prof. Tonči Matulić, PhD			
1.2. Associate teachers	Dr. Mislav Kutleša, PhD			
1.3. Graduate programme	Medical Biochemistry			
1.4. Status of the course	Obligatory			
1.5. Year of study, Semester	Firs Year, Second Semester			
1.6. Credit value (ECTS)	2			
1.7. Type of instruction (number of hours L+E+S+e-learning)	15+0+5			
1.8. Expected enrolment in the course	25			
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	1.			
2. COURSE DESCRIPTION				
2.1. Course objectives	Introduction to the basic principles of biomedical ethics. Recognition of ethical and bioethical challenge in biomedical science and practice. Arguing about ethical and bioethical dimensions of biomedical and medical-biochemistry practice. Application of bioethical principles on concrete scientific, biomedical and social cases with value charge.			
2.2. Enrolment requirements and required entry competences for the course	None.			
2.3. Learning outcomes at the level of the study programme to which the course contributes	Knowledge of ethics and bioethics in biomedical sciences and practice.			
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	Knowledge of basic ethical and bioethical notions. Knowledge of role of ethics and bioethics in biomedical sciences in general and medical biochemistry particular. Knowledge of ethical committee and institutional review board. Knowledge of main ethical and bioethical conventions and declarations. Recognition of ethical and bioethical challenge in biomedical science and practice. Arguing on the basis of ethical and bioethical principles.			
2.5. Course content broken down in detail by weekly class schedule (syllabus)				
2.6. Type of instruction	**lectures** **seminars** workshops exercises online in entirety mixed *e*-learning mixed *m*-learning		field work independent study multimedia and the internet work with the mentor (other)	
2.7. Student responsibilities				
2.8. 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	0,5	Seminar essay	0,5
	Experimental work		Oral exam	
	Essay		Project	
	Tests		Practical training	
	Written exam	1	(Other--describe)	
	Research		(Other--describe)	
	Report		(Other--describe)	
2.9. Grading and evaluation of student work over the course of instruction	Engaged participation in discussion during lectures and seminars, seminar paper and written exam.			

and at a final exam			
2.10. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	Matulić, Tonči (²2012.), *Bioetika*, Zagreb, GK.		
	Nacionalno bioetičko povjerenstvo za medicinu - Medicinski fakultet Sveučilišta u Zagrebu (2003.), *Etika u medicinskim istraživanjima i kliničkoj praksi*, Zagreb, Medicinska naklada.		
	Medicinski fakultet Sveučilišta u Zagrebu (2007.), *Medicinska etika*, Zagreb, Merkur A.B.D.		
2.11. Optional literature	Schwarz, Lisa – Preece, E. Paul – Hendry, A. Robert (2002.), *Medical Ethics: A Case-Based Approach*, Edinburgh – London – New York, Saunders. *Bioetika* (2011.), scripta ad usum privatum studentorum, Zagreb 2011.		
2.12. Methods of monitoring quality that ensure acquisition of exit competences	Through final examination.		
2.13. Comments	None.		

BIOLOGICAL CHEMISTRY

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Associate Professor Sanja Dabelić
1.2. Associate teachers	Professor Jerka Dumić Associate Professor Gordana Maravić Vlahoviček Assistant Professor Sandra Šupraha Goreta Associate Professor Olga Gornik Toma Keser, PhD
1.3. Graduate programme	Integrated study of Medical Biochemistry
1.4. Status of the course	Obligatory
1.5. Year of study, Semester	2th year
1.6. Credit value (ECTS)	6
1.7. Type of instruction (number of hours L+E+S+e-learning)	30+15+15+0 (e-learning - is not included in standard hours, but is used in teaching)
1.8. Expected enrolment in the course	25
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	3
2. COURSE DESCRIPTION	
2.1. Course objectives	To acquire the basic knowledge on the structure of biological macromolecules.To understand structure-function relationships of biological macromolecules, arrangement of biological membranes and transport across them, mechanisms of enzyme activity, and reaction-coupling in a living organism. To describe the principles of basic analytical and preparative biochemical techniques.
2.2. Enrolment requirements and required entry competences for the course	Passed exam Cellular biology with genetics Input Competence: application of high school knowledge of chemistry, physics, mathematics and biology; understanding the structure and physiology of prokaryotic and eukaryotic cells, as well as the basic principles, theories and mechanisms of heredity.
2.3. Learning outcomes at the level of the study programme to which the course contributes	• Applying basic knowledge of biochemistry in the laboratory diagnosis, in defining, analysing and proposing actions related to the research, production and quality assurance and implementation of new laboratory methods for the detection and monitoring of diseases and therapy-outcome. • Assessing the clinical significance of biochemical and molecular biological indicators, detecting variability of laboratory analysis results. • Optimizing and conducting laboratory analyses in different areas of health care. • Critical assessment and application of scientific knowledge and available information in order to improve the profession, problem solving, application of new technologies and improving the existing ones.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After successfully completing the course, students will be able to: 1. Describe the structure of biological molecules / macromolecules and biological membranes. 2. Correlate the characteristics of individual functional groups, as well as the overall properties of biological molecules / macromolecules and biological membranes with their function. 3. Analyse the modes of transport across biological membranes. 4. Give examples of the abnormal structure / localization / activity of biological macromolecules that lead to the development of the disease or are used for the diagnosis / treatment of diseases. 5. Explain the principles of bioenergetics, thermodynamics and kinetics of reactions occuring in living organisms. 6. Describe the course of enzymatic reactions and mechanisms of enzyme catalysis. 7. Compare the mechanisms of modulation of enzymatic activity. 8. Define the principles of basic biochemical analysis techniques and protein

	purification. 9. Perform simple biochemical analysis – detect particular biological macromolecules in biological samples, purify proteins using fundamental purification methods, extract lipids and determine Vm and Km of enzymes.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES • Introductory lecture; Biochemistry - the logic of life, coupling of biochemistry and molecular life sciences; Biochemistry as a basis of biomedical sciences. Life conditions. The chemical composition of cells (elemental composition of living matter, the properties of water, functional groups and structure of biomolecules, properties of biological macromolecules: directionality, modular design, conformational dynamics, information, meaning (importance) of non-covalent forces, complementarity and molecular structure of cells). • Amino acids. Proteogenic amino acids. Ionization properties of amino acids. The chemical properties of amino acids. Classification of amino acids according to the various properties. Modification of proteogenic amino acids. Biologically important non-proteogenic amino acids. Buffers in biological systems and buffer capacity. • Theoretical basis of potentiometric titration of amino acids, biochemical techniques, enzyme kinetics, structure of carbohydrates, lipids and nucleic acids (preparation to access to the laboratory exercises). • Peptide bond. The properties of peptide bond. Biologically important peptides. Proteins. Protein classification. Primary, secondary, tertiary and quaternary structure. The functional and structural domains. • Proteins - native conformation and denaturation of proteins. Fibrous proteins - keratin, collagen, silk. Globular proteins - myoglobin, hemoglobin, immunoglobulins. The evolution of protein structure. Post-translational modifications of proteins. • Biochemical techniques for protein purification. Sedimentation technique. Chromatographic techniques. Electrophoretic techniques. Determination of the protein primary structure. • Nucleic acid - nucleotides, nucleic acid structure. Complementarity of DNA double helix. DNA conformations. Thermic denaturation of DNA. Types of RNA. Secondary, tertiary structure of RNA. The flow of genetic information. • Carbohydrates. Monosaccharides. The stereochemistry of monosaccharides. Cyclization of monosaccharides. Chemical reactions of monosaccharides. Reductive properties of carbohydrates. Biologically important derivatives of monosaccharides. The glycosidic bond. Disaccharides. Oligosaccharides. Polysaccharides. The biological roles of carbohydrates. • Lipids - classification of lipids. Fatty acids. Triacylglycerols (neutral lipids). Waxes. Phospholipids and sphingolipids. Chemical reactions and properties of lipids. Soaps and detergents. Isoprenoid lipids - steroids, carotenoids, isoprenoid vitamins. Eicosanoids. • Glycoconjugates - classification, structural and functional characteristics. Synthesis of glycan / glycoconjugates. Glycoproteins. Proteoglycans. Glycolipids. Glycocylphosphatidyl-inositol anchors. Lectins. Glycan-lectin-interactions as a basis of many important biological processes. Examples of glycans in health, disease, diagnosis and treatment of disease. • The structural and functional characteristics of the membrane lipids. Biological membranes - supramolecular structures with many functions. Micelles, lipid bilayers, liposomes. Physical and chemical properties of biological membranes. Membrane proteins. Transport across the membrane. The transport mechanisms (passive, facilitated/assisted, active). Thermodynamics / energetics and kinetics of membrane transport. Concentration and electrochemical gradients. • Bioenergetics. Life - non-equilibrium steady state. Thermodynamics of biological reactions -Energy potential of reactions. Metastability of open system, the driving force of biological reactions.Cellular concentration ratios. Thermodynamic laws

	govern biological processes. Coupling endergonic and exergonic reactions. ATP - the energy currency.Potential of group transfer. • Enzymes - biological catalysts. Classification of enzymes. Active centre. Specificity and acceleration. Isoenzymes. Coenzymes - role of coenzymes. • Enzyme catalysis. The mechanisms of enzyme catalysis. Thermodynamics of enzyme-catalysed reactions. Rate of the enzymatic reaction. • Michaelis-Menten kinetics. Inhibition of enzymatic reactions. Regulation of metabolism. SEMINARS • Problems: ionization properties and titration curves of amino acids and small peptides at different pH, buffer capacity. • Problems: protein purification techniques –precipitation with ammonium sulphate, types of chromatography, electrophoresis – native and SDS-PAGE. • Problems: nitrogenous bases -structure and numbering of atoms, complementary base pairing, shares of nitrogenous bases in nucleic acids, the size of molecules. Properties of nucleosides and nucleic acids. Structure carbohydrates - stereochemistry of saccharides, reductive properties, glycosidic bond, properties of polysaccharides. • Problems: structure of lipids and glycoconjugates - classification, structure-function relationship, glycans as diagnostic markers and potential target of pharmacologically active substances. • Problems: transport of substances across the cell membrane and bioenergetics. • Problems: enzymes, mechanisms of enzyme kinetics; enzyme kinetics - the time course of enzyme reactions, steady state, Michaelis-Menten kinetics, the effect of enzyme and substrate concentration, and pH on the enzymatic reactions • Overview of processed chapters of Biological Chemistry –additional clarification of certain problems / concepts based on student queries. EXERCISES: • Potentiometric titration of amino acids - ionization properties of amino acids, assessment (determination) of the molecular weight of amino acides, the determination of the buffer capacity. • Gel-filtration of haemoglobin.Purification of immunoglobulin G from human serum (selective precipitation and desalting by gel-filtration). • Purification of immunoglobulin G from human serum (ion-exchange chromatography, detecting the presence and estimation of purity of IgG). • Enzyme kinetics - the time course of the enzymatic reaction, the dependence of the initial rate of enzyme reaction on the concentration of substrate and enzyme. • Carbohydrates-detection of starch, carbohydrates, reductive carbohydrates, proteins, glucose in biological samples, degradation of disaccharides to monosaccharides.
2.6. Type of instruction	**lectures** **seminars** workshops **exercises** online in entirety mixed *e*-learning mixed *m*-learning field work independent study multimedia and the internet work with the mentor (other)
2.7. Student responsibilities	The students are required to attend classes that take place in the form of lectures, seminars and practical classes (exercises). To be eligible to attend exercise, the students are required to describe basic macromolecule structure and principles of methods that are related to the exercise subject. The students, for the achievement of credits and grades in specified courses, are required to take the written and oral exam and pass them both successfully.

2.8. Screening of student's work (specify the proportion of ECTS credits for each				
	Class attendance	1	Seminar essay	0.5
	Experimental work	0.5	Oral exam	3

<table>
<tr><td rowspan="5">activity so that the total number of CTS credits is equal to the credit value of the course)</td><td>Essay</td><td></td><td>Project</td><td></td></tr>
<tr><td>Tests</td><td></td><td>Practical training</td><td></td></tr>
<tr><td>Written exam</td><td>1</td><td>(Other--describe)</td><td></td></tr>
<tr><td>Research</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>Report</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>2.9. Grading and evaluation of student work over the course of instruction and at a final exam</td><td colspan="4">The students are evaluated according to the performance in the written (20%) and oral examination (80%), which can be accessed only after the attended lectures, seminars and practical exercises. On the final exam students are required to demonstrate knowledge of all areas covered by the program of the course, at the level of skilled information management and integration.</td></tr>
<tr><td rowspan="4">2.10. Required literature (available at the library and via other media)</td><td>Title</td><td>Number of copies at the library</td><td colspan="2">Availability via other media</td></tr>
<tr><td>Dumić, J., Dabelić, S., Gornik, O., Maravić Vlahoviček, G., Novak, R., Šupraha Goreta, S. Biološka kemija – praktikum, Farmaceutsko-biokemijski fakultet Sveučilišta u Zagrebu, Zagreb, 2010., ISBN 978-953-6256-61-7.</td><td>1</td><td colspan="2">In pdf form available at the e-learning platform</td></tr>
<tr><td>J. M. Berg, J. L. Tymoczko, L. Stryer, Biokemija, Školska knjiga, Zagreb, 6. englesko izdanje, 1 hrvatsko, 2013., ISBN 978-953-0-309928-9</td><td>30</td><td colspan="2"></td></tr>
<tr><td>Dabelić S. and Dumić J. Biological Chemistry Powerpoint presentations – for the present academic year</td><td>0</td><td colspan="2">In pdf form available at the e-learning platform</td></tr>
<tr><td>2.11. Optional literature</td><td colspan="4">D. L. Nelson, M.M. Cox, Lehninger, Principles of Biochemistry, W.H. freeman and Co, Sixth Ed, 2013.
Voet, Voet – Biochemistry, John Wiley&Sons, Second Ed, 1995 (or later editions)
G.M. Cooper, R.E Hausmann, Stanica: molekularni pristup, Medicinska naklada, Peto izdanje, 2010. ISBN 953-176-248-1</td></tr>
<tr><td>2.12. Methods of monitoring quality that ensure acquisition of exit competences</td><td colspan="4">Outcomes 1,2,6,8 and 9 are checked orally before and during laboratory exercise, outcomes 1-9 are checked through oral problem-solving tests during seminars, and outcomes 1-9 are checked by written and oral exam.</td></tr>
<tr><td>2.13. Comments</td><td colspan="4">e-learning - is not included in standard hours, but is used in teaching and contains exams for knowledge-self-evaluation with solutions, links to different pages, video and audio materials (some produced by the teacher in collaboration with SRCE), etc.</td></tr>
</table>

BIOLOGICAL CHEMISTRY

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Associate Professor Sanja Dabelić
1.2. Associate teachers	Professor Jerka Dumić Associate Professor Gordana Maravić Vlahoviček Assistant Professor Sandra Šupraha Goreta Associate Professor Olga Gornik Toma Keser, PhD
1.3. Graduate programme	Integrated study of Pharmacy
1.4. Status of the course	Obligatory
1.5. Year of study, Semester	2th year
1.6. Credit value (ECTS)	3.5
1.7. Type of instruction (number of hours L+E+S+e-learning)	30+15+0+0 (e-learning - is not included in standard hours, but is used in teaching)
1.8. Expected enrolment in the course	130
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	3
2. COURSE DESCRIPTION	
2.1. Course objectives	To acquire the basic knowledge on the structure of biological macromolecules.To understand structure-function relationships of biological macromolecules, arrangement of biological membranes and transport across them, mechanisms of enzyme activity, and reaction-coupling in a living organism. To describe the principles of basic analytical and preparative biochemical techniques.
2.2. Enrolment requirements and required entry competences for the course	Passed exam Cellular biology with genetics Input Competence: application of high school knowledge of chemistry, physics, mathematics and biology; understanding the structure and physiology of prokaryotic and eukaryotic cells, as well as the basic principles, theories and mechanisms of heredity.
2.3. Learning outcomes at the level of the study programme to which the course contributes	• Defining, analyzing and proposing actions related to research, development, production, analysis and quality control of drugs by applying the fundamentals of biochemistry. • Critical assessment and application of scientific knowledge and available information in order to improve the profession, problem solving, application of new technologies and improving the existing ones.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After successfully completing the course, students will be able to: 1. Describe the structure of biological molecules / macromolecules and biological membranes. 2. Correlate the characteristics of individual functional groups, as well as the overall properties of biological molecules / macromolecules and biological membranes with their function. 3. Analyse the modes of transport across biological membranes. 4. Give examples of the abnormal structure / localization / activity of biological macromolecules that lead to the development of the disease or are used for the diagnosis / treatment of diseases.

	5. Explain the principles of bioenergetics, thermodynamics and kinetics of reactions occuring in living organisms. 6. Describe the course of enzymatic reactions and mechanisms of enzyme catalysis. 7. Compare the mechanisms of modulation of enzymatic activity. 8. Define the principles of basic biochemical analysis techniques and protein purification. 9. Perform simple biochemical analysis – detect particular biological macromolecules in biological samples, purify proteins using fundamental purification methods, extract lipids and determine Vm and Km of enzymes.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES • Introductory lecture; Biochemistry - the logic of life, coupling of biochemistry and molecular life sciences; Biochemistry as a basis of biomedical sciences. Life conditions. The chemical composition of cells (elemental composition of living matter, the properties of water, functional groups and structure of biomolecules, properties of biological macromolecules: directionality, modular design, conformational dynamics, information, meaning (importance) of non-covalent forces, complementarity and molecular structure of cells). • Amino acids. Proteogenic amino acids. Ionization properties of amino acids. The chemical properties of amino acids. Classification of amino acids according to the various properties. Modification of proteogenic amino acids. Biologically important non-proteogenic amino acids. Buffers in biological systems and buffer capacity. • Theoretical basis of potentiometric titration of amino acids, biochemical techniques, enzyme kinetics, structure of carbohydrates, lipids and nucleic acids (preparation to access to the laboratory exercises). • Peptide bond. The properties of peptide bond. Biologically important peptides. Proteins. Protein classification. Primary, secondary, tertiary and quaternary structure. The functional and structural domains. • Proteins - native conformation and denaturation of proteins. Fibrous proteins - keratin, collagen, silk. Globular proteins - myoglobin, hemoglobin, immunoglobulins. The evolution of protein structure. Post-translational modifications of proteins. • Biochemical techniques for protein purification. Sedimentation technique. Chromatographic techniques. Electrophoretic techniques. Determination of the protein primary structure. • Nucleic acid - nucleotides, nucleic acid structure. Complementarity of DNA double helix. DNA conformations. Thermic denaturation of DNA. Types of RNA. Secondary, tertiary structure of RNA. The flow of genetic information. • Carbohydrates. Monosaccharides. The stereochemistry of monosaccharides. Cyclization of monosaccharides. Chemical reactions of monosaccharides. Reductive properties of carbohydrates. Biologically important derivatives of monosaccharides. The glycosidic bond. Disaccharides. Oligosaccharides. Polysaccharides. The biological roles of carbohydrates. • Lipids - classification of lipids. Fatty acids. Triacylglycerols (neutral lipids). Waxes. Phospholipids and sphingolipids. Chemical reactions and properties of lipids. Soaps and detergents. Isoprenoid lipids - steroids, carotenoids, isoprenoid vitamins. Eicosanoids. • Glycoconjugates - classification, structural and functional characteristics. Synthesis of glycan / glycoconjugates. Glycoproteins. Proteoglycans. Glycolipids. Glycocylphosphatidyl-inositol anchors. Lectins. Glycan-lectin-interactions as a basis of many important biological processes. Examples of glycans in health, disease, diagnosis and treatment of disease. • The structural and functional characteristics of the membrane lipids. Biological membranes - supramolecular structures with many functions. Micelles, lipid

<table>
<tr><td></td><td colspan="4">bilayers, liposomes. Physical and chemical properties of biological membranes. Membrane proteins. Transport across the membrane. The transport mechanisms (passive, facilitated/assisted, active). Thermodynamics / energetics and kinetics of membrane transport. Concentration and electrochemical gradients.
• Bioenergetics. Life - non-equilibrium steady state. Thermodynamics of biological reactions -Energy potential of reactions. Metastability of open system, the driving force of biological reactions.Cellular concentration ratios. Thermodynamic laws govern biological processes. Coupling endergonic and exergonic reactions. ATP - the energy currency.Potential of group transfer.
• Enzymes - biological catalysts. Classification of enzymes. Active centre. Specificity and acceleration. Isoenzymes. Coenzymes - role of coenzymes.
• Enzyme catalysis. The mechanisms of enzyme catalysis. Thermodynamics of enzyme-catalysed reactions. Rate of the enzymatic reaction.
• Michaelis-Menten kinetics. Inhibition of enzymatic reactions. Regulation of metabolism.

EXERCISES:
• Potentiometric titration of amino acids - ionization properties of amino acids, assessment (determination) of the molecular weight of amino acides, the determination of the buffer capacity.
• Gel-filtration of haemoglobin.Purification of immunoglobulin G from human serum (selective precipitation and desalting by gel-filtration).
• Purification of immunoglobulin G from human serum (ion-exchange chromatography, detecting the presence and estimation of purity of IgG).
• Enzyme kinetics - the time course of the enzymatic reaction, the dependence of the initial rate of enzyme reaction on the concentration of substrate and enzyme.
• Carbohydrates-detection of starch, carbohydrates, reductive carbohydrates, proteins, glucose in biological samples, degradation of disaccharides to monosaccharides.</td></tr>
<tr><td>2.6. Type of instruction</td><td colspan="2">lectures
seminars
workshops
exercises
online in entirety
mixed e-learning
mixed m-learning</td><td colspan="2">field work
independent study
multimedia and the internet
work with the mentor
(other)</td></tr>
<tr><td>2.7. Student responsibilities</td><td colspan="4">The students are required to attend classes that take place in the form of lectures and practical classes (exercises).
To be eligible to attend exercise, the students are required to describe basic macromolecule structure and principles of methods that are related to the exercise subject. The students, for the achievement of credits and grades in specified courses, are required to take the written and oral exam and pass them both successfully.</td></tr>
<tr><td rowspan="8">2.8. 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)</td><td>Class attendance</td><td>1</td><td>Seminar essay</td><td></td></tr>
<tr><td>Experimental work</td><td>0.5</td><td>Oral exam</td><td>1.5</td></tr>
<tr><td>Essay</td><td></td><td>Project</td><td></td></tr>
<tr><td>Tests</td><td></td><td>Practical training</td><td></td></tr>
<tr><td>Written exam</td><td>0.5</td><td>(Other--describe)</td><td></td></tr>
<tr><td>Research</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>Report</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>2.9. Grading and evaluation of student work over the course of instruction and at a final exam</td><td colspan="4">The students are evaluated according to the performance in the written (20%) and oral examination (80%), which can be accessed only after the attended lectures and practical exercises. On the final exam students are required to demonstrate knowledge of all areas covered by the program of the course, at the level of skilled</td></tr>
</table>

	information management and integration.		
2.10. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	Dumić, J., Dabelić, S., Gornik, O., Maravić Vlahoviček, G., Novak, R., Šupraha Goreta, S. Biološka kemija – praktikum, Farmaceutsko-biokemijski fakultet Sveučilišta u Zagrebu, Zagreb, 2010., ISBN 978-953-6256-61-7.	1	In pdf form available at the e-learning platform
	J. M. Berg, J. L. Tymoczko, L. Stryer, Biokemija, Školska knjiga, Zagreb, 6. englesko izdanje, 1 hrvatsko, 2013., ISBN 978-953-0-309928-9	30	
	Dabelić S. and Dumić J. *Biological Chemistry* *Powerpoint presentations* – for the present academic year	0	In pdf form available at the e-learning platform
2.11. Optional literature	D. L. Nelson, M.M. Cox, Lehninger, Principles of Biochemistry, W.H. freeman and Co, Sixth Ed, 2013. Voet, Voet – Biochemistry, John Wiley&Sons, Second Ed, 1995 (or later editions) G.M. Cooper, R.E Hausmann, Stanica: molekularni pristup, Medicinska naklada, Peto izdanje, 2010. ISBN 953-176-248-1		
2.12. Methods of monitoring quality that ensure acquisition of exit competences	Outcomes 1,2,6,8 and 9 are checked orally before and during laboratory exercise and outcomes 1-9 are checked by written and oral exam.		
2.13. Comments	e-learning - is not included in standard hours, but is used in teaching and contains exams for knowledge-self-evaluation with solutions, links to different pages, video and audio materials (some produced by the teacher in collaboration with SRCE), etc.		

BIOLOGICAL MEMBRANES AND CELL SIGNALLING

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Prof. Lada Rumora, PhD.
1.2. Associate teachers	Assistant Prof. Erim Bešić, PhD.
1.3. Graduate programme	Integrated Pharmacy Study Programme
1.4. Status of the course	elective
1.5. Year of study, Semester	3. year of study, 5. semester
1.6. Credit value (ECTS)	2.5
1.7. Type of instruction (number of hours L+E+S+e-learning)	15 (L) + 0 (E) + 15 (S) + 0 (e-learning)
1.8. Expected enrolment in the course	FS: 40 – 45 (+ MBS: 15 – 20)
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2.
2. COURSE DESCRIPTION	
.1. Course objectives	Understand the structure of biological membranes, define the general principals of intracellular signalling and mechanisms of interactions between signalling molecules, identify various families of transport proteins and specify different modes of transport through biological membranes, recognize signalling molecules as potential therapeutic targets. Apply the gained knowledge and skills in other courses of Medical Biochemistry as well as Pharmacy that include in their study programmes drug transport and delivery through biological membranes, drug interactions with plasma membrane receptors and/or with intracellular molecules, diagnostics of various diseases and personalized therapeutic approaches to the patients (personalized medicine).
.2. Enrolment requirements and required entry competences for the course	Biochemistry course attendance.
.3. Learning outcomes at the level of the study programme to which the course contributes	• Implementation of gained knowledge in laboratory diagnostics, in defining, analysing and recommendation of the procedures in the research, production and quality control as well as implementation of new laboratory procedures for diagnostics of diseases, follow-up of the diseases progression and therapeutic effects. • Critical evaluation and application of scientific data and expert knowledge for the problem solving in biochemical systems.
.1. Expected learning outcomes at the level of the course (4-10 learning outcomes)	The learning outcomes after attending this course: 1. Understand dynamic aspects of structure and function of biological membranes. 2. Recognize the relationship of membrane structure and transport of ions and various molecules through membrane bilayers. 3. Identify main classes of transport proteins integrated within biological membranes and compare different types of transport across the

	membranes. 4. Define different modes of cell death. 5. Select appropriate methods for cell viability and cell death determination. 6. Compare various mechanisms of signal transduction. 7. Analyse signal transduction pathways and understand the implications of signalling activations on the final biological response of the cell. 8. Recognize the importance of signalling molecules in diagnostics and therapeutics approaches.
.2. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES AND SEMINARS: • Programmed cell death – apoptosis: morphological characteristic of apoptotic cells; cell viability methods • Caspases: activation and inhibition of caspases' cascades; caspases and apoptosis; caspases as therapeutic targets • Mitogen-activated protein kinases (MAPKs): MAPK signalling pathway, regulation of MAPK activation: kinases that activate MAPKs, phosphatases that inhibit MAPKs; MAPKs as therapeutic targets • Bcl-2 proteins: role of Bcl-2 proteins in cell survival; interrelationships between Bcl-2 proteins, MAPKs and caspases; Bcl-2 proteins as therapeutic targets • Heat shock proteins (Hsps): role of Hsps in cell survival, Hsps as therapeutic targets • Dynamic and structural organisation of biological membranes: lipids and proteins • Membrane proteins: classes of membrane proteins, integral proteins, peripheral proteins, different modes of peripheral proteins interconnections, synthesis, organisation and transport of lipids through asymmetric lipid bilayers; red blood cell membrane • Carbohydrates and lipids of biological membranes: carbohydrates and selectins, modifications of carbohydrates in Golgi apparatus, purpose of glycosylation, specific glycosylation of lysosomal enzymes – diseases related to inappropriate glycosylation • Transport of small molecules across plasma membranes: type of transport through biological membranes, gradients and forces involved in the transport process, carrier proteins, protein channels, ion channels, control of opening and closing of tight junctions, acetylcholine receptor, structure of Na^+ channel, structure of K^+ channel, three types of transport through carriers, role and function of Na^+/K^+ ATPase

<table>
<tr><td></td><td colspan="4">

- Different families of transport proteins: ATPases, ABC transport proteins, CFTR, MDR drug transporters, transport of glucose; mechanisms of transport, asymmetry of transporters distribution
- Intercellular and intracellular signalling: signalling pathways that involve cAMP or cGMP, G proteins – molecular switches, Ca^{2+} as an intracellular messenger, role and function of protein kinase C

</td></tr>
<tr><td>.3. Type of instruction</td><td colspan="2"><u>lectures</u>
<u>seminars</u>
workshops
exercises
online in entirety
mixed e-learning
mixed m-learning</td><td colspan="2">field work
independent study
multimedia and the internet
work with the mentor
(other)</td></tr>
<tr><td>2.7. Student responsibilities</td><td colspan="4">Regular attendance of the classes, individual presentation of the topic selected after searching for adequate literature data, active retrospection on other students' presented topics.</td></tr>
<tr><td rowspan="8">2.8. 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)</td><td>Class attendance</td><td>0.3</td><td>Seminar essay</td><td>1</td></tr>
<tr><td>Experimental work</td><td></td><td>Oral exam</td><td></td></tr>
<tr><td>Essay</td><td></td><td>Project</td><td></td></tr>
<tr><td>Tests</td><td></td><td>Practical training</td><td></td></tr>
<tr><td>Written exam</td><td>1.2</td><td>(Other--describe)</td><td></td></tr>
<tr><td>Research</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>Report</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td colspan="4"></td></tr>
<tr><td>2.9. Grading and evaluation of student work over the course of instruction and at a final exam</td><td colspan="4">Written exam, individual presentation of the topic selected after searching for adequate literature data.</td></tr>
<tr><td rowspan="4">2.10. Required literature (available at the library and via other media)</td><td colspan="2">Title</td><td>Number of copies at the library</td><td>Availability via other media</td></tr>
<tr><td colspan="2">Lodish, Berk, Matsudaira, Kaiser, Krieger, Scott, Zipursky, Darnell; Molecular Cell Biology. 7th edition, 2012</td><td></td><td></td></tr>
<tr><td colspan="2">Gerhard Krauss; Biochemistry of Signal Transduction and Regulation. 4th expanded and improved edition, 2008</td><td></td><td></td></tr>
<tr><td colspan="2"></td><td></td><td></td></tr>
<tr><td>2.11. Optional literature</td><td colspan="4">Up-to-date review papers regarding the course topics.</td></tr>
<tr><td>2.12. Methods of monitoring quality that ensure acquisition of exit competences</td><td colspan="4">All learning outcomes are checked by written exam, and the understanding of the course topics is additionally checked during course's seminars.</td></tr>
<tr><td>2.13. Comments</td><td colspan="4"></td></tr>
</table>

BIOLOGICAL MEMBRANES AND CELL SIGNALLING

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Prof. Lada Rumora, PhD.
1.2. Associate teachers	Assistant Prof. Erim Bešić, PhD.
1.3. Graduate programme	Integrated Medical Biochemistry Study Programme
1.4. Status of the course	elective
1.5. Year of study, Semester	3. year of study, 5. semester
1.6. Credit value (ECTS)	2.5
1.7. Type of instruction (number of hours L+E+S+e-learning)	15 (L) + 0 (E) + 15 (S) + 0 (e-learning)
1.8. Expected enrolment in the course	MBS: 15 – 20 (+ FS: 40 – 45)
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2.
2. COURSE DESCRIPTION	
.1. Course objectives	Understand the structure of biological membranes, define the general principals of intracellular signalling and mechanisms of interactions between signalling molecules, identify various families of transport proteins and specify different modes of transport through biological membranes, recognize signalling molecules as potential therapeutic targets. Apply the gained knowledge and skills in other courses of Medical Biochemistry as well as Pharmacy that include in their study programmes drug transport and delivery through biological membranes, drug interactions with plasma membrane receptors and/or with intracellular molecules, diagnostics of various diseases and personalized therapeutic approaches to the patients (personalized medicine).
.2. Enrolment requirements and required entry competences for the course	Biochemistry course attendance.
.3. Learning outcomes at the level of the study programme to which the course contributes	• Implementation of gained knowledge in laboratory diagnostics, in defining, analysing and recommendation of the procedures in the research, production and quality control as well as implementation of new laboratory procedures for diagnostics of diseases, follow-up of the diseases progression and therapeutic effects. • Critical evaluation and application of scientific data and expert knowledge for the problem solving in biochemical systems.
.1. Expected learning outcomes at the level of the course (4-10 learning outcomes)	The learning outcomes after attending this course: 1. Understand dynamic aspects of structure and function of biological membranes. 2. Recognize the relationship of membrane structure and transport of ions and various molecules through membrane bilayers. 3. Identify main classes of transport proteins integrated within biological membranes and compare different types of transport across the

	membranes. 4. Define different modes of cell death. 5. Select appropriate methods for cell viability and cell death determination. 6. Compare various mechanisms of signal transduction. 7. Analyse signal transduction pathways and understand the implications of signalling activations on the final biological response of the cell. 8. Recognize the importance of signalling molecules in diagnostics and therapeutics approaches.
.2. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES AND SEMINARS: • Programmed cell death – apoptosis: morphological characteristic of apoptotic cells; cell viability methods • Caspases: activation and inhibition of caspases' cascades; caspases and apoptosis; caspases as therapeutic targets • Mitogen-activated protein kinases (MAPKs): MAPK signalling pathway, regulation of MAPK activation: kinases that activate MAPKs, phosphatases that inhibit MAPKs; MAPKs as therapeutic targets • Bcl-2 proteins: role of Bcl-2 proteins in cell survival; interrelationships between Bcl-2 proteins, MAPKs and caspases; Bcl-2 proteins as therapeutic targets • Heat shock proteins (Hsps): role of Hsps in cell survival, Hsps as therapeutic targets • Dynamic and structural organisation of biological membranes: lipids and proteins • Membrane proteins: classes of membrane proteins, integral proteins, peripheral proteins, different modes of peripheral proteins interconnections, synthesis, organisation and transport of lipids through asymmetric lipid bilayers; red blood cell membrane • Carbohydrates and lipids of biological membranes: carbohydrates and selectins, modifications of carbohydrates in Golgi apparatus, purpose of glycosylation, specific glycosylation of lysosomal enzymes – diseases related to inappropriate glycosylation • Transport of small molecules across plasma membranes: type of transport through biological membranes, gradients and forces involved in the transport process, carrier proteins, protein channels, ion channels, control of opening and closing of tight junctions, acetylcholine receptor, structure of Na^+ channel, structure of K^+ channel, three types of transport through carriers, role and function of Na^+/K^+ ATPase

<table>
<tr><td></td><td colspan="4">

- Different families of transport proteins: ATPases, ABC transport proteins, CFTR, MDR drug transporters, transport of glucose; mechanisms of transport, asymmetry of transporters distribution
- Intercellular and intracellular signalling: signalling pathways that involve cAMP or cGMP, G proteins – molecular switches, Ca^{2+} as an intracellular messenger, role and function of protein kinase C

</td></tr>
<tr><td>.3. Type of instruction</td><td colspan="2"><u>lectures</u>
<u>seminars</u>
workshops
exercises
online in entirety
mixed e-learning
mixed m-learning</td><td colspan="2">field work
independent study
multimedia and the internet
work with the mentor
(other)</td></tr>
<tr><td>2.7. Student responsibilities</td><td colspan="4">Regular attendance of the classes, individual presentation of the topic selected after searching for adequate literature data, active retrospection on other students' presented topics.</td></tr>
<tr><td rowspan="8">2.8. 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)</td><td>Class attendance</td><td>0.3</td><td>Seminar essay</td><td>1</td></tr>
<tr><td>Experimental work</td><td></td><td>Oral exam</td><td></td></tr>
<tr><td>Essay</td><td></td><td>Project</td><td></td></tr>
<tr><td>Tests</td><td></td><td>Practical training</td><td></td></tr>
<tr><td>Written exam</td><td>1.2</td><td>(Other--describe)</td><td></td></tr>
<tr><td>Research</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>Report</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td colspan="4"></td></tr>
<tr><td>2.9. Grading and evaluation of student work over the course of instruction and at a final exam</td><td colspan="4">Written exam, individual presentation of the topic selected after searching for adequate literature data.</td></tr>
<tr><td rowspan="4">2.10. Required literature (available at the library and via other media)</td><td colspan="2">Title</td><td>Number of copies at the library</td><td>Availability via other media</td></tr>
<tr><td colspan="2">Lodish, Berk, Matsudaira, Kaiser, Krieger, Scott, Zipursky, Darnell; Molecular Cell Biology. 7th edition, 2012</td><td></td><td></td></tr>
<tr><td colspan="2">Gerhard Krauss; Biochemistry of Signal Transduction and Regulation. 4th expanded and improved edition, 2008</td><td></td><td></td></tr>
<tr><td colspan="2"></td><td></td><td></td></tr>
<tr><td>2.11. Optional literature</td><td colspan="4">Up-to-date review papers regarding the course topics.</td></tr>
<tr><td>2.12. Methods of monitoring quality that ensure acquisition of exit competences</td><td colspan="4">All learning outcomes are checked by written exam, and the understanding of the course topics is additionally checked during course's seminars.</td></tr>
<tr><td>2.13. Comments</td><td colspan="4"></td></tr>
</table>

BIOPHARMACEUTICS AND PHARMACOKINETICS

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Full Professor Jelena Filipović-Grčić, PhD Associate Professor Anita Hafner, PhD Associate Professor Jasmina Lovrić, PhD
1.2. Associate teachers	Marina Juretić, MPharm Sabina Keser, MPharm Zora Rukavina, MPharm
1.3. Graduate programme	Pharmacy
1.4. Status of the course	Obligatory course
1.5. Year of study, Semester	3rd year; 6th semester
1.6. Credit value (ECTS)	5
1.7. Type of instruction (number of hours L+E+S+e-learning)	15+30+15+0
1.8. Expected enrolment in the course	145
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2nd level
2. COURSE DESCRIPTION	
2.1. Course objectives	Student will adopt fundamentals of biopharmaceutics and understand the relationship between the drug absorption, distribution, metabolism and elimination processes and efficacy/safety of drug administration; student will understand the influence of dosage form, route of administration and dosage regimen on therapeutic outcomes. Accomplished knowledge and skills represent required entry competences for courses Drug formulation, Pharmacology, Clinical pharmacy an pharmacotherapy, Pharmaceutical care and Vocational training for pharmacist.
2.2. Enrolment requirements and required entry competences for the course	Enrolment requirements: Pharmaceutics course completed Exam: passed examination in Pharmaceutics
2.3. Learning outcomes at the level of the study programme to which the course contributes	• Select and apply technological processes in the production of pharmaceuticals. • Critical skills in the development and implementation of solutions for practical problems in the production of pharmaceuticals and the monitoring of safe and appropriate application of pharmaceuticals. • Informing and advising patients on the effects and proper application of pharmaceuticals as well as monitoring the treatment course and outcomes. • Apply expert knowledge and skills to provide advice on pharmacotherapy.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After completing the course student will be able to: 1. Correlate the processes of absorption, distribution, metabolism and elimination with efficacy/safety of drug administration. 2. Compare different routes of drug administration and explain the possibilities and limitations of each one. 3. Discuss the influence of dosage form, route of administration and dosage regimen on therapeutic outcomes. 4. Calculate absolute and relative bioavailability of the drug. 5. Calculate (recommend) the dosage regimen for single/multiple intravenous/oral drug administration using population/individual pharmacokinetic parameters. 6. Calculate plasma drug concentration at single/multiple intravenous/oral drug administration prior to or at steady-state.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES: • Introduction to biopharmaceutics and pharmacokinetics • Basic principles of biopharmaceutics • Fate of drugs in the body (absorption, distribution, metabolism, elimination) • Oral drug administration

	• Bioavailability • Biopharmaceutical classification system • Relationship between oral bioavailability and physicochemical properties of the drug and dosage form • Parenteral routes of administration • Introduction to pharmacokinetics, basis of pharmacodynamics, therapeutic drug monitoring • Pharmacokinetics – compartment models; plasma drug concentration-time curve, apparent volume of distribution, physiological fluids, clearance • One-compartment model – IV bolus, elimination rate, elimination rate constant, elimination half-life, interdependence of pharmacokinetic parameters • One-compartment model – IV infusion, loading dose + IV infusion • Two-compartment model – IV bolus, pharmacokinetic parameters • Enteral drug administration: one-compartment model, multiple dose administration • Non-linear pharmacokinetics • Controlled-release formulation pharmacokinetics, drug delivery systems • Bioequivalence, IVIVC SEMINARS: • Routes of drug administration: advantages, disadvantages, requirements of (trans)dermal, pulmonary, vaginal, rectal, nasal, intravenous, subcutaneous, ocular drug administration; Examples: approved medicinal products or drug formulations in certain phase of clinical investigations • Bioavailability • Compartment models, clearance, apparent volume of distribution • Pharmacokinetics – IV drug single dose/multiple dose/continuous administration • Pharmacokinetics – two-compartment model, extravascular drug administration • Determination of the fraction of the absorbed drug • Therapeutic drug monitoring • Bioequivalence LABORATORY: • Rheology of pharmaceuticals • Micrometry • Stability testing of pharmaceuticals • Microencapsulation by phase separation or coacervation • Drying processes of pharmaceuticals, and Mass transfer phenomena • In vitro drug dissolution testing - Drug release mechanisms and kinetics in vitro
2.6. Type of instruction	**lectures** **seminars** workshops **exercises** online in entirety mixed *e*-learning mixed *m*-learning field work independent study multimedia and the internet **laboratory** work with the mentor (other)
2.7. Student responsibilities	Regular attendance of lectures, seminars and laboratory.
2.8. Screening of student's work (specify the proportion of ECTS credits for each	**Class attendance** | Seminar essay **Experimental work** | Oral exam

activity so that the total number of CTS credits is equal to the credit value of the course)	Essay		Project	
	Tests		Practical training	
	Written exam		(Other--describe)	
	Research		(Other--describe)	
	Report		(Other--describe)	
2.9. Grading and evaluation of student work over the course of instruction and at a final exam	Continuous assessment (ISVU system) – 3 written examinations during semester and/or final written examination, assessment of practical skills in laboratory.			
2.10. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**	
	I. Jalšenjak, V. Jalšenjak, J. Filipović-Grčić, Farmaceutika, Školska knjiga, Zagreb 1998.	23		
	Worksheets		Merlin-e-learning system	
	Alexander T. Florence and David Attwood, Physicochemical Principles of Pharmacy, Fourth edition, Pharmaceutical Press, London, UK, 2007.			
2.11. Optional literature	G.L. Amidon, M. Bermejo, Modern Biopharmaceutics, Version 6, Computer based training software. TSRL Inc., University of Michigan, Ann Arbor, MI, 2003.			
2.12. Methods of monitoring quality that ensure acquisition of exit competences	Assessment of learning outcomes through practical exams, continuous assessment by exams during semester and final examination. Analysis of assessment results to improve the quality of teaching.			
2.13. Comments				

CELL BIOLOGY WITH GENETICS

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Assoc. Prof. Ana-Marija Domijan, PhD
1.2. Associate teachers	-
1.3. Graduate programme	Integrated study of Medicinal Biochemistry (Master of Medicinal Biochemistry)
1.4. Status of the course	Obligatory
1.5. Year of study, Semester	The 1st year, the 1st semester
1.6. Credit value (ECTS)	7.5
1.7. Type of instruction (number of hours L+E+S+e-learning)	30+30+15
1.8. Expected enrolment in the course	25
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	The 2nd
2. COURSE DESCRIPTION	
2.1. Course objectives	The objectives of the course are to teach students structure and processes in the cell, as basic biological unit of living organisms as well as basic hereditary principles. Acquired knowledge will able students to follow courses on higher years of Study programme as Biological Chemistry, Physiology with Human Anatomy, Biochemistry, and Microbiology and Parasitology. For that courses basic knowledge of cell biology and genetic is necessary.
2.2. Enrolment requirements and required entry competences for the course	None; basic knowledge on the biology from secondary school education.
2.3. Learning outcomes at the level of the study programme to which the course contributes	Apply of fundamental knowledge of cell biology and genetics for defining, analysing and proposing procedures related to research, production and quality assurance in order to diagnose and monitor disease and treatment.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After passing exam students will be able to: 1. list and describe basic characteristics of prokaryotic and eukaryotic cells and recognise type of organisation of an organism; 2. describe structure and functions of basic cells' macromolecules, importance of DNA macromolecule and principle of transcription, DNA packing into the chromosome, importance of cell cycle and mechanism of cell cycle control as well as distinguish difference between mitosis and meiosis; 3. explain cells' membrane structure and basic principles of transport through cell membrane, list and describe organelles within the eukaryotic cell, synthesis of protein on ribosome, and importance of organelles included in protein trafficking; 4. define metabolism, importance of ATP molecule, basic characteristic of cellular respiration and photosynthesis; 5. name advantages of sexual reproduction; 6. define basic genetic terms as homolog chromosome, allele, loci, homozygote, heterozygote, genotype, phenotype and Mendel's lows of inheritance; 7. identify human disorders connected with changes on genome; 8. recognise cell compartments, cell functions and cell division under the microscope.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	TEACHING: Cell biology with genetics, introduction: introductory information to students about subjects that will be teach, available literature, their duties and tasks in order to gain knowledge described by learning objectives; information on grading of their activities. Cell evolution: basic cell macromolecules, their "building blocks" and functions within the cell, from macromolecules to cell, from prokaryotic cell to eukaryotic cell; organisation of multicellular organisms.

	Cell nucleus: morphology of cell nucleus, packing of DNA helix, chromosome structure, DNA replication and transcription. Cell membrane: cell membrane components, phospholipids, proteins, carbohydrates and cholesterol in cell membrane, transport through cell membrane (passive and active), ion channels and pumps. Cell organelles and protein trafficking: organelles of eukaryotic cell, their structure and functions, protein synthesis on ribosome, trafficking of proteins within eukaryotic cell. Vesicular transport: importance of vesicular transport, cell compartments included in vesicular transport, exocytosis (constitutive secretory pathway and regulatory secretory pathway), endocytosis (phagocytosis, pinocytosis, endocytosis controlled by receptors). Metabolism and mitochondrion: basic principles of metabolism, ATP molecule, structure of mitochondria, cellular respiration (glycolysis, citric cycle, oxidative phosphorylation). Cell energy and chloroplasts: type of plastids, chloroplast structure, photosynthesis. Cytoskeleton: importance and functions of cytoskeleton, actin filaments, microtubules and intermediate filaments, their structure and functions in the cell, structures of flagellum and cilia in the eukaryotic and prokaryotic cell. Cell cycle: phases of cell cycle, control system of cell cycle, cell signal transduction, apoptosis. Cell division - mitosis and meiosis: phases of mitosis, control system of mitosis, cytokines, phases of meiosis, importance of meiosis, fertilisation, advantage of sexual reproduction. Genetics – lows of inheritance: basic terms in genetics, Mendel and gen, Mendel's lows of inheritance (classical genetics), incomplete dominance, co-dominance, epistasis. Genetics and chromosome: Morgan and *Drosophilla*, sex-linked inheritance, genetic linkage, X-inactivation, types of chromosome abnormalities. Human genetics: hereditary diseases, their division and examples. SEMINARS: Introductory seminar on methods in cell biology and distribution of seminars' tasks: Methods in cell biology – monitoring of cell structures by use of microscope, organisms as experimental models, cells in culture, cells fractioning, analysis of macromolecules, monitoring macromolecules in the cell. Cell nucleus and cell membrane: Morphology of cell nucleus; Packing of DNA helix; Chromosome structure; Components of cell membrane; Passive transport through cell membrane; Active transport through cell membrane. Cell compartments and trafficking of proteins: Endoplasmic Reticulum; Golgi apparatus; Peroxisome, Lysosome; Protein trafficking within the eukaryotic cells; Exocytosis; Endocytosis. Cell metabolism and cytoskeleton: Mitochondria and cellular respiration; Chloroplast and photosynthesis; Actin filaments, Microtubules; Intermediate filaments; Flagella and cilia. Cell cycle and cell division: Cell cycle; Apoptosis; Mitosis and cytokinesis; Meiosis and fertilisation; Advantage of sexual reproduction. Genetics: Mendel's low of inheritance; Advance in Mendel's lows; Morgan's discoveries; X-linked inheritance; Chromosome abnormalities; Human genetics. EXERCISES: Introduction to microscopy: parts of a light microscope and basic rules in microscopy. Students learn how to use microscope and prepare microscopic slides. Different type of cells – prokaryotic and eukaryotic cells: students prepare slides of prokaryotic cells (*Agrobacterium tumerofaciens* and *Oscillatoria* sp.) and eukaryotic cells (protozoa, yeast, buccal epithelial cells, pig kidney epithelial cells, various tumour cell lines grown *in vitro*, human blood cells, plant cells) to learn the difference in size and shape of various cells type. Cell membrane – plasmolysis: the experiment of plasmolysis and deplasmolysis is

	conducted on *Rhoeo discolour* by exchanging water and salt solution – transport of water could be observed. Compartments of eukaryotic cell: cells' compartments that can be observed under light microscope (*Allium cepa*), and cell compartment observed under electron microscope. Cell energetics: students perform experiment in order to confirm that starch is product of photosynthesis (in reaction with Lugol solution); under light microscope they observe various plastides involved in plant cell energetics (from production to stores) as chloroplasts, chromoplasts, leucoplasts and amyloplasts (*Helodea canadensis*, *Rhoeo discolour*, *Solanium tuberosum*). By paper chromatography they separate photosynthetic pigments. Cell cycle - mitosis: students prepare slide of *Allium cepa* roots and observe various stages of cell cycle. Meiosis: students observe and recognise various stages of meiosis on slide of gland of *Caelifera.* Solving problems. Nucleus in interphase-polytene chromosome: students observe *Drosophilla melanogaster* life cycle and prepare slide of *Drosophilla* salivary gland (in stage larva) to observe polytene chromosome. Human karyotype: under the microscope students observe human karyotype. From given karyotype students prepare karyogram. DNA isolation: students perform simple process of DNA isolation.
2.6. Type of instruction	**lectures** **seminars** workshops **exercises** online in entirety mixed *e*-learning mixed *m*-learning field work **independent study** multimedia and the internet work with the mentor (other)
2.7. Student responsibilities	

2.8. 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	1	Seminar essay	1.5
	Experimental work	1	Oral exam	3
	Essay		Project	
	Tests		Practical training	
	Written exam	0.5	(Other--describe)	
	Research		(Other--describe)	
	Report	0.5	(Other--describe)	

2.9. Grading and evaluation of student work over the course of instruction and at a final exam	Filled report form during experimental work (left after experimental work and graded), exercise (experimental work) knowledge is graded by final written exam. Seminar report (seminar essay) and activity (participation in discussion) during seminars. Oral exam.

2.10. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	Cooper, G.M., Hausman, R.E. The cell, third edition, Medicinska naklada, Zagreb, 2004 (in Croatian)	30	Through internet
	Cell biology – exercises (experimental work). Script for experimental work available through e-learning		e-learning
	Domijan, A.-M. Cell biology and genetics. Presentation of lectures are available through e-		e-learning

	learning		
2.11. Optional literature	Pavlica, M. Online book on genetics; www.gnetics.biol.pmf.unizg.hr		
2.12. Methods of monitoring quality that ensure acquisition of exit competences	Learning outcomes 1-7 (informations that are learned on exercise, seminars and lectures) are checked by oral exam. Regular attendance of seminars, interest and autonomy in preparation of seminar add to learning outcomes 1-7. Learning outcome 8 is checked by written exam after exercises.		
2.13. Comments			

CELL BIOLOGY WITH GENETICS

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Assoc. Prof. Ana-Marija Domijan, PhD
1.2. Associate teachers	-
1.3. Graduate programme	Integrated study of Pharmacy (Master of Pharmacy)
1.4. Status of the course	Obligatory
1.5. Year of study, Semester	The 1st year, the 1st semester
1.6. Credit value (ECTS)	7.5
1.7. Type of instruction (number of hours L+E+S+e-learning)	30+30+15
1.8. Expected enrolment in the course	130
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	The 2nd
2. COURSE DESCRIPTION	
2.1. Course objectives	The objectives of the course are to teach students structure and processes in the cell, as basic biological unit of living organisms as well as basic hereditary principles. Acquired knowledge will able students to follow courses on higher years of Study programme as Biological Chemistry, Physiology with Human Anatomy, Biochemistry, and Microbiology and Parasitology. For that courses basic knowledge of cell biology and genetic is necessary.
2.2. Enrolment requirements and required entry competences for the course	None; basic knowledge on the biology from secondary school education.
2.3. Learning outcomes at the level of the study programme to which the course contributes	Apply of fundamental knowledge of cell biology and genetics to define, analyse and propose procedures related to research and development of pharmaceuticals.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After passing exam students will be able to: 1. list and describe basic characteristics of prokaryotic and eukaryotic cells and recognise type of organisation of an organism; 2. describe structure and functions of basic cells' macromolecules, importance of DNA macromolecule and principle of transcription, DNA packing into the chromosome, importance of cell cycle and mechanism of cell cycle control as well as distinguish difference between mitosis and meiosis; 3. explain cells' membrane structure and basic principles of transport through cell membrane, list and describe organelles within the eukaryotic cell, synthesis of protein on ribosome, and importance of organelles included in protein trafficking; 4. define metabolism, importance of ATP molecule, basic characteristic of cellular respiration and photosynthesis; 5. name advantages of sexual reproduction; 6. define basic genetic terms as homolog chromosome, allele, loci, homozygote, heterozygote, genotype, phenotype and Mendel's lows of inheritance; 7. identify human disorders connected with changes on genome; 8. recognise cell compartments, cell functions and cell division under the microscope.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	TEACHING: Cell biology with genetics, introduction: introductory information to students about subjects that will be teach, available literature, their duties and tasks in order to gain knowledge described by learning objectives; information on grading of their activities. Cell evolution: basic cell macromolecules, their "building blocks" and functions within the cell, from macromolecules to cell, from prokaryotic cell to eukaryotic cell; organisation of multicellular organisms. Cell nucleus: morphology of cell nucleus, packing of DNA helix, chromosome

	structure, DNA replication and transcription. Cell membrane: cell membrane components, phospholipids, proteins, carbohydrates and cholesterol in cell membrane, transport through cell membrane (passive and active), ion channels and pumps. Cell organelles and protein trafficking: organelles of eukaryotic cell, their structure and functions, protein synthesis on ribosome, trafficking of proteins within eukaryotic cell. Vesicular transport: importance of vesicular transport, cell compartments included in vesicular transport, exocytosis (constitutive secretory pathway and regulatory secretory pathway), endocytosis (phagocytosis, pinocytosis, endocytosis controlled by receptors). Metabolism and mitochondrion: basic principles of metabolism, ATP molecule, structure of mitochondria, cellular respiration (glycolysis, citric cycle, oxidative phosphorylation). Cell energy and chloroplasts: type of plastids, chloroplast structure, photosynthesis. Cytoskeleton: importance and functions of cytoskeleton, actin filaments, microtubules and intermediate filaments, their structure and functions in the cell, structures of flagellum and cilia in the eukaryotic and prokaryotic cell. Cell cycle: phases of cell cycle, control system of cell cycle, cell signal transduction, apoptosis. Cell division - mitosis and meiosis: phases of mitosis, control system of mitosis, cytokines, phases of meiosis, importance of meiosis, fertilisation, advantage of sexual reproduction. Genetics – lows of inheritance: basic terms in genetics, Mendel and gen, Mendel's lows of inheritance (classical genetics), incomplete dominance, co-dominance, epistasis. Genetics and chromosome: Morgan and *Drosophilla*, sex-linked inheritance, genetic linkage, X-inactivation, types of chromosome abnormalities. Human genetics: hereditary diseases, their division and examples. SEMINARS: Introductory seminar on methods in cell biology and distribution of seminars' tasks: Methods in cell biology – monitoring of cell structures by use of microscope, organisms as experimental models, cells in culture, cells fractioning, analysis of macromolecules, monitoring macromolecules in the cell. Cell nucleus and cell membrane: Morphology of cell nucleus; Packing of DNA helix; Chromosome structure; Components of cell membrane; Passive transport through cell membrane; Active transport through cell membrane. Cell compartments and trafficking of proteins: Endoplasmic Reticulum; Golgi apparatus; Peroxisome, Lysosome; Protein trafficking within the eukaryotic cells; Exocytosis; Endocytosis. Cell metabolism and cytoskeleton: Mitochondria and cellular respiration; Chloroplast and photosynthesis; Actin filaments, Microtubules; Intermediate filaments; Flagella and cilia. Cell cycle and cell division: Cell cycle; Apoptosis; Mitosis and cytokinesis; Meiosis and fertilisation; Advantage of sexual reproduction. Genetics: Mendel's low of inheritance; Advance in Mendel's lows; Morgan's discoveries; X-linked inheritance; Chromosome abnormalities; Human genetics. EXERCISES: Introduction to microscopy: parts of a light microscope and basic rules in microscopy. Students learn how to use microscope and prepare microscopic slides. Different type of cells – prokaryotic and eukaryotic cells: students prepare slides of prokaryotic cells (*Agrobacterium tumerofaciens* and *Oscillatoria* sp.) and eukaryotic cells (protozoa, yeast, buccal epithelial cells, pig kidney epithelial cells, various tumour cell lines grown *in vitro*, human blood cells, plant cells) to learn the difference in size and shape of various cells type. Cell membrane – plasmolysis: the experiment of plasmolysis and deplasmolysis is conducted on *Rhoeo discolour* by exchanging water and salt solution – transport of

	water could be observed. Compartments of eukaryotic cell: cells' compartments that can be observed under light microscope (*Allium cepa*), and cell compartment observed under electron microscope. Cell energetics: students perform experiment in order to confirm that starch is product of photosynthesis (in reaction with Lugol solution); under light microscope they observe various plastides involved in plant cell energetics (from production to stores) as chloroplasts, chromoplasts, leucoplasts and amyloplasts (*Helodea canadensis*, *Rhoeo discolour*, *Solanium tuberosum*). By paper chromatography they separate photosynthetic pigments. Cell cycle - mitosis: students prepare slide of *Allium cepa* roots and observe various stages of cell cycle. Meiosis: students observe and recognise various stages of meiosis on slide of gland of *Caelifera.* Solving problems. Nucleus in interphase-polytene chromosome: students observe *Drosophilla melanogaster* life cycle and prepare slide of *Drosophilla* salivary gland (in stage larva) to observe polytene chromosome. Human karyotype: under the microscope students observe human karyotype. From given karyotype students prepare karyogram. DNA isolation: students perform simple process of DNA isolation.
2.6. Type of instruction	**lectures** **seminars** workshops **exercises** online in entirety mixed *e*-learning mixed *m*-learning field work **independent study** multimedia and the internet work with the mentor (other)
2.7. Student responsibilities	

2.8. 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	1	Seminar essay	1.5
Experimental work	1	Oral exam	3
Essay		Project	
Tests		Practical training	
Written exam	0.5	(Other--describe)	
Research		(Other--describe)	
Report	0.5	(Other--describe)	

2.9. Grading and evaluation of student work over the course of instruction and at a final exam	Filled report form during experimental work (left after experimental work and graded), exercise (experimental work) knowledge is graded by final written exam. Seminar report (seminar essay) and activity (participation in discussion) during seminars. Oral exam.

2.10. Required literature (available at the library and via other media)

Title	Number of copies at the library	Availability via other media
Cooper, G.M., Hausman, R.E. The cell, third edition, Medicinska naklada, Zagreb, 2004 (in Croatian)	30	Through internet
Cell biology – exercises (experimental work). Script for experimental work available through e-learning		e-learning
Domijan, A.-M. Cell biology and genetics. Presentation of lectures are available through e-learning		e-learning

2.11. Optional literature	Pavlica, M. Online book on genetics; www.gnetics.biol.pmf.unizg.hr
2.12. Methods of monitoring quality that ensure acquisition of exit competences	Learning outcomes 1-7 (informations that are learned on exercise, seminars and lectures) are checked by oral exam. Regular attendance of seminars, interest and autonomy in preparation of seminar add to learning outcomes 1-7. Learning outcome 8 is checked by written exam after exercises.
2.13. Comments	

CLINICAL PHARMACY AND PHARMACOTHERAPY

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Professor Vesna Bačić Vrca, MPharm, PhD
1.2. Associate teachers	Assistant professor Srećko Marušić, MD, PhD Assistant professor Iva Mucalo, MPharm, PhD Maja Ortner Hadžiabdić, MPharm, PhD
1.3. Graduate programme	Integrated study programme of Pharmacy
1.4. Status of the course	Compulsory
1.5. Year of study, Semester	4th year, 8th semester
1.6. Credit value (ECTS)	6
1.7. Type of instruction (number of hours L+E+S+e-learning)	(L30+S45)
1.8. Expected enrolment in the course	120
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2nd level
2. COURSE DESCRIPTION	
2.1. Course objectives	Students will gain knowledge and obtain greater awareness of the role of clinical pharmacy in the decision making on pharmacotherapy depending of the individuals' indications, contraindications, drug interactions and adverse drug reactions.
2.2. Enrolment requirements and required entry competences for the course	Enrolment requirement: Pharmacology course. Entry competencies: understanding of the pathological mechanisms of diseases, understanding of the physiological processes and physiological changes of aging, knowledge in pharmacology.
2.3. Learning outcomes at the level of the study programme to which the course contributes	• Recognize therapeutic problems and medication errors including clinically significant drug interactions and act with the aim of avoiding them; • Develop skills in advising patients on the effects and proper application of pharmaceuticals, as well as monitoring the treatment course and outcomes; • Develop awareness of pharmacist active role in disease prevention and health protection as well as in public health initiatives; • Understanding pharmacist role in diverse situations and contexts, such as inter-professional groups; • Apply information technology and databases for enhancing expert knowledge and skills and self-learning.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	At the end of the course, the student will be able: 1. Describe the clinical pharmacist role in the health professional team. 2. Analyse and comment on patient's pharmacotherapy and recognize therapeutic problems or medication errors. 3. Identify drug interactions and evaluate it clinical significance. 4. Choose appropriate therapy for particular disease. 5. Choose appropriate therapy based on individual characteristics, ie. age, gender, medical conditions etc. 6. Assess the risk of applying particular medicine in the risk group of patients, ie. elderly, toddlers and children, pregnant and breastfeeding women, patients with renal and liver impairment. 7. Anticipate adverse drug reactions
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LEACTURES: • Introduction to clinical pharmacy. Rational pharmacotherapy • Clinical trials. Medication errors. Drug interactions. Adverse drug reactions.

<table>
<tr><td></td><td colspan="4">

Drug use in elderly patients. Drug use in renal and liver impairment. Drug use in pregnancy and breastfeeding. Drug use in paediatrics.
Individualization of drug therapy.
Basic concepts of pharmacoeconomics.
Drug therapy in hypertension. Drug therapy in hyperlipidaemia.
Guidelines for antimicrobial usage. Drug therapy in diabetes.
Drug therapy in asthma and COPD
Use of hormone replacing therapy. Use of hormonal contraceptives methods.
Drug therapy in gastrointestinal diseases.
Antithrombotic drugs – special considerations
Antipsychotics and anxiolytics - special considerations
Antidepressant and antiepileptic drugs - special considerations
Analgesic drugs - special considerations
Self-medication and OTC drugs

SEMINARS:

Evidence based pharmacotherapy.
Pharmacotherapy in hypertensive patients.
Prophylactic drug usage.
Antimicrobial drug usage.
Diabetes management.
Hyperlipidemia and elderly care.
Consultation skills.
Drug therapy in asthma and COPD.
Drug therapy in sportsman.
Usage of antithrombotic drugs.
Drug therapy in osteoporosis.
Usage of antidepressants and antiepileptic drugs.
Usage of anxiolytics and antipsychotics.
Patient case scenarios.
Drug interactions
Drug usage in renal and liver impairment
Adverse drug reactions
Relevant laboratory parameters
Drug usage in pregnancy and breastfeeding
Drug usage in paediatrics
Usage of analgesics and OTC drugs

</td></tr>
<tr><td>2.6. Type of instruction</td><td colspan="2"><u>lectures</u>
<u>seminars</u>
workshops
exercises
online in entirety
mixed e-learning
mixed m-learning</td><td colspan="2">field work
<u>independent study</u>
multimedia and the internet
work with the mentor
(other)</td></tr>
<tr><td>2.7. Student responsibilities</td><td colspan="4"></td></tr>
<tr><td rowspan="7">2.8. 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)</td><td>Class attendance</td><td>1</td><td>Seminar essay</td><td>1</td></tr>
<tr><td>Experimental work</td><td></td><td>Oral exam</td><td>2</td></tr>
<tr><td>Essay</td><td></td><td>Project</td><td></td></tr>
<tr><td>Tests</td><td></td><td>Practical training</td><td></td></tr>
<tr><td>Written exam</td><td>2</td><td>(Other--describe)</td><td></td></tr>
<tr><td>Research</td><td></td><td>(Other--describe)</td><td></td></tr>
</table>

	Report		(Other--describe)	
2.9. Grading and evaluation of student work over the course of instruction and at a final exam	Two partial written exams during the course of semester; two seminar essays; final written and oral exams at the end of the course.			
2.10. Required literature (available at the library and via other media)	**Title**		**Number of copies at the library**	**Availability via other media**
	R. Walker, C. Edwards. Klinička farmacija i terapija – croatian edition, Školska knjiga 2004.		22	
	I. Francetić, D. Vitezić. Osnove kliničke farmakologije, Medicinska naklada, Zagreb, 2007.		11	
	R. Walker, C. Whittlesea. Clinical Pharmacy and Therapeutics. 5th Ed, 2012.		12	
	I. Francetić i sur. Farmakoterapijski priručnik. 2015.		12	
	PPT predavanja i dodatni materijali dostupni putem sustava za e-učenje (Merlin)			Sustav za e-učenje (Merlin)
2.11. Optional literature				
2.12. Methods of monitoring quality that ensure acquisition of exit competences	Learning outcomes are assessed during seminars, independent study and written exam.			
2.13. Comments				

COAGULATION

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Professor Renata Zadro, PhD
1.2. Associate teachers	/
1.3. Graduate programme	Integrated study of Medical biochemistry
1.4. Status of the course	Compulsory
1.5. Year of study, Semester	4th , VII
1.6. Credit value (ECTS)	4
1.7. Type of instruction (number of hours L+E+S+e-learning)	15+15+15
1.8. Expected enrolment in the course	25
1.9. 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	Understand basic biochemistry and physiology of haemostasis, pathophysiology of haemostasis and thrombosis disorders, get acquainted with treatment methods and diagnose haemostatic disorders by laboratory methods
2.2. Enrolment requirements and required entry competences for the course	Audited course in Haematology 2 and exam in General Clinical Biochemistry passed.
2.3. Learning outcomes at the level of the study programme to which the course contributes	Implementation of basic knowledge in biochemistry and physiology of haemostasis when defining, analysing and proposing methods for detection and follow-up of haemostatic and thrombotic disorders and efficacy of therapy
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	Student will be able to: 1. Describe the haemostasis model; 2. Explain the physiology of haemostasis; 3. Identify major coagulation and fibrinolytic factors; 4. Explain hereditary and acquired haemostatic and thrombotic disorders; 5. Enumerate types of therapies for particular coagulation disorders; 6. Explain the principle of anticoagulation therapy; 7. Perform laboratory analyses for the diagnostics of coagulation disorders
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES: • Coagulation mechanism. • Primary haemostasis – the role of platelets and blood vessels in haemostasis. • Secondary haemostasis – biochemistry of coagulation factors. • Structure and function of factor VIII and von Willebrand factor. • Fibrinolysis. • Classification and clinical manifestation of haemostatic and thrombotic disorders. • Inherited coagulation disorders – haemophilia A and B. • Inherited coagulation disorders – von Willebrand's disease. • Acquired coagulation disorders – disseminated intravascular coagulation. • Acquired coagulation disorders – inhibitors and lupus anticoagulant. • Inherited thrombophilias. • Acquired thrombophilias. • Oral anticoagulation therapy. • Anticoagulation heparin therapy. • Antiaggregation therapy. SEMINARS: • Laboratory diagnosis of coagulation disorders. • Pre-analytical variables. • Methodology. • Prothrombin time. • Activated partial thromboplastin time.

	• Fibrinogen. • Measurement of coagulation factor activities. • Measurement of coagulation inhibitors activities. • Thromboplastins. • Measurement of coagulation factors antigen concentration. • Therapies for haemophilias. • Examination of platelet functions. • Anticoagulants in thrombosis prevention. • Natural inhibitors. • Haemostasis and thrombosis in liver diseases. EXERCISES: • Prothrombin time. Activated partial thromboplastin time. • Fibrinogen activity. Coagulation factor activity. • Screening for coagulation factor inhibitors: global test and coagulation factor residual activity. Antithrombin activity. Fibrin degradation products. • Platelet function – platelet aggregation and primary haemostasis capacity.
2.6. Type of instruction	**lectures** **seminars** workshops **exercises** online in entirety mixed *e*-learning mixed *m*-learning field work **independent study** multimedia and the internet work with the mentor **laboratory**
2.7. Student responsibilities	Regular attendance at lectures, seminars and exercises mandatory

2.8. 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	0.5	Seminar essay	0.5
	Experimental work	0.5	Oral exam	
	Essay		Project	
	Tests		Practical training	
	Written exam	2.5	(Other--describe)	
	Research		(Other--describe)	
	Report		(Other--describe)	

2.9. Grading and evaluation of student work over the course of instruction and at a final exam	Checking of regular attendance, activities at lectures, seminars, written exam.

2.10. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	Labar B, Hauptmann E et al. HEMATOLOGIJA. Zagreb: Školska knjiga 2007.		
	Dacie i Lewis. Practical Hematology, 11. ed., Churchill Livingstone Elsevier, 2012.		

2.11. Optional literature	Koagulacija (Zadro R, ed.), Medicinska naklada 2010. Priručnik za trajno usavršavanje Hrvatske komore medicinkih biokemičara Trombociti (Zadro R, ed.), Medicinska naklada 2008. Priručnik za trajno usavršavanje Hrvatske komore medicinkih biokemičara
2.12. Methods of monitoring quality that ensure acquisition of exit competences	Learning outcomes 1-6 re checked by written exams and during seminars, LO 7 is tested during laboratory practice.
2.13. Comments	/

COMMUNICATION SKILLS

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Prof. Živka Juričić, Ph.D.
1.2. Associate teachers	-
1.3. Graduate programme	Integrated study of medical biochemistry
1.4. Status of the course	Optional
1.5. Year of study, Semester	4. year, 7. semester
1.6. Credit value (ECTS)	1.5
1.7. Type of instruction (number of hours L+E+S+e-learning)	6+0+9+0
1.8. Expected enrolment in the course	15
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course online (20% maximum)	1.level; 10% online instruction
2. COURSE DESCRIPTION	
2.1. Course objectives	The course objective is to introduce students to the essential principles and modalities of verbal and non-verbal interpersonal communication in a medical context. A special attention should be paid to training students in acquiring interpersonal and communication skills aiming at realisation of as much fruitful as possible cooperation, not only with patients but also with all other participants in the system of providing healthcare. Mastering of general and specific social-communication skills will enable students an equal position in a healthcare team.
2.2. Enrolment requirements and required entry competencies for the course	None
2.3. Learning outcomes at the level of the study programme to which the course contributes	1. By using an efficient communication to create a frame for an optimal application of professional knowledge and technical-manipulative skills. 2. To realise an efficient interaction with patients, co-workers, other healthcare professionals and the public. 3. To recognise and timely remove negative effects of a patient's unwillingness to cooperate during procedures of perfoming medical tests.
2.4 Expected learning outcomes at the level of the course (4-10 learning outcomes)	After having attended the course, students will be able to: 1. Understand that professional work of a medical biochemist is based not only on professional knowledge and technical-manipulative skills but also on social and communication skills. 2. To explain the procedure and the importance of medical tests in accordance to the patient's perception and expectations. 3. To successfully design, present, analyse and interpret test results to the various participants in the healthcare system as well as to the public. 4. To give a patient consolation, reassurance, empathy.
2.5 Course content broken down in detail by weekly class schedule (syllabus)	**Lectures** 1. Constitutive principles and functional importance of interpersonal verbal and non-verbal communication in a medical context. 2. Communicational understanding: ethos (*ἦθος),* pathos (*πάθος)* logos (*λόγος*). 3. The meaning and and specific therapeutical effect of empathy in professional work of medical biochemists. **Seminars** 1. Integrative model of shared decision making in the medical context. 2. Heterogeneousness of professional cultures as an obstacle in building an inter-professional team. 3. General and specific social and communication competencies in professional work of medical biochemists. 4. Medical treatment and dialogue: application of Gadamer's theory of

	communication in medicine and healthcare.			
2.6 Type of instruction	**lectures** **seminars** workshops exercises online in entirety **mixed *e*-learning** mixed *m*-learning		field work independent study multimedia and the internet work with the mentor (other)	
2.7. Student responsibilities	Regular attendance to the lectures and active participation in discussion lead by the teacher by applying so-called maieutic type of dialogue. Writing the seminar paper based on chosen literature from science magazines in English.			
2.8. 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	0,5	Seminar essay	0,5
	Experimental work		Oral exam	0,5
	Essay		Project	
	Tests		Practical training	
	Written exam		(Other--describe)	
	Research		(Other--describe)	
	Report		(Other--describe)	
2.9. Grading and evaluation of student work over the course of instruction and at a final exam	Grading of student's activity and preparedness during lectures and seminars. The final exam is oral.			
2.10. Required literature (available at the library and via other media)	**Title**		**Number of copies at the library**	**Availability via other media**
	Teacher's lectures published in the Merlin system for e-learning (PowerPoint presentation)			Online
	White, H. B. et all., (2013) What Skills Should Students of Undergraduate Biochemistry and Molecular Biology Programs Have Upon Graduation?			Online
2.11. Optional literature				
2.12. Methods of monitoring quality that ensure acquisition of exit competencies	Exit competencies 1-4 are checked on the basis of writing the seminar paper and the final oral exam.			
2.13. Comments				

COMPLEX GENETICS

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Associate Professor Sanja Dabelić
1.2. Associate teachers	Professor Jerka Dumić Associate Professor Gordana Maravić Vlahoviček Assistant Professor Sandra Šupraha Goreta
1.3. Graduate programme	Integrated study of Medical Biochemistry
1.4. Status of the course	Optional
1.5. Year of study, Semester	5th year, 9th semester
1.6. Credit value (ECTS)	2.5
1.7. Type of instruction (number of hours L+E+S+e-learning)	15+15+0+0 (e-learning - is not included in standard hours, but is used in teaching)
1.8. Expected enrolment in the course	10
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	Level 2, 0%
2. COURSE DESCRIPTION	
2.1. Course objectives	To know and understand (i) the importance of human genome variability, (ii) the methods and procedures in complex genetics studies, (iii) the importance of molecular genetics epidemiology for diagnosis, prevention and therapy of complex genetic, (iv) social, legal and ethical issues related to complex genomics and (v) the impact of knowledge on the genetic basis of disease in the process of developing new drugs.
2.2. Enrolment requirements and required entry competences for the course	Passed exam Human and Population Genetics Input competence: application of knowledge acquired during previous studies, especially in courses Biological Chemistry, Biochemistry, Molecular Biology with Genetic Engineering and Human and Population Genetics; describing and understanding the structure and physiology of cells and organisms, the basic mechanisms of inheritance and gene expression and principles of nucleic acids analysis techniques.
2.3. Learning outcomes at the level of the study programme to which the course contributes	• Applying basic knowledge of biochemistry in the laboratory diagnosis, in defining, analysing and proposing actions related to the research, production and quality assurance and implementation of new laboratory methods for the detection and monitoring of diseases and therapy-outcome. • Assessing the clinical significance of biochemical and molecular biology indicators, detecting the sources of errors and variability of laboratory analysis results, interpreting the results of laboratory analysis from analytical and clinical point of view • Critical assessment and application of scientific knowledge and available information in order to improve the profession, problem solving, application of new technologies and improving the existing ones. • Use of informational technology and databases for the purpose of improving professional knowledge and skills.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After successfully completing the course, students will be able to:

	1. Describe the structure of the human genome, types and effects of genetic variability. 2. Define complex genetic disease and interplay of genetic and environmental factors. 3. Compare the methods for identifying genes / genome-variations responsible for the formation of complex genetic disease. 4. Present examples of genes / genetic variations that represent susceptibility factors for the development of certain diseases and aging process. 5. Analyze the impact of complex genetics on the direction of pharmaceutical research and drug design. 6. Argue the reasons, advantages and disadvantages of genetic testing and ethical, legal and sociological challenges of complex genetics and genetic testing in the disease prevention, therapy and prognosis.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES: • Genes and genome structure and the regulation of gene expression, Monogenic diseases, Complex genetic diseases, the interplay of genetic and environmental factors • Methods for identification of genes involved in the complex genetic disorders • Planning and performing genetic experiments, legal and social aspects, informed constent • Alcoholism and Mental disorders – genetic basis, diagnostic criteria, social attitude • Aging – aging theories, the impact of genetic factors • Genetic testing - advantages and disadvantages, genetic testing in highly-developed countries and in Croatia, prenatal diagnostics • Complex genetic diseases: importance of information and education. Discussion of ethical, advisory and legal problems of genetic testing, biological and social aspects of genetic manipulation, expectations for the future. • The effect of genes on individual response to drug therapy-pharmacogenetic and pharmacokinetic aspects of genetics. The impact of complex genetics on the direction of pharmaceutical research and drug design. Advantages, disadvantages and problems of implementation of complex genetics in the process of development of new drugs. SEMINARS: • Coronary artery disease (CAD) as an example of complex genetic disorder. Databases and biobanks - reviews of individual bases and biobanks. • Inflammatory bowel disease - Crohn's disease and ulcerative colitis, predisposition, etiology and treatment methods, the genetic models, the methods for gene identification, genes involved in the etiology of inflammatory bowel disease • Diet and food production in modern world – the effect on human health. Obesity- etiology, genetic basis of disease, research methods, guidelines for further research • Autism and Alzheimer's disease - definition, etiology, genetic basis of disease, research methods, guidelines for further research • Modern diet and food production – impact on human health. Obesity -

<table>
<tr><td></td><td colspan="4">definition, etiology, genetic basis of disease, research methods, guidelines for further research
• Schizophrenia, Vitiligo, Systemic lupus erithematosus - definition, etiology, genetic basis of disease, research methods, guidelines for further research
• Genetic basis for virus diseases susceptibility and resistance
• Homosexuality and Intelligence - research methods, genetic and epigenetic basis, the study throughout history, social, ethical and legal aspects
• Malignant tumors - the complexity of etiology, targeted drugs, drug resistance, genetic and ethical aspects of prevention and treatment of tumors</td></tr>
<tr><td>2.6. Type of instruction</td><td colspan="2">lectures
seminars
workshops
exercises
online in entirety
mixed e-learning
mixed m-learning</td><td colspan="2">field work
independent study
multimedia and the internet
work with the mentor
(other)</td></tr>
<tr><td>2.7. Student responsibilities</td><td colspan="4">The students are required to attend classes that take place in the form of lectures and seminars and prepare and present one study theme in the form of seminar.</td></tr>
<tr><td rowspan="8">2.8. 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)</td><td>Class attendance</td><td>0.5</td><td>Seminar essay</td><td>0.5</td></tr>
<tr><td>Experimental work</td><td></td><td>Oral exam</td><td></td></tr>
<tr><td>Essay</td><td></td><td>Project</td><td></td></tr>
<tr><td>Tests</td><td></td><td>Practical training</td><td></td></tr>
<tr><td>Written exam</td><td>1.5</td><td>(Other--describe)</td><td></td></tr>
<tr><td>Research</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>Report</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>2.9. Grading and evaluation of student work over the course of instruction and at a final exam</td><td colspan="4">Seminar presentation and written exam.</td></tr>
<tr><td rowspan="4">2.10. Required literature (available at the library and via other media)</td><td colspan="2">Title</td><td>Number of copies at the library</td><td>Availability via other media</td></tr>
<tr><td colspan="2">Dabelić S. : Complex genetics lectures (powerpoint presentations) – for the present academic year</td><td>0</td><td>In pdf form available at the e-learning platform</td></tr>
<tr><td colspan="2">Selected original and review scientific articles</td><td>0</td><td>In pdf form available at the e-learning platform</td></tr>
<tr><td colspan="2"></td><td></td><td></td></tr>
<tr><td>2.11. Optional literature</td><td colspan="4">T. Strachan, A. P. Read: Human molecular genetics, 4th Ed. BIOS Scientific Publishers, 2010, ISBN-10: 0815341490</td></tr>
<tr><td>2.12. Methods of monitoring quality that ensure acquisition of exit competences</td><td colspan="4">All outcomes are checked by written exam.</td></tr>
<tr><td>2.13. Comments</td><td colspan="4"></td></tr>
</table>

CONSULTATION SKILLS

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Professor Živka Juričić, PhD
1.2. Associate teachers	Assistant Professor Iva Mucalo, PhD; Maja Ortner Hadžiabdić, PhD
1.3. Graduate programme	Integrated study programme of Pharmacy
1.4. Status of the course	compulsory
1.5. Year of study, Semester	5th, 9th semester
1.6. Credit value (ECTS)	1,5
1.7. Type of instruction (number of hours L+E+S+e-learning)	2 h lectures + 13 hours workshops
1.8. Expected enrolment in the course	120
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	1st level
2. COURSE DESCRIPTION	
2.1. Course objectives	The course objectives are to acquaint students with the basic notions, models and principles of interpersonal communication within the context of pharmacy. Students' training will be focused on the development of *consultation skills*, skills which are essential not only for identifying patients' drug-therapy needs, but for preventing all possible adverse clinical outcomes. Following introduction with the strictly structured consultation skills model, the student will be able to both identify and foresee the negative outcomes of patient's non-adherence.
2.2. Enrolment requirements and required entry competences for the course	Taken course Clinical pharmacy and Pharmacotherapy
2.3. Learning outcomes at the level of the study programme to which the course contributes	• Applying professional knowledge and skills in consulting and carrying out pharmacist's care of the patient. (Applying expert knowledge on pharmacotherapy). • Establishing positive interaction with the patients, associates, other health-care professionals and the public through oral and written communication (personal skills: cognitive, psychomotor behavioural. social). • As a part of health-care team, the pharmacist will provide corresponding care for the patients which implies informing and counselling the patient about effects and correct application of the medicine and following the outcome of the therapy (professional skills).
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	• List the basic ingredients for an affective and professional patient consultation • Ask relevant questions when taking a patient medication (drug) history • Establish whether the patient has any medication related problems or barriers to compliance • Make appropriate recommendations in response to symptoms • Provide patients with appropriate education and advice regarding their illness or drug therapy • Motivate patients to adhere to their treatment • Apply their clinical knowledge to patient care
2.5. Course content broken down in detail by weekly class schedule (syllabus)	Lectures: 1. Functional importance of inter-personal verbal and non-verbal comunication 2. Introduction to consultation skills: structure of the consultation skills process Workshops 1. Observation and evaluation of video-clips 2. Drug history taking-simulated patient teaching 3. The consultation process- simulated patient teaching 1 4. The consultation process- simulated patient teaching 2 5. The consultation process- simulated patient teaching 3

2.6. Type of instruction	**lectures** seminars **workshops** exercises online in entirety mixed *e*-learning mixed *m*-learning		field work independent study multimedia and the internet work with the mentor (other)	
2.7. Student responsibilities	Attending lectures and workshops			
2.8. 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 (workshops)	1,0	Seminar essay	
	Experimental work		Oral exam	0,5
	Essay		Project	
	Tests		Practical training	
	Written exam		(Other--describe)	
	Research		(Other--describe)	
	Report		(Other--describe)	
2.9. Grading and evaluation of student work over the course of instruction and at a final exam	Individual student assessment (evaluating each student's consultation); Final exam (*engl.* Objective Structured Clinical Examination, OSCE)			

2.10. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	Robert S. Beardsley,Carole L. Kimberlin,William N. Tindall (2012) Communication Skills in Pharmacy Practice: A Practical Guide for Students Lippincott Williams & Wilkins.	1	
	Abdel Tawab,R.; James, D.; Davies, J.G.; Horne, R. Guidelines to the Medication-related consultation framework. School of Pharmacy & Biomolecular Sciences; University of Brighton, 2005.	/	Merlin

2.11. Optional literature	
2.12. Methods of monitoring quality that ensure acquisition of exit competences	Acquired students competencies are examined through workshops and by individual student assessment
2.13. Comments	

COSMETOLOGY

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Full Professor Jelena Filipović-Grčić, PhD Assistant Professor Ivan Pepić, PhD
1.2. Associate teachers	Marina Juretić, MPharm Sabina Keser, MPharm Zora Rukavina, MPharm
1.3. Graduate programme	Pharmacy
1.4. Status of the course	Obligatory course
1.5. Year of study, Semester	5th year, 9th semester
1.6. Credit value (ECTS)	5
1.7. Type of instruction (number of hours L+E+S+e-learning)	30+30+0
1.8. Expected enrolment in the course	130
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2nd level
2. COURSE DESCRIPTION	
2.1. Course objectives	The objective of the course is to develop student practical skills, theoretical knowledge and professional attitudes necessary for success in the Pharmacist profession. Dermopharmacy/Cosmetology is an area where a lot of medicines and health products are used, being the pharmacist often asked for advice and local production of this kind of products. It is well recognized that a deep and updated understanding is required in order to better serve patients. With these objectives in mind, the course was created with in order to promote the cross knowledge between chemistry, biology, pharmaceutics and dermopharmacy. It is required to update previous knowledge on skin biology and skin permeation, focusing the relevance of damaged skin, and pointing out the physicochemical characteristic of drugs/cosmeceuticals and drug/cosmetic formulations/products. The acquired knowledge and skills provide the basis for Pharmaceutical care and Vocational training for pharmacists.
2.2. Enrolment requirements and required entry competences for the course	At the start of this course the student should have acquired the Drug formulation course completed. At the end of this course, before final exam the students should have acquired the Drug formulation exam. Enrolment requirements: Drug formulation course completed Exam: passed examination in Drug formulation
2.3. Learning outcomes at the level of the study programme to which the course contributes	• Select and apply technological processes in the production of (dermo)pharmaceuticals. • Critical skills in the development and implementation of solutions for practical problems in the production of (dermo)pharmaceuticals and the monitoring of safe and appropriate application of (dermo)pharmaceuticals and cosmetics. • Informing and advising patients on the effects and proper application of (dermo)pharmaceuticals as well as monitoring the treatment course and outcomes. • Apply expert knowledge and skills to provide advice on pharmacotherapy.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	The objective of this course is to enable the future pharmacist to provide expert advice about (dermo)pharmaceutical products and cosmetics. After completing the course student will be able to 1. Categorize and differentiate dermatological care products and evaluate their

<table>
<tr><td></td><td>scientific justification.
2. Asses the formulation of (dermo)pharmaceutical products and cosmetics
3. Understand and advise on the potential side effects on the skin of cosmetics and topical pharmaceutical products.
4. Understand and apply the general principles of the dermatological therapy.</td></tr>
<tr><td>2.5. Course content broken down in detail by weekly class schedule (syllabus)</td><td>LECTURES:
• Principles and methods of dermopharmacy/cosmetology
• The structure and function of the skin
• The structure and function of skin adnexa
• The most common disorders of the physiological skin functions (aging, acne, eczema, dermatitis, dry and sensitive skin)
• Raw materials for dermatological/cosmetic preparations
• Dyes and fragrances
• Physicochemical methods in dermopharmacy/cosmetology, formulation of dermatological/cosmetic products
• Skin care products
• Hair care products
• Oral care products and decorative cosmetics
• Aerosol formulations and containers for cosmetic products
• Quality assurance and legislation of dermatological/cosmetic preparations
LABORATORY:
• Formulation and evaluation of creams
• Formulation and evaluation of lotions
• Formulation and evaluation of gels, shampoos, roll-ons and toothpastes
• Formulation and evaluation of dermatological/cosmetic vehicles and powders</td></tr>
<tr><td>2.6. Type of instruction</td><td>lectures
seminars
workshops
exercises
online in entirety
mixed e-learning
mixed m-learning
field work
independent study
multimedia and the internet
laboratory
work with the mentor
(other)</td></tr>
<tr><td>2.7. Student responsibilities</td><td>Regular attendance of lectures and laboratory. Taking the final written and practical exams.</td></tr>
<tr><td>2.8. 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)</td><td>
<table>
<tr><td>Class attendance</td><td>1</td><td>Seminar essay</td><td></td></tr>
<tr><td>Experimental work</td><td></td><td>Oral exam</td><td></td></tr>
<tr><td>Essay</td><td></td><td>Project</td><td></td></tr>
<tr><td>Tests</td><td></td><td>Practical training</td><td>1</td></tr>
<tr><td>Written exam</td><td>3</td><td>(Other--describe)</td><td></td></tr>
<tr><td>Research</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>Report</td><td></td><td>(Other--describe)</td><td></td></tr>
</table>
</td></tr>
<tr><td>2.9. Grading and evaluation of student work over the course of instruction and at a final exam</td><td>Continuous assessment (ISVU system) - written final examination.</td></tr>
<tr><td>2.10. Required literature (available at the library and via other media)</td><td>
<table>
<tr><th>Title</th><th>Number of copies at the library</th><th>Availability via other media</th></tr>
<tr><td>1. M. Čajkovac, Kozmetologija, Slap, Zagreb, 2004.</td><td></td><td></td></tr>
<tr><td>2. J. Filipović-Grčić, Praktikum kozmetologije, FBF, Zagreb, 2001.</td><td></td><td>Merlin, e-learning system</td></tr>
<tr><td>3. Handbook of Cosmetic Science and Technology, Marc Paye (Editor), Andre O.</td><td></td><td></td></tr>
</table>
</td></tr>
</table>

	Barel (Editor), Howard I. Maibach (Editor) 3rd Ed., Informa HealthCare, 2009. PDF version of lecturer's presentations (available to the students enrolled into this course).		
2.11. Optional literature	Takeo Mitsui (ed.), New Cosmetic Science, Elsevier, Amsterdam, 1997.		
2.12. Methods of monitoring quality that ensure acquisition of exit competences	Assessment of learning outcomes through continuous assessment by written examinations during semester and final practical and written examinations. Analysis of assessment results to improve the quality of teaching.		
2.13. Comments			

DERMATICS IN PHARMACY PRACTICE

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Assistant professor Petra Turčić, PhD
1.2. Associate teachers	Professor Branka Marinović, PhD, MD, dermatologist Associate Professor Lidija Bach Rojecky, PhD Ana Dugonjić, assistant
1.3. Graduate programme	Integrated study of pharmacy
1.4. Status of the course	Elective
1.5. Year of study, Semester	5th year of study, IX semester
1.6. Credit value (ECTS)	2.5
1.7. Type of instruction (number of hours L+E+S+e-learning)	L(20) + E (0) + S(10)
1.8. Expected enrolment in the course	60
1.9. 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	The course objective is to develop students' skills that will aid them in assessing simple, easily recognizable skin conditions and diseases that are available for self-treatment. Course acquired skills and knowledge will serve as a basis for Pharmaceutical care and Professional training for pharmacists courses.
2.2. Enrolment requirements and required entry competences for the course	Passed courses: Pathophysiology and pathology, Pharmacology Attended courses: Immunology
2.3. Learning outcomes at the level of the study programme to which the course contributes	• Applying expert knowledge and skills in counseling on pharmacotherapy • Informing and counseling patients about the effects and the correct application of medications • Monitoring the course and outcome of therapy
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After completion of the course, students will be able to: • Identify most common skin conditions and diseases addressed in pharmacies • Differentiate between skin diseases available for self-treatement and those that require medical care • Advise about general care topics during treatment (hygiene, immune system, supplements) • Advise on self-treatment options and aid in deciding on selection of medication • Follow patient during treatment for timely identification of treatment progress or ineffectiveness • Increase patient adherence during long term treatment • Choose optimal medication from pharmacotherapeutic group for treatment of respective skin disease
2.5. Course content broken down in detail by weekly class schedule (syllabus)	Lectures: • Pharmacist's role in prevention and treatment of skin disease • Safe application of dermatics • Medications in treatment of bacterial skin diseases • Medications in treatment of viral skin diseases • Medications in treatment of fungal and yiest skin diseases • Medications in treatment o parasitic skin diseases • Pharmacotherapy of contact allergic and non-alergic dermatitis • Pharmacotherapy of atopic dermatitis • Treatment of diaper and heat related rashes

<table>
<tr><td></td><td colspan="4">

New therapeutic options in treatment of Psoriasis
Medications in treatment of Acne and Rosascea
Preparations in treatment of hair, scalp and nail diseases
Treatment of stings, wounds and burns
Allergic skin reactions (food, medicine, sun, cosmetics, plants)
Prevention of skin disorders due to sun exposure
Photosensitivity, photoaging and pigmentation disorders
Preparations in treatment of hypostatic dermatitis and varices of hemorrhoidal plexus
Skin changes due to systemic disease

Seminars

Recognition of most common skin conditions and diseases addressed by pharmacists
Therapy options for allergy realted skin diseases – case studies
Aftermath of sun exporure – case studies
Viral, bacterial and fungal skin diseases – case studies
Treatment of wounds, burns, callauses and blisters

</td></tr>
<tr><td>2.6. Type of instruction</td><td colspan="2"><u>lectures</u>
<u>seminars</u>
<u>workshops</u>
exercises
online in entirety
mixed e-learning
mixed m-learning</td><td colspan="2">field work
independent study
multimedia and the internet
work with the mentor
(other)</td></tr>
<tr><td>2.7. Student responsibilities</td><td colspan="4">Participation in lectures with the possible absence of the 20% of lectures</td></tr>
<tr><td rowspan="7">2.8. 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)</td><td>Class attendance</td><td>0,5</td><td>Seminar essay</td><td>1</td></tr>
<tr><td>Experimental work</td><td></td><td>Oral exam</td><td></td></tr>
<tr><td>Essay</td><td></td><td>Project</td><td></td></tr>
<tr><td>Tests</td><td></td><td>Practical training</td><td></td></tr>
<tr><td>Written exam</td><td>1</td><td>(Other--describe)</td><td></td></tr>
<tr><td>Research</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>Report</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>2.9. Grading and evaluation of student work over the course of instruction and at a final exam</td><td colspan="4">Multiple choice written exam after completion of all lectures, recognition of most common skin diseasesand conditoins and completion of case studies</td></tr>
<tr><td rowspan="4">2.10. Required literature (available at the library and via other media)</td><td colspan="2">Title</td><td>Number of copies at the library</td><td>Availability via other media</td></tr>
<tr><td colspan="2">Lectures available on the web sites of the Faculty of Pharmacology</td><td></td><td></td></tr>
<tr><td colspan="2"></td><td></td><td></td></tr>
<tr><td colspan="2"></td><td></td><td></td></tr>
<tr><td>2.11. Optional literature</td><td colspan="4">Aleksandra Basta-Juzbašić i sur. Dermatovenerologija. Medicinska naklada, 2014. Zagreb, Hrvatska
Jasna Lipozenčić i sur. Update in dermatologic drug therapy. AMZH, 2012. Zagreb, Hrvatska</td></tr>
<tr><td>2.12. Methods of monitoring quality that ensure acquisition of exit competences</td><td colspan="4">Outcomes 1-5 are checked through written examination.</td></tr>
<tr><td>2.13. Comments</td><td colspan="4"></td></tr>
</table>

DIAGNOSTICS AND THERAPY OF VIRAL INFECTIONS

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Asst. Prof. Sandra Šupraha Goreta, PhD Assoc. Prof. Maja Šegvić Klarić, PhD
1.2. Associate teachers	Assoc. Prof. Lidija Bach-Rojecky, PhD
1.3. Graduate programme	Medical Biochemistry integrated study programme
1.4. Status of the course	Elective
1.5. Year of study, Semester	3rd year, VI semester
1.6. Credit value (ECTS)	2.5
1.7. Type of instruction (number of hours L+E+S+e-learning)	12+0+8+0
1.8. Expected enrolment in the course	30 students
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2nd level of e-learning (not included in standard hours, but it is used in teaching)
2. COURSE DESCRIPTION	
2.1. Course objectives	Students will learn the basics of immunopathogenesis of viral infections, clinical syndromes in virology, application of modern methods of virological diagnostics, relating the mechanism of action of antiviral drugs to the biological characteristics of the virus.
2.2. Enrolment requirements and required entry competences for the course	Enrolled VI semester, passed exam of the course Microbiology and Parasitology Entry competences: it is understood that the students who enrolled the course are able to: - Apply knowledge in microbiology and biochemistry acquired current high school and academic education - Describe the biological characteristics of the virus - List medically important groups of the virus and ways of spreading viral infections - List viral vaccines of the vaccination schedule
2.3. Learning outcomes at the level of the study programme to which the course contributes	• The application of professional knowledge and skills in the virological diagnostic procedures, evaluation of clinical significance of molecular and biological parameters, interpretation of the results of laboratory analysis of the analytical and clinical aspects. • Demonstrate analytical and critical skills in developing and implementing solutions to practical problems in laboratory diagnostics.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	At the end of the course students will be able to: 1. Explain the concept of immunopathogenesis of viral infections 2. List and describe the clinical syndromes in virology 3. Explain, understand and apply direct and indirect methods of virological diagnostics 4. Understand the mechanisms of action of antiviral drugs and link them to the biological characteristics of the virus
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES: 1. Pathogenesis of viral infection and immune response of the host (the interaction of virus and host, the concept of the pathogenesis of viral infection, host immune response and viral mechanisms to avoid immune response) 2. Clinical syndromes in virology (viral infection of the central nervous system, eye, liver, respiratory, gastrointestinal and reproductive systems, and viral infections in immunocompromised patients) 3. Methods of direct and indirect virological diagnosis (virus isolation from clinical materials, immunoassays and serological methods, molecular diagnostics) 4. Antiviral drugs; the latest findings from biotechnology and pharmaceutical industries

	5. Emergent viral infection SEMINARS: 1. Viral infections in pregnancy 2. Therapy of virus in the pediatric population 3. Exotic and travellers viral infections 4. Viruses and cancer 5. Viruses and bioterrorism

2.6. Type of instruction	lectures seminars workshops exercises online in entirety mixed *e*-learning mixed *m*-learning	field work independent study multimedia and the internet work with the mentor (other)

2.7. Student responsibilities	Students are obligate to attend the lectures and seminars and to actively participate in the course activity.

2.8. 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	0.5	Seminar essay	0.5
	Experimental work		Oral exam	1.5
	Essay		Project	
	Tests		Practical training	
	Written exam		(Other--describe)	
	Research		(Other--describe)	
	Report		(Other--describe)	

2.9. Grading and evaluation of student work over the course of instruction and at a final exam	In grading and evaluation of student work class attendance and active participation in the course activity and results of oral exam are taken into account.

2.10. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	Kudesia, G, Wreghitt, T. Clinical and Diagnostic Virology (Cambridge University Press, UK,1st), 2009, ISBN-13: 978-0-511-50668-0		eBook-PDF
	Marks, RS, Lobel, L, Sall, AA. Viral diagnostics; Advances and Applications (Pan Stanford Publishing, FL, Volume 2), 2013, ISBN-13: 978-981-4364-44-7		eBook- PDF
	Kalenić S. et al. Medicinska mikrobiologija, Medicinska naklada, Zagreb, 2013, ISBN: 978-953-176-637-1	9	

2.11. Optional literature	Cann AJ. Principles of Molecular Virology, 4th Edition (Elsevier Academic Press), 2005, ISBN: 0-12-088787-8 (eBook- PDF)
2.12. Methods of monitoring quality that ensure acquisition of exit competences	Learning outcomes 1-4 are evaluated by oral exam.
2.13. Comments	

DIAGNOSTICS AND THERAPY OF VIRAL INFECTIONS

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Asst. Prof. Sandra Šupraha Goreta, PhD Assoc. Prof. Maja Šegvić Klarić, PhD
1.2. Associate teachers	Assoc. Prof. Lidija Bach-Rojecky, PhD
1.3. Graduate programme	Pharmacy integrated study programme
1.4. Status of the course	Elective
1.5. Year of study, Semester	4th year, VIII semester
1.6. Credit value (ECTS)	2.5
1.7. Type of instruction (number of hours L+E+S+e-learning)	12+0+8+0
1.8. Expected enrolment in the course	30 students
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2nd level of e-learning (not included in standard hours, but it is used in teaching)
2. COURSE DESCRIPTION	
2.1. Course objectives	Students will learn the basics of immunopathogenesis of viral infections, clinical syndromes in virology, application of modern methods of virological diagnostics, relating the mechanism of action of antiviral drugs to the biological characteristics of the virus.
2.2. Enrolment requirements and required entry competences for the course	Enrolled VIII semester, passed exam of the course Microbiology and Parasitology Entry competences: it is understood that the students who enrolled the course are able to: - Apply knowledge in microbiology and biochemistry acquired current high school and academic education - Describe the biological characteristics of the virus - List medically important groups of the virus and ways of spreading viral infections - List viral vaccines of the vaccination schedule
2.3. Learning outcomes at the level of the study programme to which the course contributes	• The application of professional knowledge and skills in consultation on pharmacotherapy of viral diseases and implementation of pharmaceutical care to patients • Demonstrating analytical and critical skills in developing and implementing solutions to practical problems in monitoring the safe and appropriate use of medicines
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	At the end of the course students will be able to: 1. Explain the concept of immunopathogenesis of viral infections 2. List and describe the clinical syndromes in virology 3. Explain, understand and apply direct and indirect methods of virological diagnostics 4. Understand the mechanisms of action of antiviral drugs and link them to the biological characteristics of the virus
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES: 1. Pathogenesis of viral infection and immune response of the host (the interaction of virus and host, the concept of the pathogenesis of viral infection, host immune response and viral mechanisms to avoid immune response) 2. Clinical syndromes in virology (viral infection of the central nervous system, eye, liver, respiratory, gastrointestinal and reproductive systems, and viral infections in immunocompromised patients) 3. Methods of direct and indirect virological diagnosis (virus isolation from clinical materials, immunoassays and serological methods, molecular diagnostics) 4. Antiviral drugs; the latest findings from biotechnology and pharmaceutical industries

	5. Emergent viral infection SEMINARS: 1. Viral infections in pregnancy 2. Therapy of virus in the pediatric population 3. Exotic and travellers viral infections 4. Viruses and cancer 5. Viruses and bioterrorism

2.6. Type of instruction	lectures seminars workshops exercises online in entirety mixed *e*-learning mixed *m*-learning	field work independent study multimedia and the internet work with the mentor (other)

2.7. Student responsibilities	Students are obligate to attend the lectures and seminars and to actively participate in the course activity.

2.8. 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	0.5	Seminar essay	0.5
	Experimental work		Oral exam	1.5
	Essay		Project	
	Tests		Practical training	
	Written exam		(Other--describe)	
	Research		(Other--describe)	
	Report		(Other--describe)	

2.9. Grading and evaluation of student work over the course of instruction and at a final exam	In grading and evaluation of student work class attendance and active participation in the course activity and results of oral exam are taken into account.

2.10. Required literature (available at the library and via other media)

Title	Number of copies at the library	Availability via other media
Kudesia, G, Wreghitt, T. Clinical and Diagnostic Virology (Cambridge University Press, UK,1st), 2009, ISBN-13: 978-0-511-50668-0		eBook-PDF
Marks, RS, Lobel, L, Sall, AA. Viral diagnostics; Advances and Applications (Pan Stanford Publishing, FL, Volume 2), 2013, ISBN-13: 978-981-4364-44-7		eBook- PDF
Kalenić S. et al. Medicinska mikrobiologija, Medicinska naklada, Zagreb, 2013, ISBN: 978-953-176-637-1	9	

2.11. Optional literature	Cann AJ. Principles of Molecular Virology, 4th Edition (Elsevier Academic Press), 2005, ISBN: 0-12-088787-8 (eBook- PDF)
2.12. Methods of monitoring quality that ensure acquisition of exit competences	Learning outcomes 1-4 are evaluated by oral exam.
2.13. Comments	

DRUG DESIGN

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Assist. Prof. Monika Barbarić, PhD
1.2. Associate teachers	Višnja Stepanić, PhD
1.3. Graduate programme	Pharmacy integrated study programme
1.4. Status of the course	elective
1.5. Year of study, Semester	5th year/9th semester
1.6. Credit value (ECTS)	3.5
1.7. Type of instruction (number of hours L+E+S+e-learning)	30+0+15
1.8. Expected enrolment in the course	30
1.9. 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	Introduce students to an interdisciplinary approach to research in the development of new drugs and to various methods such as quantitative structure-activity relationship (QSAR), molecular modelling, pharmacophore research, searching of databases and their application in drug design.
2.2. Enrolment requirements and required entry competences for the course	The prerequisite for admission: inscribed 9th semester and attended Medicinal Chemistry 2.
2.3. Learning outcomes at the level of the study programme to which the course contributes	Recognize the important parts of the drug structure and connect them with the mechanism of action and physical and chemical properties of drugs. Apply acquired knowledge in analyzing and proposing methods for the design of new drugs. Knowledge and skills acquired in this course are an extension of knowledge gained in the courses Medicinal Chemistry 1 and 2, Drug Metabolism and Pharmacology .
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	Students will be able to: 1. describe the phases of drug development 2. identify parts of the drug structure essential for the activity (pharmacophore groups) and for the physical and chemical properties of the drug 3. describe the binding of ligands to receptors and explain the influence of enthalpy and entropy on the binding affinity 4. explain the methods used for finding lead compounds and describe the methods of lead compound structure optimization 5. explain the terms QSPR and QSAR, molecular descriptors and molecular modelling 6. describe the ligand-based drug design 7. describe the structure-based drug design 8. search and use databases important for research of potential drugs, find and analyze relevant scientific information 9. use computer programs to calculate the descriptors and predict the activity, metabolism and toxicity of potential drugs; 10. use computer programs for the docking of ligands into active sites (*docking*)
2.5. Course content broken down in detail by weekly class schedule (syllabus)	**Lectures:** • Drug Development - Yesterday, Today, Tomorrow Traditional Medicines Serendipity Drug Development and Market • Binding of Drugs to Receptors Role of the Membrane Inhibition Constant Types of Interactions between Ligands and Receptors Contribution of Entropy in the Ligand-Receptor Interaction Optical Activity and Biological Effect

<table>
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Lead Compound in Drug Development
Searching for lead compounds (searching through natural products of plants, animals, and microorganisms; imitation of endogenous ligands; side effects as guideposts for new therapeutic options; high-throughput screening)
Lead Compound Structure Optimization (strategies for structure optimization; bioisostere; activity and selectivity optimization; from agonist to antagonist; optimization of bioavailability and extended effect; optimization of the binding affinity depending on enthalpy, entropy and the receptor-ligand binding kinetics)
Prediction and optimization of the ADME properties in drug research
Quantitative Structure-Activity Relationship
Molecular descriptors (physical-chemical, topological, geometric and electronic descriptors; Hammett equation; lipophilicity determination; Hansch analysis and Free-Wilson model)
3D-QSAR
Comparative Molecular Field Analysis
Molecular Modeling
Models in chemistry
Fundamental methods (molecular mechanics, quantum chemistry method)
Ligand-based drug design
Structure-based drug design
De novo drug design

Seminars:

Searching and use of databases important for research of potential drugs
Watching and evaluation of videos about drug design
Using computer programs to calculate descriptors and predict the activity, metabolism and toxicity of potential drugs
Using computer programs for ligand-receptor docking simulations
Writing and presentation of seminar according a given topic

</td></tr>
<tr><td>2.6. Type of instruction</td><td colspan="2">lectures
seminars
workshops
exercises
fully online
hybrid e-learning
hybrid m-learning</td><td colspan="2">fieldwork
independent study
multimedia and the internet
work with the mentor
(other)</td></tr>
<tr><td>2.7. Student responsibilities</td><td colspan="4">Class attendance (lectures, seminars), writing and presenting a seminar essay</td></tr>
<tr><td rowspan="8">2.8. 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)</td><td>Class attendance</td><td>0.5</td><td>Seminar essay</td><td>1.0</td></tr>
<tr><td>Experimental work</td><td></td><td>Oral exam</td><td></td></tr>
<tr><td>Essay</td><td></td><td>Project</td><td></td></tr>
<tr><td>Tests</td><td>2.0</td><td>Practical training</td><td></td></tr>
<tr><td>Written exam</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>Research</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>Report</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>2.9. Grading and evaluation of student work over the course of instruction and at a final exam</td><td colspan="4">Written final exam grade and seminar essay grade</td></tr>
<tr><td rowspan="2">2.10. Required literature (available at the library and via other media)</td><td>Title</td><td colspan="2">Number of copies at the library</td><td>Availability via other media</td></tr>
<tr><td>Monika Barbarić, handouts are available through the Merlin e-learning system</td><td colspan="2"></td><td>Internet</td></tr>
</table>

	Gerhard Klebe, Drug Design Methodology, Concepts, and Mode of Action, Springer-Verlag Berlin Heidelberg, 2013. ISBN 978-3-642-17906-8 ISBN 978-3-642-17907-5 (eBook), ISBN 978-3-642-17908-2 (print and electronic bundle)		Internet
	Graham L. Patrick, An Introduction to Medicinal Chemistry, 5t^{h} ed., Oxford University Press, Oxford, 2013. ISBN 978-0-19-969739-7	1	
2.11. Optional literature	Recent relevant literature (current professional and scientific papers)		
2.12. Methods of monitoring quality that ensure acquisition of exit competences	Outcomes 1-7 are tested in a written final exam and outcomes 8-10 during the review and presentation of a seminar essay		
2.13. Comments			

DRUG FORMULATION

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Associate Professor Željka Vanić, PhD Associate Professor Mario Jug, PhD
1.2. Associate teachers	Zora Rukavina, MPharm Marina Juretić, MPharm Sabina Keser, MPharm
1.3. Graduate programme	Pharmacy
1.4. Status of the course	Obligatory course
1.5. Year of study, Semester	4th year, 7th semester
1.6. Credit value (ECTS)	9
1.7. Type of instruction (number of hours L+E+S+e-learning)	60 + 45 + 0 + 0
1.8. Expected enrolment in the course	130
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2nd level
2. COURSE DESCRIPTION	
2.1. Course objectives	The course objectives include studying of scientific principles relative to the design, manufacture and quality control of pharmaceutical formulations; fundamentals on excipients and their influence on drug stability and therapeutic efficiency as well as features of pharmaceutical formulations. The course provides basis for: Magistral formulation, Cosmetology, Innovative drug delivery systems, Industrial pharmacy, Clinical pharmacy with pharmacotherapy, Quality assurance and registration of drugs, Student practice II, Pharmaceutical care and Professional Training for Pharmacists.
2.2. Enrolment requirements and required entry competences for the course	Enrolment: • Pharmaceutics-passed examination • Biopharmaceutics and Pharmacokinetics-course completed • Requirement for exam: Biopharmaceutics and Pharmacokinetics-passed examination
2.3. Learning outcomes at the level of the study programme to which the course contributes	• Expert knowledge on the development of pharmaceuticals in order to produce drug formulations by selecting and applying technological processes as well as their innovations to ensure quality in the process of the production by applying the rules of good laboratory and manufacturing practice, as well as relevant European and ISO directives. • Professional skills which would allow to recommend an optimal pharmaceutical drug formulation regarding the pathology, route of application, patient age and general condition; consulting the patient about proper application of pharmaceuticals. • Critical assessment and application of relevant scientific knowledge in development of advanced drug delivery systems as well as improvement of existing and design of new technologies for production of pharmaceuticals.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After completing this course the student will be able to: 1. Define and distinguish between different drug formulations and to discuss advances and/or limitations of their use. 2. Categorize various pharmaceutical excipients, describe their application in

	production of pharmaceuticals and analyze their impact on stability and therapeutic efficiency of drugs. 3. Define and describe the preparation of various drug dosage forms, analyze their advantages/disadvantages and assess their influence on stability and therapeutic efficiency of drugs. 4. Select an appropriate technology and processing conditions based on physicochemical properties of drug/excipients, administration route and target patient groups. 5. List and describe protocols for quality insurance of various drug dosage forms and to estimate the impact of excipients and technology used on their quality. 6. Recognize technologically relevant incompatibilities between drugs, excipients and/or containers. 7. Formulate and evaluate various drug dosage forms.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	<u>Lectures:</u> • Introduction, definition of drug dosage forms, preformulation • Excipients-classification, requirements, preservatives, antioxidants, flavoring agents and colorants • Cyclodextrines as pharmaceutical excipients • Sterilization of pharmaceuticals, principles of sterilization, aseptic procedure and sterility control • Herbal dosage forms-tea mixtures, extraction methods, extracts, tinctures, infusions, decocts, elixirs, quality control • Liquid dosage forms-solutions, solvents and cosolvents, solubility issues, micellar solubilization, osmolarity and tonicity, preparation methods • Suspensions as pharmaceutical dosage form-excipients, stability aspects, preparation methods (technology), flocculated and deflocculated systems, quality control • Emulsions as pharmaceutical dosage form-emulsifiers, stability aspects, preparation methods (technology), quality control • Liquid formulations for ophthalmic, nasal, otic and oral application-drops, rinsing solutions, syrups, liquid mixtures • Small volume parenterals-routes of applications, types of injections, solvents, excipients and technology of their preparation • Large volume parenterals-electrolytes, plasma expanders, admixtures for parenteral and enteral nutrition, dialysis solutions • Parenterals for prolonged drug delivery-principles and examples, delivery of pharmaceutical proteins • Liposomes as drug carriers for parenteral application • Production of parenterals-aseptic preparation, clean rooms, quality control, containers • Radiopharmaceuticals-radionuclide generator, quality control • Aerosols-propelents, metered dose inhalers, dry powder inhalers, preparation methods (principles), innovative delivery systems for pulmonary delivery, quality control • Semisolid drug dosage forms-ointments, creams and gels, excipients and ointment bases, preparation methods (technology)

<table>
<tr><td></td><td colspan="4">

Semisolid formulations for ophthalmic and transdermal drug delivery, quality control of semisolid dosage forms
Medicinal soaps and suppositories for rectal and vaginal delivery-bases, excipients, preparation methods (technology), quality control
Solid oral dosage forms-powders, soft/hard gelatin capsules, excipients, preparation methods (technology), quality control
Tablets as solid oral dosage form-classification, excipients
Tablets as solid oral dosage form-granulation methods and tableting process
Sugar coated and film coated tablets
Modified release tablets, quality control of solid dosage forms
Pharmaceutical packaging-classification, materials, regulatory and quality considerations

<u>Laboratory:</u>

Preparation and technological evaluations of herbal dosage forms: tea mixtures, tinctures, extracts, syrups
Preparation and technological evaluations of liquid dosage forms: solutions for internal/external application, aromatic waters
Preparation and technological evaluations of liquid dosage forms: suspensions and emulsions
Preparation and technological evaluations of semisolid dosage forms: ointment bases, ointments, hydrogels, pastes
Preparation and technological evaluations of semisolid dosage forms: medicinal soaps and liniments
Preparation and technological evaluations of solid dosage forms: suppositories for rectal and vaginal application
Preparation and technological evaluations of solid dosage forms: granules and tablets

</td></tr>
<tr><td>2.6. Type of instruction</td><td colspan="2"><u>lectures</u>
seminars
workshops
<u>exercises</u>
online in entirety
mixed e-learning
mixed m-learning</td><td colspan="2">field work
independent study
multimedia and the internet
<u>laboratory</u>
work with the mentor
(other)</td></tr>
<tr><td>2.7. Student responsibilities</td><td colspan="4">Regular class attendance and completed laboratory exercises.</td></tr>
<tr><td rowspan="8">2.8. 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)</td><td>Class attendance</td><td>2</td><td>Seminar essay</td><td></td></tr>
<tr><td>Experimental work</td><td></td><td>Oral exam</td><td>2</td></tr>
<tr><td>Essay</td><td></td><td>Project</td><td></td></tr>
<tr><td>Tests</td><td>1</td><td>Practical training</td><td>2</td></tr>
<tr><td>Written exam</td><td>2</td><td>(Other--describe)</td><td></td></tr>
<tr><td>Research</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>Report</td><td></td><td>(Other--describe)</td><td></td></tr>
</table>

2.9. Grading and evaluation of student work over the course of instruction and at a final exam	Continuous assessment over 3 partial written exams or final written exam and oral exam. Monitoring and evaluation of experimental work and final test.		
2.10. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	1. R. Senjković, Osnove oblikovanja lijekova, Školska knjiga, Zagreb, 2003, (1994).	19 (4)	
	2. Bećirević-Laćan, Mira; Jug, Mario; Vanić, Željka. Oblikovanje lijekova: praktikum. Zagreb: Farmaceutsko-biokemijski fakultet Sveučilišta u Zagrebu, 2015		Merlin, e-learning
2.11. Optional literature	Pharmaceutics, the science of dosage form design, edited by M.E. Aulton, Churchil Livingstone, Edinburgh, London, Melbourne, New York, 1st ed. 1998, 2nd ed. 2002, 3rd ed. 2007.		
2.12. Methods of monitoring quality that ensure acquisition of exit competences	Assessment of learning outcomes by evaluation of practical work in laboratory as well as by continuous examinations during semester and final evaluation by written examination; Analysis of assessment results to improve the quality of teaching.		
2.13. Comments			

DRUGS, DOPING AND ADDICTION

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Associate prof. Lidija Bach-Rojecky, PhD
1.2. Associate teachers	Prof. Željan Maleš Assist. prof. Sandra Šupraha Goreta Višnja Drinovac Vlah, MPharm
1.3. Graduate programme	Study programme Medicinal biochemistry
1.4. Status of the course	elective
1.5. Year of study, Semester	4.,8.
1.6. Credit value (ECTS)	2.5
1.7. Type of instruction (number of hours L+E+S+e-learning)	20 + 0 + 5 + 5
1.8. Expected enrolment in the course	20
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2.
2. COURSE DESCRIPTION	
2.1. Course objectives	Introduce students to the problems of abuse of drugs and other xenobiotics of synthetic and natural origin for the purpose of mood and behavior changes. Integrative approach will cover social, pharmacological and biochemical diagnostic aspects of this subject matter.
2.2. Enrolment requirements and required entry competences for the course	Passed exam in Physiology with human anatomy, attended Biochemistry and Patophysilogy and patology.
2.3. Learning outcomes at the level of the study programme to which the course contributes	• Monitoring the course and outcomes of therapy in order to prevent drugs' abuse. • Participation in the prevention of illness and the preservation of health through public health initiatives.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After completion the course students will be able to: 1. List drugs and xenobiotics with abuse potential, 2. Specify the basic effects of certain drugs/xenobiotics in the organism, 3. Explain the basic mechanisms of addiction, 4. Describe the basic approaches in the treatment of addictions, 5. Distinguish and describe the methods of detection of drugs/xenobiotics in biological samples.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES: • Addiction - a disease of modern era (2 hours) - Define basic concepts (drugs, addictive drug, abuse, tolerance, psychological and physical dependence, withdrawal syndrome, etc) - List of substances with the potential of causing addiction - Prevalence of addiction, risk factors, diagnostic criteria • How "drugs" alter brain function? (2 hours) - Neurobiological changes in the central nervous system - Genetic of addiction • Drugs of abuse (routes of administration, basic effects at the cellular / organic level, risks of abuse) - Drugs (non-prescription drugs, psychostimulants, opiates and opioids, sedatives) (3 hours) - Herbal drugs (hallucinogenic, drugs with psychostimulant effects) (2 hours) - "Synthetic drugs" (2 hours) - Legal addictive substances (alcohol, nicotine) (1 hour) • Addiction treatment (2 hours) - Basic non-pharmacological and pharmacological approach • Doping - yesterday, today and tomorrow (historical aspect of development of

	doping, a group of drugs / substances, basic effects) (2 hours) • The detection of doping (sampling, analytical methods for detection) (2 hours) • Gene doping (potential genes and goals, candidates for use, side effects, detection of gene doping) (2 hours) SEMINARS (problem-based learning): • Misuse of drugs - case-studies from practice (3 hours) • Modern doping as the future of elite sport (discussion of selected cases of doping) (2 hours)

2.6. Type of instruction	**lectures** **seminars** workshops exercises online in entirety **mixed *e*-learning** mixed *m*-learning	field work **independent study** multimedia and the internet work with the mentor (other)

2.8. 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	0.5	Seminar essay	
	Experimental work		Oral exam	1.0
	Essay		Project	1.0
	Tests		Practical training	
	Written exam		(Other--describe)	
	Research		(Other--describe)	
	Report		(Other--describe)	

2.9. Grading and evaluation of student work over the course of instruction and at a final exam	Active participation in case-studies discussion; oral exam.

2.10. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	Recent scientific papers.		On line data-bases
	Selected topics from: Neuroscience of psychoactive substance use and dependence. World Health Organization 2004, Geneva		

2.11. Optional literature	Relevant web-pages: http://www.who.int/topics/substance_abuse/en/, www.drugabuse.gov
2.12. Methods of monitoring quality that ensure acquisition of exit competences	Outcomes 1-5 are monitored during the lessons and verified by oral exam.
2.13. Comments	-

EMERGENCY LABORATORY DIAGNOSTICS

1. COURSE DESCRIPTION – GENERAL INFORMATION	
1.1. Course teacher	assoc prof Dunja Rogić, PhD
1.2. Associate teachers	Ivana Rako, PhD, Gordana Fressl Juroš, med. biochem. specialist
1.3. Graduate programme	integrated study of medical biochemistry
1.4. Status of the course	elective
1.5. Year of study, Semester	5th year, 9th semester
1.6. Credit value (ECTS)	2.5
1.7. Type of instruction (number of hours L+E+S+e-learning)	15+10+5
1.8. Expected enrolment in the course	15-20
1.9. 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	Make student aware of patients in emergency condition and introduce students to the role of medical biochemistry laboratory in patient's care by synthetizing information and knowledge in the field of general, specialist and highly differentiated medical biochemistry.
2.2. Enrolment requirements and required entry competences for the course	Enrolment requirement: audited course: Special Areas of Clinical Biochemistry
2.3. Learning outcomes at the level of the study programme to which the course contributes	- Application of professional knowledge in laboratory diagnostic procedures, assessment of clinical significance of biochemical and molecular-biological indicators, detection of the source of errors and variability of results of laboratory analyses, interpretation of results of laboratory analyses from analytical and clinical aspects. - Employment of observational, analytical and critical skills in development and implementation of solutions for practical problems in laboratory diagnostics.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After passing the course exam, students will be able to: 1) define the significance of emergency laboratory service in individual emergency conditions 2) describe emergency laboratory organization 3) recognize patients in most frequent emergency conditions based on the knowledge of the categories of emergency 4) select and explain the choice of laboratory analysis for specific emergency pathological condition.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	Lectures: - Introduction to emergency laboratory diagnostics. Organization of the service. Types of samples. Emergency patient. - Organization of emergency laboratory, critical values, categories of emergency. - Significance of emergency laboratory service in individual emergency conditions. - Emergency conditions - the most frequent cases of patient care. Seminars - Diagnosis of anemia - Anaphylactic shock, myocardial infarction, urothelial infection. Exercises - Complete case histories
2.6. Type of instruction	lectures seminars workshops exercises online in entirety mixed *e*-learning mixed *m*-learning field work independent study multimedia and the internet laboratory work with the mentor (other)
	Regular attendance and active participation in classes

<table>
<tr><td>2.7. Student responsibilities</td><td colspan="4"></td></tr>
<tr><td rowspan="7">2.8. 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)</td><td>Class attendance</td><td>1</td><td>Seminar essay</td><td>0.5</td></tr>
<tr><td>Experimental work</td><td></td><td>Oral exam</td><td></td></tr>
<tr><td>Essay</td><td></td><td>Project</td><td></td></tr>
<tr><td>Tests</td><td></td><td>Practical training</td><td></td></tr>
<tr><td>Written exam</td><td>1</td><td>(Other--describe)</td><td></td></tr>
<tr><td>Research</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>Report</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>2.9. Grading and evaluation of student work over the course of instruction and at a final exam</td><td colspan="4">Student's activity is evaluated over the course of instructions. Final grade is determined on the basis of achievement in the written exam.</td></tr>
<tr><td rowspan="4">2.10. Required literature (available at the library and via other media)</td><td colspan="2">Title</td><td>Number of copies at the library</td><td>Availability via other media</td></tr>
<tr><td colspan="2">Čvorišćec D, Čepelak I, editors. Štrausova medicinska biokemija. Zagreb: Medicinska naklada, 2009.</td><td></td><td></td></tr>
<tr><td colspan="2"></td><td></td><td></td></tr>
<tr><td colspan="2"></td><td></td><td></td></tr>
<tr><td>2.11. Optional literature</td><td colspan="4"></td></tr>
<tr><td>2.12. Methods of monitoring quality that ensure acquisition of exit competences</td><td colspan="4">Outcomes 3 and 4 are acquired and evaluated during seminars and exercises, while outcome 1 and 2 are evaluated through written exam.</td></tr>
<tr><td>2.13. Comments</td><td colspan="4"></td></tr>
</table>

ESSENTIALS OF CYTOLOGY AND HISTOLOGY

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Professor Mirna Sučić, PhD
1.2. Associate teachers	
1.3. Graduate programme	Integrated Medical Biochemistry Study Programme
1.4. Status of the course	Obligatory
1.5. Year of study, Semester	1
1.6. Credit value (ECTS)	5.5
1.7. Type of instruction (number of hours L+E+S+e-learning)	30+10+5
1.8. Expected enrolment in the course	15-25
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2.
2. COURSE DESCRIPTION	
2.1. Course objectives	To learn essentials of human histology and human cell cytology, apply knowledge of human histology and cytology with specific cell physiology, anatomy and physiology of tissues and organ systems; learn about standard a nd new techniques of cell and tissue specimen preparation for microscope analysis; recognise essential cytology of inflammation and tumor cells.
2.2. Enrolment requirements and required entry competences for the course	None.
2.3. Learning outcomes at the level of the study programme to which the course contributes	• Evaluating the clinical relevance of diagnostic indicators of basic cytomorphology and histology of normal cells and normal tissue and of cytomorphology of inflammation and tumor cells. • Implementation of standard and new technical methods (laboratory techniques for cell ad tissue specimen preparation for microscope analyisis) for detecting and follow-up of disease and treatment monitoring.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	• At the end of the course the trainee will be able to: • Apply fundamental knowledge of histology of tissue and histology of organ systems with essentials of human anatomy. • Apply fundamental knowledge of various cell cytology and histology of tissue and histology of organ systems with cell, tissue and organ system physiology. • Describe and define laboratory techniques fo preparing cell and tissue specimens for microscope analysis. • Describe and recognise cells of specific tissues and organ systems. • Describe and recognize specific histologic tissues. • Describe and recognize cytomorphology of inflammation and tumors.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES: • Cell and tissue techniques for microscope analysis. • Cell, cell organells and cell cycle. • Epithelial and connective tissue. • Adipose tissue and cartilage. • Bone tissue and muscule tissue. • Nervous tissue. Cardiovascular and lymph vascular systems. • Hemopoietic tissue. Development of hemopoietic cells, hemopoietic cells. • Lymphatic (immunological) system. Endocrine system. • Urinary system. Respiratory system. • Digestive system and digestve glands. • Male reproductive system. Skin. • Female reproductive system. Sensory organs.

	SEMINARS: • Cytochemical and immunocytochemical techniques.T*elomerase.* • Morphology of epithelial tissue. *Desmosomes.* • Morphology of connective and adipose tissue. *Mitochondria and oxidative phosphorylation.* • Morphology of cartilage and bone tissue. *Bone morphogenic proteins.* • Morphology of muscule tissue and nervous tissue. *Alzheimer's disease.* • Morphology of cardiovascular and lymph vascular systems. *Atherosclerosis.* • Morphology of hemopoietic cells. *Stem cells.* • Morphology of lymphatic system and endocrine system. *Melatonin.* • Morphology of respiratory system and urinary system. *Epithelial metaplasia and smoking.* • Morphology of digestive system and digestive glands. *Intrinsic factor and B12.* • Morphology of male and female reproductive system. *Human Papillomavirus.* • Skin and sensory organs morphology. *Pheromones.* EXERCISES: • Recognition of respiratory epithelial cells, urine epithelial cells, mesothelial effusion cells and hemopoietic bone marrow cells. Essentials of cytochemical and immunocytochemical techniques. • Recognition of histology of specific tissues and specific organe systems. Recognition of cytomorphology of inflammation and tumor cells.
2.6. Type of instruction	**lectures** **seminars** **workshops** **exercises** online in entirety mixed *e*-learning mixed *m*-learning field work independent study multimedia and the internet work with the mentor (other): **Fonts in italic indicate students seminars.**
2.7. Student responsibilities	

2.8. 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	1	Seminar essay	1
	Experimental work		Oral exam	
	Essay		Project	
	Tests		Practical training	
	Written exam	3,5	(Other--describe)	
	Research		(Other--describe)	
	Report		(Other--describe)	

2.9. Grading and evaluation of student work over the course of instruction and at a final exam	Regular attendance of classes; active participation in seminares, practical test of excercises classes, final exam (written test)

2.10. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	Junqueira LC, Carneiro J. Osnove histologije, Školska knjiga, 2005.	5	
	Junqueria LC, Carneiro J, Kelly RO. Osnove hisologije. Školska knjiga, Zagreb 1999.	6	
	Sučić M. Osnove citologije i histologije, priručnik za nastavu, FBF, 2006.	1	
	Sučić M. Šoljić V. Osnove citologije i histologije, skripta, FBF, 2014.	1	
2.11. Optional literature			
2.12. Methods of monitoring quality that ensure acquisition of exit	Final exam;(wriiten test).		

competences	
2.13. Comments	

Course teacher: Professor Mirna Sučić, PhD

Head of Deperatment of Medical Biochemistry and Hematology: Professor Karmela Barišić, PhD

EXPERIMENTAL PHARMACOLOGY

1. COURSE DECRIPTION – GENERAL INFORMATION		
1.1. Course teacher	Associate prof. Lidija Bach-Rojecky, PhD	
1.2. Associate teachers	Assistant prof. Petra Turčić, PhD Višnja Drinovac Vlah, MPharm Ana Dugonjić Okroša, MPharm	
1.3. Graduate programme	Pharmacy study programme	
1.4. Status of the course	elective	
1.5. Year of study, Semester	4.,8.	
1.6. Credit value (ECTS)	2.5	
1.7. Type of instruction (number of hours L+E+S+e-learning)	15 + 7 + 8	
1.8. Expected enrolment in the course	30	
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2.	
2. COURSE DESCRIPTION		
2.1. Course objectives	Student will learn diverse experimental methods and models used in pharmacological and toxicological research, planning the experiments, searching scientific literature and writing scientific paper. Acquired knowledge complement knowledge and skills obtained in subject Pharmacology.	
2.2. Enrolment requirements and required entry competences for the course	Pre-requisite: attended Pharmacology Necessary competences: understanding basic pharmacokinetic and pharmacodynamics principles of drugs' action	
2.3. Learning outcomes at the level of the study programme to which the course contributes	• Suggest procedures related to drug research and development • Critical assessment and application of scientific knowledge • Preparation of scientific publications • Knowing and accepting ethical principles	
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After completeing this course, student will be able to: 1. Plan pharmacological in vivo experiment in concordance with ethical principles and directives 2. Compare experimental methods and models, and highlight their advantages and disadvantages 3. Interpret experimental data 4. Analyse experimental data and present them in a form of scientific paper	
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES AND SEMINARS: • Introduction to experimental pharmacology • Placebo effect – myth or fact? • Experimental models of pain • Experimental models of peripheral organs (hepatitis, ulcerative colitis) • Experimental models of neuropsychiatric diseases • Experimental models of addiction • Therapeutic potential of cannabinoids EXERCISES: • Experimental models of pain • Experimental models of depression • Collecting samples	
2.6. Type of instruction	**lectures** **seminars** workshops **exercises** online in entirety mixed *e*-learning	field work **independent study** multimedia and the internet work with the mentor (other)

	mixed *m*-learning			
2.7. Student responsibilities	Active participation and contribution to realisation of theme project. Possible non-attendance of 20% of lectures.			
2.8. 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	0.5	Seminar essay	
	Experimental work		Oral exam	
	Essay		Project	1.0
	Tests		Practical training	
	Written exam		(Other--describe)	
	Research	1.0	(Other--describe)	
	Report		(Other--describe)	
2.9. Grading and evaluation of student work over the course of instruction and at a final exam	Student's participation in preparation and elaboration of theme project are evaluated.			

2.10. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	Sceintific papers		On-line database
	Relevant pharmacological web-pages: http://www.guidetopharmacology.org/		

2.11. Optional literature	-
2.12. Methods of monitoring quality that ensure acquisition of exit competences	Outcomes 1-4 are verified during project presentation and discussion.
2.13. Comments	Team consists of 4-5 students.

FREE RADICALS AND ANTIOXIDANTS IN HEALTH AND DISEASES

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Prof. Lada Rumora, PhD.
1.2. Associate teachers	Prof. Jozsef Petrik, PhD. Associate Prof. Ana-Marija Domijan, PhD. Associate Prof. Dubravka Vitali Čepo, PhD. Assistant Prof. Ana Budimir, PhD. Assistant Prof. Erim Bešić, PhD.
1.3. Graduate programme	Integrated Medical Biochemistry Study Programme
1.4. Status of the course	elective
1.5. Year of study, Semester	3. year of study, 5. semester
1.6. Credit value (ECTS)	2.5
1.7. Type of instruction (number of hours L+E+S+e-learning)	16 (L) + 2 (E) + 12 (S) + 0 (e-learning)
1.8. Expected enrolment in the course	MBS: 15 – 20 (+ FS: 40 – 45)
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2.
2. COURSE DESCRIPTION	
.1. Course objectives	Understand mechanisms of free radicals generation in both physiological and pathological conditions, identify various subgroups of antioxidative molecules and recognize different modes of their action in the attempt to remove reactive oxygen and nitrogen species, describe methods for determination of oxidative-antioxidative imbalance, single out antioxidants with therapeutic potential. Apply the gained knowledge and skills in other courses of Medical Biochemistry as well as Pharmacy that include in their study programmes oxidative stress involvement in disease pathoethiology, drugs interactions with intracellular redox environment, and implementation of antioxidants in diagnostics of various diseases as well as in personalized therapeutic approaches to the patients (personalized medicine).
.2. Enrolment requirements and required entry competences for the course	Biochemistry course attendance.
.3. Learning outcomes at the level of the study programme to which the course contributes	• Implementation of gained knowledge in laboratory diagnostics, in defining, analysing and recommendation of the procedures in the research, production and quality control as well as implementation of new laboratory procedures for diagnostics of diseases, follow-up of the diseases progression and therapeutic effects. • Critical evaluation and application of scientific data and expert knowledge for the problem solving in biochemical systems.
.1. Expected learning outcomes at the level of the course (4-10 learning outcomes)	The learning outcomes after attending this course: 1. Understand physiological and pathological generation of free radicals provoked by endogenous and exogenous sources. 2. Identify main classes of antioxidative molecules and compare different modes

	of their action. 3. Recognize the significance of cellular redox homeostasis. 4. Analyse the effects of redox-sensitive transcription factors on cell's capacity to cope with oxidative burst. 5. Select appropriate methods for oxidative stress detection in both intracellular and extracellular environment. 6. Recognize interconnection between oxidative stress and carcinogenesis. 7. Understand the role of nutrition and personal lifestyle on antioxidative status. 8. Recognize the importance of antioxidants and oxidatively modified molecules in diagnostics and therapeutics approaches.
.2. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES AND SEMINARS: • Free radicals and antioxidants – overview: free radicals effects, role and function of various antioxidants, oxidative stress. • Chemistry of free radicals: nomenclature of free radicals, endogenous and exogenous sources of free radicals, mechanisms of free radicals reactions. • Electron spin resonance: EPR spectroscopy, method of spin entrapments, method of spin marks. • Nitric oxide – function and effects: biosynthesis of nitric oxide (NO), NO signalling and its effects on cells, isoforms of NO synthase (NOS). • Polyphenols – antioxidants: classification of polyphenols, flavonoids, catechins, resveratrol, methods for determination of flavonoids' antioxidative activities. • Effects of nutrition on human antioxidative status: antioxidants in the food, food components with pro-oxidative effects, bioactivation of food antioxidants, mechanisms of action of nutritional antioxidants, carotenoids, vitamin E, vitamin C. • Oxidative stress and carcinogenesis: mechanisms of metal action (iron, copper, chromium, cadmium), oxidative modifications of DNA, oxidative modifications of proteins, role and function of glutathione, activation of redox-sensitive transcription factors. LABORATORY PRACTICE: • Electron spin resonance spectroscopy technique.
.1. Type of instruction	**lectures** **seminars** workshops **exercises** online in entirety mixed *e*-learning mixed *m*-learning field work independent study multimedia and the internet work with the mentor (other)
2.7. Student responsibilities	Regular attendance of the classes, individual presentation of the topic selected after searching for adequate literature data, active retrospection on other students'

<table>
<tr><td></td><td colspan="4">presented topics, active participation in laboratory presentation of electron spin resonance spectroscopy technique.</td></tr>
<tr><td rowspan="7">2.8. 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)</td><td>Class attendance</td><td>0.2</td><td>Seminar essay</td><td>0.8</td></tr>
<tr><td>Experimental work</td><td>0.5</td><td>Oral exam</td><td></td></tr>
<tr><td>Essay</td><td></td><td>Project</td><td></td></tr>
<tr><td>Tests</td><td></td><td>Practical training</td><td></td></tr>
<tr><td>Written exam</td><td>1</td><td>(Other--describe)</td><td></td></tr>
<tr><td>Research</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>Report</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>2.9. Grading and evaluation of student work over the course of instruction and at a final exam</td><td colspan="4">Written exam, active participation in laboratory practice, individual presentation of the topic selected after searching for adequate literature data.</td></tr>
<tr><td rowspan="4">2.10. Required literature (available at the library and via other media)</td><td colspan="2">Title</td><td>Number of copies at the library</td><td>Availability via other media</td></tr>
<tr><td colspan="2">Lushchak V.I., Semchyshyn H.M. (editors): Oxidative Stress - Molecular Mechanisms and Biological Effects. InTech, 2012.</td><td></td><td></td></tr>
<tr><td colspan="2">Andreescu S., Maria Hepel M. (editors): Oxidative Stress: Diagnostics, Prevention, and Therapy. American Chemical Society, 2011.</td><td></td><td></td></tr>
<tr><td colspan="2">Čvorišćec D., Čepelak I. (editors): Štrausova medicinska biokemija. Medicinska naklada, 2009.</td><td></td><td></td></tr>
<tr><td>2.11. Optional literature</td><td colspan="4">Up-to-date review papers regarding the course topics.</td></tr>
<tr><td>2.12. Methods of monitoring quality that ensure acquisition of exit competences</td><td colspan="4">All learning outcomes are checked during course's seminars and by written exam.</td></tr>
<tr><td>2.13. Comments</td><td colspan="4"></td></tr>
</table>

FREE RADICALS AND ANTIOXIDANTS IN HEALTH AND DISEASES

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Prof. Lada Rumora, PhD.
1.2. Associate teachers	Prof. Jozsef Petrik, PhD. Associate Prof. Ana-Marija Domijan, PhD. Associate Prof. Dubravka Vitali Čepo, PhD. Assistant Prof. Ana Budimir, PhD. Assistant Prof. Erim Bešić, PhD.
1.3. Graduate programme	Integrated Pharmacy Study Programme
1.4. Status of the course	elective
1.5. Year of study, Semester	3. year of study, 5. semester
1.6. Credit value (ECTS)	2.5
1.7. Type of instruction (number of hours L+E+S+e-learning)	16 (L) + 2 (E) + 12 (S) + 0 (e-learning)
1.8. Expected enrolment in the course	FS: 40 – 45 (+ MBS: 15 – 20)
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2.
2. COURSE DESCRIPTION	
.1. Course objectives	Understand mechanisms of free radicals generation in both physiological and pathological conditions, identify various subgroups of antioxidative molecules and recognize different modes of their action in the attempt to remove reactive oxygen and nitrogen species, describe methods for determination of oxidative-antioxidative imbalance, single out antioxidants with therapeutic potential. Apply the gained knowledge and skills in other courses of Medical Biochemistry as well as Pharmacy that include in their study programmes oxidative stress involvement in disease pathoethiology, drugs interactions with intracellular redox environment, and implementation of antioxidants in diagnostics of various diseases as well as in personalized therapeutic approaches to the patients (personalized medicine).
.2. Enrolment requirements and required entry competences for the course	Biochemistry course attendance.
.3. Learning outcomes at the level of the study programme to which the course contributes	• Implementation of gained knowledge in laboratory diagnostics, in defining, analysing and recommendation of the procedures in the research, production and quality control as well as implementation of new laboratory procedures for diagnostics of diseases, follow-up of the diseases progression and therapeutic effects. • Critical evaluation and application of scientific data and expert knowledge for the problem solving in biochemical systems.
.1. Expected learning outcomes at the level of the course (4-10 learning outcomes)	The learning outcomes after attending this course: 1. Understand physiological and pathological generation of free radicals provoked by endogenous and exogenous sources. 2. Identify main classes of antioxidative molecules and compare different modes

	of their action. 3. Recognize the significance of cellular redox homeostasis. 4. Analyse the effects of redox-sensitive transcription factors on cell's capacity to cope with oxidative burst. 5. Select appropriate methods for oxidative stress detection in both intracellular and extracellular environment. 6. Recognize interconnection between oxidative stress and carcinogenesis. 7. Understand the role of nutrition and personal lifestyle on antioxidative status. 8. Recognize the importance of antioxidants and oxidatively modified molecules in diagnostics and therapeutics approaches.
.2. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES AND SEMINARS: • Free radicals and antioxidants – overview: free radicals effects, role and function of various antioxidants, oxidative stress. • Chemistry of free radicals: nomenclature of free radicals, endogenous and exogenous sources of free radicals, mechanisms of free radicals reactions. • Electron spin resonance: EPR spectroscopy, method of spin entrapments, method of spin marks. • Nitric oxide – function and effects: biosynthesis of nitric oxide (NO), NO signalling and its effects on cells, isoforms of NO synthase (NOS). • Polyphenols – antioxidants: classification of polyphenols, flavonoids, catechins, resveratrol, methods for determination of flavonoids' antioxidative activities. • Effects of nutrition on human antioxidative status: antioxidants in the food, food components with pro-oxidative effects, bioactivation of food antioxidants, mechanisms of action of nutritional antioxidants, carotenoids, vitamin E, vitamin C. • Oxidative stress and carcinogenesis: mechanisms of metal action (iron, copper, chromium, cadmium), oxidative modifications of DNA, oxidative modifications of proteins, role and function of glutathione, activation of redox-sensitive transcription factors. LABORATORY PRACTICE: • Electron spin resonance spectroscopy technique.
.1. Type of instruction	**lectures** **seminars** workshops **exercises** online in entirety mixed *e*-learning mixed *m*-learning field work independent study multimedia and the internet work with the mentor (other)
2.7. Student responsibilities	Regular attendance of the classes, individual presentation of the topic selected after searching for adequate literature data, active retrospection on other students'

	presented topics, active participation in laboratory presentation of electron spin resonance spectroscopy technique.			
2.8. 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	0.2	Seminar essay	0.8
	Experimental work	0.5	Oral exam	
	Essay		Project	
	Tests		Practical training	
	Written exam	1	(Other--describe)	
	Research		(Other--describe)	
	Report		(Other--describe)	
2.9. Grading and evaluation of student work over the course of instruction and at a final exam	Written exam, active participation in laboratory practice, individual presentation of the topic selected after searching for adequate literature data.			

2.10. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	Lushchak V.I., Semchyshyn H.M. (editors): Oxidative Stress - Molecular Mechanisms and Biological Effects. InTech, 2012.		
	Andreescu S., Maria Hepel M. (editors): Oxidative Stress: Diagnostics, Prevention, and Therapy. American Chemical Society, 2011.		
	Čvorišćec D., Čepelak I. (editors): Štrausova medicinska biokemija. Medicinska naklada, 2009.		

2.11. Optional literature	Up-to-date review papers regarding the course topics.
2.12. Methods of monitoring quality that ensure acquisition of exit competences	All learning outcomes are checked during course's seminars and by written exam.
2.13. Comments	

HEALTH ECOLOGY

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Associate Professor Dubravka Vitali Čepo, PhD
1.2. Associate teachers	Assistant Professor Lovorka Vujić, PhD
1.3. Graduate programme	Integrated study of medicinal biochemistry
1.4. Status of the course	Elective
1.5. Year of study, Semester	3rd year, 5th semester
1.6. Credit value (ECTS)	1.5
1.7. Type of instruction (number of hours L+E+S+e-learning)	15+0+0+0
1.8. Expected enrolment in the course	10-15
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2
2. COURSE DESCRIPTION	
2.1. Course objectives	Students will learn to list and to explain basic terms and relationships within ecology, toxicology and epidemiology. This will enable their understanding of mechanism of action of the most important physical, chemical and biological factors of the environment on human health. Students will be able to explain consequences of such effects and to describe responsibilities and obligations of health care professionals in their prevention. Students will be able to use the acquired knowledge in further studies of toxicology and epidemiology; will gain insight into the important role of pharmacists/medical biochemists in the implementation of public health measures and to develop awareness of the importance of environmental protection.
2.2. Enrolment requirements and required entry competences for the course	Enrolment requirements: students have to enroll 5th semester Entry competences: basics of physiology, organic chemistry, analytic chemistry and physics
2.3. Learning outcomes at the level of the study programme to which the course contributes	• Active participation in the prevention of diseases caused by environmental factors, the preservation of health, and public health initiatives. • The use of information technology and databases in order to improve professional knowledge and skills, and for self-education. • Critical evaluation and application of scientific knowledge and available data for the purpose of improving the profession. • In general, the subject contributes to the acquisition of technical knowledge that students will use in the pharmaceutical care. By encouraging students to seek, critically assess and apply scientific knowledge and other available information related to issues of the case, subject contributes to the development of their research capabilities.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	1. Explain basic terms related to ecology, epidemiology, and toxicology (ecosystem, biosphere, biome, biocenosis, biotope, acute and chronic toxicity, exposure pathways, dose-response relationship, epidemiological studies, etc.). 2. Define the basic concepts of environmental protection (sustainable development) and global environmental problems (waste, global warming), and explain their impact on human health. 3. Explain the importance of drinking water, list the categories of water, recognize the health risks associated with poor quality/insufficient water supply, and describe the importance of monitoring residues of drugs/metabolites of drugs in water. 4. Explain the concept of air quality, describe the most important concepts related to air quality (smog, photo-smog), list the categories of air quality, and recognize the health risks associated with poor air quality. 5. List, describe and explain the mechanisms of action of potentially harmful chemical environmental factors (heavy metals, mycotoxins, pesticides, dioxins, products formed by thermal treatment of food, food additives), explain the

	possible health effects and propose measures for prevention of exposure. 6. Describe types of radiation, and enumerate and explain the health risks of exposure to different types of radiation (UV radiation, radioactive radiation, ELF radiation), suggest methods of protection against radiation and methods of prevention of possible consequences on health. 7. Describe the possibilities and obligations of healthcare professionals (pharmacists) to participate actively in the promotion of a healthy lifestyle (nutrition, movement), patient education (vaccinations, smoking cessation, prevention of sexually transmitted diseases, prevention of diabetes and cardiovascular disease), and support for diseases caused by exposure to various environmental factors (adherence).
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES: • **Basic concepts**, classical partition and new fields of ecology. Environment, biocenosis, biotope. Ecological factors of the environment, ecosystem and ecological valence. Deterioration of the environmental quality. Health ecology - definitions and tasks. Ecological concept of health and practical ecological assessment. The main factors affecting the health - important factors of maintaining life, human activities, residues and waste. Factors endangering the environment and combating health risks. Basic concepts of epidemiology. Basic concepts of toxicology. • **Global environmental problems** - pollution of the atmosphere, hydrosphere, and soil - factors and effects. Sustainable development. Micro- and macroclimatic factors. • **Chemical environmental factors:** the reasons of increase in their concentration in the environment. Toxic risks in food; priorities. Nitrates, nitrites, secondary amines, N-nitroso compounds; absorption, metabolism, exposure, tolerance. Hormones and compounds with hormonal effects in food; mechanisms of toxicity and legislation. Pesticides - definition, classification, mechanisms of toxicity, the presence in food, risks; estimation of daily intake, the FAO / WHO recommendations for pesticide residues in food. Toxic metals and non-metals - sources, exposure, metabolism, the most common contaminants. • **Physical environmental factors**: radiation. Electromagnetic Spectrum, types of radiation, possible health effects. Non-ionizing radiation - basic terms. Radio waves - radio frequency range (RF) and microwave (MW): Infrared and UV - exposure, biological effects, prevention. Ionizing radiation - basic terms, units in dosimetry of radiation, effects of ionizing radiation, genetic effects. Sources of contamination of the environment (natural and artificial). The intensity of natural radiation. Technological sources. Doses and risks of radiation from different sources. • **Improving public health through pharmacy**: the role of pharmacists in health education and health promotion (promoting the importance of physical activity, healthy eating and weight control). Routine monitoring, and support for diseases of public health significance (type 2 diabetes, cardiovascular disease, asthma, allergies). Smoking; chemical composition of tobacco smoke, toxicity mechanism, public health importance of smoking; support patients to stop smoking) • **Improving public health through pharmacy**: vaccination: public health importance, compulsory vaccination of children (in Croatia and the EU): the importance, risks, side effects; vaccination of adults. Respiratory allergies: incidence, prevention, treatment - the role of pharmacists. Prevention and treatment of sexually transmitted diseases - role of pharmacists.
2.6. Type of instruction	**lectures** seminars workshops exercises online in entirety field work **independent study** multimedia and the internet work with the mentor (other)

	mixed *e*-learning mixed *m*-learning			
2.7. Student responsibilities				
2.8. 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	0.3	Seminar essay	
	Experimental work		Oral exam	
	Essay		Project	
	Tests		Practical training	
	Written exam	1.2	(Other--describe)	
	Research		(Other--describe)	
	Report		(Other--describe)	
2.9. Grading and evaluation of student work over the course of instruction and at a final exam				

2.10. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	Lectures synopsis		Merlin

2.11. Optional literature	1. Public health and human ecology, McGraw-Hill Professional, 2nd edition 1998. 2. Health ecology: Health, culture and human-environment interaction. Thomas Boleyn, Morteza Honari, Routledge, 1999. 3. Environmental health/from global to local. Howard Frumkin (Ed), 2nd edition 2010.
2.12. Methods of monitoring quality that ensure acquisition of exit competences	Learning outcomes are tested with written exam.
2.13. Comments	

HEALTH ECOLOGY

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Associate Professor Dubravka Vitali Čepo, PhD
1.2. Associate teachers	Assistant Professor Lovorka Vujić, PhD
1.3. Graduate programme	Integrated study of pharmacy
1.4. Status of the course	Elective
1.5. Year of study, Semester	3rd year, 5th semester
1.6. Credit value (ECTS)	1.5
1.7. Type of instruction (number of hours L+E+S+e-learning)	15+0+0+0
1.8. Expected enrolment in the course	30-40
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2
2. COURSE DESCRIPTION	
2.1. Course objectives	Students will learn to list and to explain basic terms and relationships within ecology, toxicology and epidemiology. This will enable their understanding of mechanism of action of the most important physical, chemical and biological factors of the environment on human health. Students will be able to explain consequences of such effects and to describe responsibilities and obligations of health care professionals in their prevention. Students will be able to use the acquired knowledge in further studies of toxicology and epidemiology; will gain insight into the important role of pharmacists/medical biochemists in the implementation of public health measures and to develop awareness of the importance of environmental protection.
2.2. Enrolment requirements and required entry competences for the course	Enrolment requirements: students have to enroll 5th semester Entry competences: basics of physiology, organic chemistry, analytic chemistry and physics
2.3. Learning outcomes at the level of the study programme to which the course contributes	• Active participation in the prevention of diseases caused by environmental factors, the preservation of health, and public health initiatives. • The use of information technology and databases in order to improve professional knowledge and skills, and for self-education. • Critical evaluation and application of scientific knowledge and available data for the purpose of improving the profession. • In general, the subject contributes to the acquisition of technical knowledge that students will use in the pharmaceutical care. By encouraging students to seek, critically assess and apply scientific knowledge and other available information related to issues of the case, subject contributes to the development of their research capabilities.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	1. Explain basic terms related to ecology, epidemiology, and toxicology (ecosystem, biosphere, biome, biocenosis, biotope, acute and chronic toxicity, exposure pathways, dose-response relationship, epidemiological studies, etc.). 2. Define the basic concepts of environmental protection (sustainable development) and global environmental problems (waste, global warming), and explain their impact on human health. 3. Explain the importance of drinking water, list the categories of water, recognize the health risks associated with poor quality/insufficient water supply, and describe the importance of monitoring residues of drugs/metabolites of drugs in water. 4. Explain the concept of air quality, describe the most important concepts related to air quality (smog, photo-smog), list the categories of air quality, and recognize the health risks associated with poor air quality. 5. List, describe and explain the mechanisms of action of potentially harmful chemical environmental factors (heavy metals, mycotoxins, pesticides, dioxins, products formed by thermal treatment of food, food additives), explain the

	possible health effects and propose measures for prevention of exposure. 6. Describe types of radiation, and enumerate and explain the health risks of exposure to different types of radiation (UV radiation, radioactive radiation, ELF radiation), suggest methods of protection against radiation and methods of prevention of possible consequences on health. 7. Describe the possibilities and obligations of healthcare professionals (pharmacists) to participate actively in the promotion of a healthy lifestyle (nutrition, movement), patient education (vaccinations, smoking cessation, prevention of sexually transmitted diseases, prevention of diabetes and cardiovascular disease), and support for diseases caused by exposure to various environmental factors (adherence).
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES: • **Basic concepts**, classical partition and new fields of ecology. Environment, biocenosis, biotope. Ecological factors of the environment, ecosystem and ecological valence. Deterioration of the environmental quality. Health ecology - definitions and tasks. Ecological concept of health and practical ecological assessment. The main factors affecting the health - important factors of maintaining life, human activities, residues and waste. Factors endangering the environment and combating health risks. Basic concepts of epidemiology. Basic concepts of toxicology. • **Global environmental problems** - pollution of the atmosphere, hydrosphere, and soil - factors and effects. Sustainable development. Micro- and macroclimatic factors. • **Chemical environmental factors:** the reasons of increase in their concentration in the environment. Toxic risks in food; priorities. Nitrates, nitrites, secondary amines, N-nitroso compounds; absorption, metabolism, exposure, tolerance. Hormones and compounds with hormonal effects in food; mechanisms of toxicity and legislation. Pesticides - definition, classification, mechanisms of toxicity, the presence in food, risks; estimation of daily intake, the FAO / WHO recommendations for pesticide residues in food. Toxic metals and non-metals - sources, exposure, metabolism, the most common contaminants. • **Physical environmental factors**: radiation. Electromagnetic Spectrum, types of radiation, possible health effects. Non-ionizing radiation - basic terms. Radio waves - radio frequency range (RF) and microwave (MW): Infrared and UV - exposure, biological effects, prevention. Ionizing radiation - basic terms, units in dosimetry of radiation, effects of ionizing radiation, genetic effects. Sources of contamination of the environment (natural and artificial). The intensity of natural radiation. Technological sources. Doses and risks of radiation from different sources. • **Improving public health through pharmacy**: the role of pharmacists in health education and health promotion (promoting the importance of physical activity, healthy eating and weight control). Routine monitoring, and support for diseases of public health significance (type 2 diabetes, cardiovascular disease, asthma, allergies). Smoking; chemical composition of tobacco smoke, toxicity mechanism, public health importance of smoking; support patients to stop smoking) • **Improving public health through pharmacy**: vaccination: public health importance, compulsory vaccination of children (in Croatia and the EU): the importance, risks, side effects; vaccination of adults. Respiratory allergies: incidence, prevention, treatment - the role of pharmacists. Prevention and treatment of sexually transmitted diseases - role of pharmacists.
2.6. Type of instruction	**lectures** seminars workshops exercises online in entirety field work **independent study** multimedia and the internet work with the mentor (other)

	mixed *e*-learning mixed *m*-learning			
2.7. Student responsibilities				
2.8. 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	0.3	Seminar essay	
	Experimental work		Oral exam	
	Essay		Project	
	Tests		Practical training	
	Written exam	1.2	(Other--describe)	
	Research		(Other--describe)	
	Report		(Other--describe)	
2.9. Grading and evaluation of student work over the course of instruction and at a final exam				

2.10. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	Lectures synopsis		Merlin

2.11. Optional literature	1. Public health and human ecology, McGraw-Hill Professional, 2nd edition 1998. 2. Health ecology: Health, culture and human-environment interaction. Thomas Boleyn, Morteza Honari, Routledge, 1999. 3. Environmental health/from global to local. Howard Frumkin (Ed), 2nd edition 2010.
2.12. Methods of monitoring quality that ensure acquisition of exit competences	Learning outcomes are tested with written exam.
2.13. Comments	

HEALTHCARE LEGISLATION IN LABORATORY MEDICINE

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Assistant Professor Ivan Pepić, PhD
1.2. Associate teachers	
1.3. Graduate programme	Medical Biochemistry
1.4. Status of the course	Obligatory course
1.5. Year of study, Semester	5th year, 9th semester
1.6. Credit value (ECTS)	1.5
1.7. Type of instruction (number of hours L+E+S+e-learning)	15+0+0+0
1.8. Expected enrolment in the course	25
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2nd level
2. COURSE DESCRIPTION	
2.1. Course objectives	Students will be able to define and explain the basic regulations in the Republic of Croatia that regulate: (i) the medical biochemical activity; (ii) testing, production, trade, vigilance, quality control and supervision of medical devices; (iii) the rights, duties, tasks and objectives in the field of health care; (iv) the rights and obligations of the compulsory health insurance; (v) the rights and obligations of voluntary (additional, supplementary and private) health insurance. The student will be abl eto explain the legal framework of the health care system in the Republic of Croatia.
2.2. Enrolment requirements and required entry competences for the course	Enrolled 9th semester.
2.3. Learning outcomes at the level of the study programme to which the course contributes	• Use of information technology and databases in order to improve professional knowledge, skills and self-education. • Application of the legal and ethical principles of the profession in independent and team work. • Application of the professional knowledge inprocedures of laboratory diagnostics, evaluation of the clinical significance of the biochemical and molecular markers, detection of sources of error and variability of laboratory analysis, interpretation of the laboratory analysis results consideringtheir analytical and clinical aspects while respecting the current legislation, health policy and guidelines/principles of medical biochemistry profession.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After completing the course students will be able to: 1. Explain the basic characteristics of the entire health care system of the Republic of Croatia. 2. Name and explain the regulations governing the medical biochemistry profession of the Republic of Croatia. 3. Name and explain the health services and health institutions at the primary,

	secondary and tertiary level of health protection and health activities at the (Croatian) health institutes, as well as the structure, basic tasks and authorities of the Croatian Chamber of Medical Biochemists. 4. Analyze the public health service network. 5. Explain the principles and measures in order to ensure and reduce the risk to health and life of patients. 6. Name basic testing procedures, authority approval, production, labelling, classification, transport, vigilance, advertising, quality control and supervision of medical devices. 7. List the types of diagnostic tests carried out in general, specialist, subspecialist and clinical medical-biochemical laboratories.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES: • Health care • Health insurance: compulsory, supplementary, additional and private • Regulations concerning medical devices • Regulations concerning medical biochemists activities • Patients' Rights Protection; Accreditation in Healthcare

2.6. Type of instruction			
	lectures	field work	
	seminars	independent study	
	workshops	multimedia and the internet	
	exercises	work with the mentor	
	online in entirety	(other)	
	mixed *e*-learning		
	mixed *m*-learning		

2.7. Student responsibilities	
	Regular attendance of lectures.

2.8. 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	0.5	Seminar essay	
	Experimental work		Oral exam	
	Essay		Project	
	Tests		Practical training	
	Written exam	1.0	(Other--describe)	
	Research		(Other--describe)	
	Report		(Other--describe)	

2.9. Grading and evaluation of student work over the course of instruction and at a final exam	
	The course is the theoretical part of the professional training.

2.10. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	Health Care Act ("Official Gazette" No 150/08, 71/10, 139/10, 22/11, 84/11, 154/11, 12/12, 35/12, 70/12, 144/12, 82/13, 159/13, 22/14, 154/14, 70/16)		The document is available on the website of Official Gazette of the Republic of Croatia
	Health Care Quality and Social Welfare Act ("Official Gazette" No 124/11)		
	Patients' Rights Protection Act ("Official Gazette" No 169/04, 37/08)		
	Compulsory Health Insurance Act ("Official Gazette" No 80/13, 137/13)		

	Voluntary Health Insurance Act ("Official Gazette" No 85/06, 150/08, 71/10)		
	Medical Devices Act ("Official Gazette" No 76/13)		
	Act on Medical Biochemisty Activities ("Official Gazette" No 121/03, 117/08)		
	Ordinance on categorisation of medical-biochemical tests performed by medical biochemistry laboratories ("Official Gazette" No 197/03)		
2.11. Optional literature	Ordinance on performing point-of-care testing ("Official Gazette" No 34/05) Ordinance on performing medical biochemical activities in medical office practice ("Official Gazette" No 34/05)		
2.12. Methods of monitoring quality that ensure acquisition of exit competences	Evaluation of learning outcomes is an integral part of the final professional exam.		
2.13. Comments			

HEALTHCARE LEGISLATION

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Assistant Professor Ivan Pepić, PhD
1.2. Associate teachers	
1.3. Graduate programme	Pharmacy
1.4. Status of the course	Obligatory course
1.5. Year of study, Semester	5th year, 9th semester
1.6. Credit value (ECTS)	1.5
1.7. Type of instruction (number of hours L+E+S+e-learning)	15+0+0+0
1.8. Expected enrolment in the course	130
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2nd level
2. COURSE DESCRIPTION	
2.1. Course objectives	Students will be able to define and explain the basic regulations in the Republic of Croatia that regulate: (i) the pharmacists activities; (ii) testing, production, trade, pharmacovigilance, quality control and supervision of medicinal products and medical devices; (iii) the rights, duties, tasks and objectives in the field of health care; (iv) the rights and obligations of the compulsory health insurance; (v) the rights and obligations of voluntary (additional, supplementary and private) health insurance. The student will be able to explain the legal framework of the health care system of the Republic of Croatia.
2.2. Enrolment requirements and required entry competences for the course	Enrolled 9th semester.
2.3. Learning outcomes at the level of the study programme to which the course contributes	• Application of professional knowledge and skills in pharmacotherapy interventions and implementation of pharmaceutical patient care while respecting the legislation of the current health policy and guidelines/principles of pharmaceutical ethics and deontology. • Monitoring and participation in drug distribution. • Use of information technology and databases in order to improve professional knowledge, skills and self-education. • Application of the legal and ethical principles of the profession in independent and team work.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After completing the course students will be able to: 1. Explain the basic characteristics of the entire health care system of the Republic of Croatia. 2. Name and explain the regulations governing the pharmacy profession of the Republic of Croatia. 3. Name and explain the rules of medicinal product prescribing that can be used

	in the therapy within the health care system through the compulsory or supplementary health insurance. 4. Name and explain the health services and health institutions at the primary, secondary and tertiary level of health protection and health activities at the (Croatian) health institutes, as well as the structure, basic tasks and authorities of the Croatian Chamber of Pharmacists. 5. Analyze the public health service network. 6. Explain the principles and measures in order to ensure and reduce the risk to health and life of patients. 7. Name basic testing procedures, authority approval, production, labelling, classification, transport, pharmacovigilance, advertising, quality control and supervision of medicinal products and medical devices.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES: • Health care • Health insurance: compulsory, supplementary, additional and private • Regulations concerning medicinal products • Regulations concerning medical devices • Regulations concerning pharmacists activities • Patients' Rights Protection; Accreditation in Healthcare

2.6. Type of instruction		
	lectures seminars workshops exercises online in entirety mixed *e*-learning mixed *m*-learning	field work independent study multimedia and the internet work with the mentor (other)

2.7. Student responsibilities	
	Regular attendance of lectures.

2.8. 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	0.5	Seminar essay	
	Experimental work		Oral exam	
	Essay		Project	
	Tests		Practical training	
	Written exam	1.0	(Other--describe)	
	Research		(Other--describe)	
	Report		(Other--describe)	

2.9. Grading and evaluation of student work over the course of instruction and at a final exam	
	The course is the theoretical part of the professional training.

2.10. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	Health Care Act ("Official Gazette" No. 150/08, 71/10, 139/10, 22/11, 84/11, 154/11, 12/12, 35/12, 70/12, 144/12, 82/13, 159/13, 22/14, 154/14, 70/16)		The document is available on the website of Official Gazette of the Republic of Croatia
	Health Care Quality and Social Welfare Act ("Official Gazette" No 124/11)		
	Patients' Rights Protection Act ("Official Gazette"		

	No. 169/04, 37/08)		
	Compulsory Health Insurance Act ("Official Gazette" No 80/13, 137/13)		
	Voluntary Health Insurance Act ("Official Gazette" No 85/06, 150/08, 71/10)		
	Medicinal Products Act ("Official Gazette" No 76/13, 90/14)		
	Medical Devices Act ("Official Gazette" No 76/13)		
	Law on Pharmacy ("Official Gazette" No 121/03, 35/08, 117/08)		
	Ordinance on prescribing and dispensing of prescription medicinal products ("Official Gazette" No 17/09, 46/09, 4/10, 110/10, 131/10, 1/11, 16/11, 52/11, 129/13, 146/13, 45/14, 81/14, 17/15)		
	Ordinance on the criteria for the classification of medicinal products and prescribing and dispensing of prescription medicinal products ("Official Gazette" No NN 86/13, 90/13, 102/14, 107/15, 72/16)		
2.11. Optional literature	Drug Abuse Prevention Act ("Official Gazette" No 7/01, 87/02, 163/03, 141/04, 40/07, 149/09, 84/11, 80/13) Ordinance on Food Supplements ("Official Gazette" No 46/11 i 41/13) Ordinance on nutrition and health claims ("Official Gazette" No 84/10, 113/11, 42/13) Law on nutrition and health claims, and foods enriched with nutrients ("Official Gazette" No 39/13) Regulation on cosmetic products (Official Journal of the European Union No 1223/2009, 344/2013, 483/2013, 655/2013, 658/2013, 358/2014)		
2.12. Methods of monitoring quality that ensure acquisition of exit competences	Evaluation of learning outcomes is an integral part of the final professional exam.		
2.13. Comments			

HEMATOLOGY I

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Professor Mirna Sučić, PhD Professor Renata Zadro, PhD
1.2. Associate teachers	Ivana Horvat, mag. med. biochem.
1.3. Graduate programme	Integrated Medical Biochemistry Study Programme
1.4. Status of the course	Obligatory
1.5. Year of study, Semester	3.
1.6. Credit value (ECTS)	5
1.7. Type of instruction (number of hours L+E+S+e-learning)	30+25+5
1.8. Expected enrolment in the course	15-25
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2,
2. COURSE DESCRIPTION	
2.1. Course objectives	The aim of the course is to learn structure and function of hemopoietic and lymphatic system, development of blood cells, to learn about function of leukocytes, erythrocytes and thrombocytes, to learn and perform routine haematology tests of whole blood and sedimentation, to learn and interpretate normal parameters of whole blood tests.
2.2. Enrolment requirements and required entry competences for the course	Physiology with anatomy
2.3. Learning outcomes at the level of the study programme to which the course contributes	• To apply basic knowledge of biology, biochemistry and physiology (knowledge about development hematopoietic cells and their cytomorphology and physiology) for defining, analysing and propsing procedures related for detecting and follow-up of diseases and for treatment monitoring. • Evaluating the clinical relevance of biochemical and molecular biology indicators (apply knowledge of differentiation of leukocytes, erythrocytes and thromobcytes and their function in immunodefense, oxygen transport, hemoglobin synthesis and hemostasis) and interpreting laboratory hematological analysis results from an analytical and clinical point of view.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	At the end of the course the trainee will be able to: • Describe and define development of hemopoietic cells and function of cytokines. • Define connection of hemopoietic cells with their action in physiology of hemopoietic system. • Describe molecular structure of hemoglobin, metabolism of iron, metabolism of hemoglobin and metabolism of B12 and folate acid. • Describe and explain metabolism of granulocytes linked to the innate immune system comprises and mechanisms that defend the host from infection by other organisms in a non-specific manner. • Describe and explain differentiation of thrombocytes and their key molecules in regulation of hemostasis. • Describe and explain lymphopoiesis , cytomorphology of lymphopoiesis and role of lymphatic cells in processes of specific or the adaptive immune system in elimination or prevention infections. • Identify hemopoetic bone marrow cells and peripheral blood cells. • To perform parameters of whole blood count and to demonstrate analytical and critical skills in routine hematologjcal laboratory diagnostics.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES: • Function and regulation of hemopoiesis. Stem cells. Development and differentiation of hemopoietic cells. • Organization of hemopoietic system. Hematology – multidisciplinary profession.

	• Cytokines and chemokynes. Erythropoiesis. Cytomorphology of erythropoeisis. • Subcellular structure and metabolism of erythrocyte. Function of B12 and folate acid. • Function of erythrocyte, iron metabolism, haemoglobin structure and metabolism. • Granulopoiesis and neutrophils – differentiation and functions of cells. • Adhesion molecules in cell interactions and chemoattractation processes. • Megakaryocyte and thrombocyte development, functions of thrombocytes. • Monopoiesis- differentiation and functions of cells. • Eosinophils and basophils- differentiation and function of cells. • Lymphopoiesis and differentiation of lymphatic cells. Immunological characteristics of B, T and NK lymphoid cells. • Cellular and humoral immunological immunity. Complement system. System of the histocompatibility complex (MHC) and functions. SEMINARS: • Automated blood cell counting instruments. • Cytomorphology of erythropoiesis. *Immunological antigens of myelopoiesis.* • Cytomorphology of granulopoiesis and monopoiesis. *Immunological antigens of monocytic cells.* • Cytomorphology of thrombopoiesis. *Immunological antigens of thrombopoiesis erythropoiesis.* • Cytomorphology of lymohopoiesis. *Immunological antigens of lymohopoiesis* • Bone marrow examination. *Substance P. Defensins.* • Cytomorphology of lymph nodule. *MHC I and MHC II class molecule and exogenous and endogenous antigens.* EXERCISES: • Erytrocytes, leukocytes, haemoglobin, hematocrit, erythrocyte indices. • Erytrocytes, leukocytes, haemoglobin, hematocrit, erythrocyte indices. Thrombocytes. Automated instrumente leukocyte differential count. Staining of peripheral blood smears. • Automated instrumente leukocyte differential count. Peripheral blood smear cell examination on microscope. Enumeration of thrombocytes (Fonio). • Automated instrumente leukocyte differential count. Peripheral blood smear cell examination and total leukocyte count on microscope. • Reticulocyte - supravital staining and flow cytometry count. • Peripheral blood smear cell examination on microscope. • Prussian blue iron stain- siderocytes, sideroblasts, Basophilic stippling in erythrocytes. Total leukocyte count on microscope. • Sedimentation erythrocyte rate. Osmotic fragility test. Total leukocyte count on microscope. • Cytomorphology of hemopoiesis- cytomorphology of bone marrow and lymph node.
2.6. Type of instruction	**lectures** **seminars** **workshops** **exercises** online in entirety mixed *e*-learning mixed *m*-learning field work independent study multimedia and the internet work with the mentor (other): **Fonts in italic indicate students seminars**
2.7. Student responsibilities	Regular attendance of classes; active participation in seminares, practical test of excercises classes, final exam.

2.8. 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	1,5	Seminar essay	1
	Experimental work		Oral exam	
	Essay		Project	
	Tests	1	Practical training	
	Written exam	1,5	(Other--describe)	

	Research		(Other--describe)	
	Report		(Other--describe)	
2.9. Grading and evaluation of student work over the course of instruction and at a final exam	Final exam;(wriiten test), practical test of excercises classes, credits for regulary attendance of classes, credits for active participation in seminars.			
2.10. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**	
	1. Labar B, Hauptmann E and coworkers. Hematology. Zagreb: Školska knjiga, 2007.	8		
	2. Labar B, Hauptmann E and coworkers. Hematology. Zagreb: Školska knjiga, 1998.	5		
2.11. Optional literature	1. Radić Antolic M, Sučić M; Zadro R. Skripta- Clinical biochemistry with hematology (Hematology), University of Zagreb Faculty of Pharmacy and Biochemistry, 2005. (1 copy at the library) 2. McKenzie SB. Clinical Laboratory Hematology (2nd edition). Prentice Hall 2010.			
2.12. Methods of monitoring quality that ensure acquisition of exit competences	Final exam (wriiten test).			
2.13. Comments				

Course teacher:

Professor Mirna Sučić, PhD

Professor Reanata Zadro, PhD

Head of Deperatment of Medical Biochemistry and Hematology:

Professor Karmela Barišić, PhD

HEMATOLOGY II

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Professor Mirna Sučić, PhD
1.2. Associate teachers	Professor Renata Zadro, PhD
1.3. Graduate programme	Integrated Medical Biochemistry Study Programme
1.4. Status of the course	Obligatory
1.5. Year of study, Semester	3
1.6. Credit value (ECTS)	5
1.7. Type of instruction (number of hours L+E+S+e-learning)	25+20+15
1.8. Expected enrolment in the course	15-25
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2
2. COURSE DESCRIPTION	
2.1. Course objectives	The aim of the course is to learn pathophysiology and classifications of benign and malignant disorders of leukocytes, erythrocytes and thrombocytes, to describe diagnostic indicators of these disorders and to learn about connection of laboratory indicators with pathophisiology and clinics of benign and malignant disorders of leukocytes, erythrocytes and thromocytes.
2.2. Enrolment requirements and required entry competences for the course	Hematology I and Pathophysiology with pathology courses
2.3. Learning outcomes at the level of the study programme to which the course contributes	• Applying fundamental knowledge about hematopoiesis, hematopoietic cytomorphology and their role in physiology and pathophysiology of hematopoetic system in defining, analyzing and proposal of laboratory tests for detecting and follow-up of diseses and treatment monitoring. • Evaluating the clinical relevance of biochemical and molecular biology indicators (detecting ceratin indicators of whole blood count and other haematological laboratory indicators specific for ceratin benign and malignant disorders of leukocytes, erythrocytes and thrombocytes) in interpreting laboratory analysis results from an analytical and clinical point of view.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	At the end of the course the trainee will be able to: • Define basic pathophysiological causes of disorders of leukocytes, erythrocytes and thrombocytes. • Define classifications of disorders of leukocytes, erythrocytes and thrombocytes. • Apply expert knowledge of connection of pathophysiology with clinical and laboratory indicators of disorders of leukocytes, erythrocytes and thrombocytes. • Define and interprete specific hematological and other laboratory results of certain leukocyte, erythrocyte and thrombocyte disorders from an analytical and clinical point of view,
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES: • Pathophysiological classification of anemias. Hemolytic anemias. • Pathophysiological and erythrpcyte indices classifications of anemias. Megaloblastic and iron deficiency anemia. • Disorders of hematopietic stem cell. Hypoproliferative anemia. Aplastic anemia. PNH. • Disorders of granulocytes. • Disorders of monocytes. • Thrombocytopenias. Thromobocytosis. Thrombopathias. • Immunodeficiency. AIDS. • Classification of malignant lymphoproliferative disorders. Malignant lymphomas. • Chronic lymphocytic leukaemia. Amyloidosis. Multipole myeloma.

	• Classification of tumors of myeloid cells. Chronic myeloproliferative disorders. • Classification of tumors of myeloid cells. Myelodysplasia (MDS). • Acute leukaemia. Bone marrow transplantation. SEMINARS: • Anemias I- cytomorphology and laboratory indicators. *Diagnostic approach to patient with anemia.* • Anemias II- cytomorphology and laboratory indicators. *Diagnostics of hemolytic anemias.* • Cytomorphology of leukocytosis. *Guidelines for haematological diagnostics of leukocytosis.* • Disorders of lymphocytes. *HIV.* • Cytomorphology and immunology of lymphoid cell tumors. *Flow cytometry.* • Cytomorphology of malignant lymphoproliferative disorders. *Cytogentics and molecular biology of malignant lymphoproliferative disorders*. • Cytomorphology and laboratory indicators of chronic myeloproliferative disorders. *Philadelphia chromosome. Jak2 mutation.* • Cytomorphology and laboratory indicators of myelodisplasia. 5q deletion. Cytogenetics of MDS. • Cytochemistry and immunodiagnostics of acute leukemias. *Cytogentics and molecular biology of acute leukemias.* EXERCISES: • Megaloblastic anemia in bone marrow. Cytomorphology of megaloblastic and normal bone marrow. • Cytomorphology and erythrocyte indices of iron deficiency anemia and megaloblastic anemia. • Hemolytic anemias: cytomorphology and erythrocyte indices. • Cytomorphology of granulocyte disorders. • Cytomorphology of infective mononucleosis and multiple myeloma. • Cytomorphology of chronic lymphocytic leukaemia and chronic myeloid leukaemia. • Cytomorphology of acute myeloid leukaemia and acute lymphoid leukaemia. Myelodisplasia. • Cytochemistry- technique and analysis of acid and alkaline phosphatase. Score of granulocyte alkaline phosphatase. • Cytochemistry- technique and analysis of myeloperoxidase. Immunocytochemistry. • Repetition of all exercises and preparation for practical exam.
2.6. Type of instruction	**lectures** **seminars** **workshops** **exercises** online in entirety mixed *e*-learning mixed *m*-learning field work independent study multimedia and the internet work with the mentor (other): **Fonts in italic indicate students seminars.**
2.7. Student responsibilities	Regular attendance of classes; active participation in seminares, practical test of excercises classes, final exam (written test)
2.8. 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: 1,5 — Seminar essay: 1 Experimental work — Oral exam Essay — Project Tests: 1 — Practical training Written exam: 1,5 — (Other--describe) Research — (Other--describe) Report — (Other--describe)
2.9. Grading and evaluation of student work over the course of instruction and at a final exam	Final exam;(wriiten test), practical test of excercises classes, credits for regulary attendance of classes, credits for active participation in seminars.

2.10. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	1. Labar B, Hauptmann E and coworkers. Hematology. Zagreb: Školska knjiga, 2007.	8	
	2. Labar B, Hauptmann E. And coworkers. Hematology. Zagreb: Školska knjiga, 1998.	5	
2.11. Optional literature	1. Radić Antolic M, Sučić M; Zadro R. Skripta- Clinical biochemistry with hematology (Hematology), University of Zagreb Faculty of Pharmacy and Biochemistry, 2005. (1 copy at the library) 2. McKenzie SB. Clinical Laboratory Hematology (2nd edition). Prentice Hall 2010.		
2.12. Methods of monitoring quality that ensure acquisition of exit competences	Final exam;(wriiten test).		
2.13. Comments			

Course teacher: Professor Mirna Sučić, PhD

Head of Deperatment of Medical Biochemistry and Hematology: Professor Karmela Barišić, PhD

HUMAN PHYSIOLOGY AND ANATOMY

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Professor Danica Galešić Ljubanović, MD PhD
1.2. Associate teachers	Ivica Horvatić, MD PhD Miroslav Tišljar, MD PhD Matija Crnogorac, MD Petar Šenjug, MD
1.3. Graduate programme	Pharmacy integrated study programme
1.4. Status of the course	Obligatory
1.5. Year of study, Semester	2nd Year, 4th Semester
1.6. Credit value (ECTS)	9
1.7. Type of instruction (number of hours L+E+S+e-learning)	60+0+45
1.8. Expected enrolment in the course	130
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2.
2. COURSE DESCRIPTION	
2.1. Course objectives	Course will provide students with basic knowledge regarding anatomical and physiological organization of human tissues, organs and organism as a whole. Providing this knowledge, students will be able to understand interrelation of anatomical structure, function and regulatory mechanisms necessary for the normal function of human organism.
2.2. Enrolment requirements and required entry competences for the course	Passed course Cellular biology and genetics is required.
2.3. Learning outcomes at the level of the study programme to which the course contributes	Apply expert knowledge and skills to provide advice on pharmacotherapy and medical care to patients.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	At the end of the course the student will be able to: 1. Describe anatomy of human organs and organ systems; 2. Define functions and describe physiology of human organs and organ systems; 3. Explain basic homeostasis mechanisms necessary for the normal function of human organism; 4. Establish association of physiological changes to the patophysiological basis of diseases.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	**LECTURES:** • Introduction to the Physiology; Basics of Histology. • Physiology of cell membranes, nerves and muscles. • Anatomy and physiology of the heart. • Vascular system anatomy. • Physiology of the circulation 1: basic principles; functions of arterials and venous system; microcirculation and lymphatic system; local and humoral control of tissue blood flow. • Physiology of the circulation 2: nervous regulation of the circulation and rapid control of arterial pressure; role of the kidneys in long-term control of the arterial pressure; cardiac output, venous return and their regulation; muscle blood flow and cardiac output during exercise. • Body fluids and kidneys 1: body fluids compartments; anatomy and histology of the kidney; production of the urine; urine concentration and dilution. • Body fluids and kidneys 2: regulation of the extracellular fluid osmolarity and sodium concentration; renal regulation of potassium, calcium, phosphate, and magnesium; integration of renal mechanisms for control of the blood volume and extracellular fluids; acid-base regulations. • Blood cells, immunity and blood coagulation 1: red blood cells, leukocytes,

	granulocytes, monocyte-macrophage system; inflammation, immunity and allergy. • Blood cells, immunity and blood coagulation 2: blood type, transfusion, tissue and organ transplantation; hemostasis and blood coagulation. • Respiratory system1: anatomy of the respiratory system; pulmonary ventilation and circulation. • Respiratory system 2: physical principles of gas exchange; diffusion of oxigen and carbon dioxide through respiratory membrane and transport in blood and tissue fluids, regulation of respiration. • Osteomuscular anatomy I (bones). • Osteomuscular anatomy II (joints and muscles) • Central nervous system anatomy. • Peripheral nervous system anatomy. • The nervous system: general principles and sensory physiology; the chemical senses. • Special senses: anatomy and physiology of the eye and ear; sense of vision and hearing. • Motoric and integrative neurophysiology. • The limbic system and hypothalamus; vegetative nervous system; adrenal medulla; cerebral blood flow, cerebrospinal fluid. • Digestive system 1: anatomy of digestive organs; general principles of gastrointestinal functions; motility, propulsion and mixing of food. • Digestive system 2: secretion functions, digestion and absorption in gastrointestinal tract. • Metabolism of carbohydrates, lipids and proteins; liver as an organ, regulation of feeding; vitamins and minerals; energetic and metabolic rate; temperature regulation. • Endocrine system 1: introduction to endocrinology; anatomy and physiology of hypothalamus, pituitary gland and thyroid. • Endocrine system 2: adrenocortical hormones; pancreatic hormones: insulin and glucagon; parathyroid hormone; calcitonin; calcium and phosphate metabolism and vitamin D. • Male and female reproductive organ anatomy. • Reproductive and hormonal functions of the male. • Reproductive and hormonal functions of the female before pregnancy. • Human embrional and fetal developement; hormonal functions during pregnancy and lactation SEMINARS: • Introduction to the Physiology; Basic of Histology; Physiology of cell membranes, nerves and muscles. • Anatomy of the cardiovascular system; physiology of the heart. • Physiology of the circulation: basic principles; functions of arterial and venous system; microcirculation and lymphatic system; local and humoral control of tissue blood flow; nervous regulation of the circulation and rapid control of arterial pressure; role of the kidneys in long-term control of the arterial pressure; cardiac output, venous return and their regulation; muscle blood flow and cardiac output during exercise. • Body fluids and kidneys: body fluids compartments; anatomy and histology of the kidney; production of the urine; urine concentration and dilution; regulation of the extracellular fluid osmolarity and sodium concentration; renal regulation of potassium, calcium, phosphate, and magnesium; integration of renal mechanisms for control of the blood volume and extracellular fluids; acid-base regulations. • Blood cells, immunity and blood coagulation: red blood cells, leukocytes, granulocytes, monocyte-macrophage system; inflammation, immunity and allergy; blood type, transfusion, tissue and organ transplantation; hemostasis and blood coagulation • Respiratory system: anatomy of the respiratory system; pulmonary ventilation and circulation; physical principles of gas exchange; diffusion of oxygen and carbon

	dioxide through respiratory membrane and transport in blood and tissue fluids, regulation of respiration. • Osteomuscular anatomy (bones, joints and muscles). • Central and peripheral nervous system anatomy. • The nervous system: general principles and sensory physiology; the chemical senses; anatomy and phisiology of the eye and ear; sense of vision and hearing; motoric and integrative neurophysiology; the limbic system and hypothalamus; vegetative nervous system; adrenal medulla; cerebral blood flow, cerebrospinal fluid. • Digestive system: anatomy of digestive organs; general principles of gastrointestinal functions; motility, propulsion and mixing of food; secretion functions, digestion and absorption in gastrointestinal tract • Metabolism of carbohydrates, lipids and proteins; liver as an organ, regulation of feeding; vitamins and minerals; energetic and metabolic rate; temperature regulation; introduction to endocrinology; anatomy and physiology of hypotalamus, pituitary gland and thyroid • Endocrine system: adrenocortical hormones; pancreatic hormones: insulin and glucagon; parathyroid hormone; calcitonin; calcium and phosphate metabolism and vitamin D; Male and female reproductive organ anatomy. • Reproductive and hormonal functions of the male; reproductive and hormonal functions of the female before pregnancy.
2.6. Type of instruction	**lectures** **seminars** workshops exercises online in entirety mixed *e*-learning mixed *m*-learning field work independent study multimedia and the internet work with the mentor (other)
2.7. Student responsibilities	Regular attendance to lectures and active participation during seminars.

2.8. 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	Seminar essay	1,5
	Experimental work		Oral exam	2,5
	Essay		Project	
	Tests		Practical training	
	Written exam	2,5	(Other--describe)	
	Research		(Other--describe)	
	Report		(Other--describe)	

2.9. Grading and evaluation of student work over the course of instruction and at a final exam	Student work is graded and evaluated during and at the end of each Seminar. Written exam will be held after completion of the lectures and seminars, and encloses the whole Course content (120 questions). 71 correct answers are needed for passing the written exam. The students who passed the written exam, than take the oral exam.

2.10. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	Guyton AC, Hall JE. Medicinska fiziologija, 12. izdanje, Medicinska naklada. Zagreb, 2012.		
	Jalšovec D: Anatomija: osnove građe tijela čovjeka za studente 1.izdanje. ZT Zagraf, Zagreb 2013.		

2.11. Optional literature	Keros P, Pećina M, Ivančić-Košuta M. Temelji anatomije čovjeka. Naprijed, Zagreb, 1999.
2.12. Methods of monitoring quality that ensure acquisition of exit	Exit competences 1-4 will be evaluated during seminars and written exam.

competences	
2.13. Comments	

HUMAN PHYSIOLOGY AND ANATOMY

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Professor Danica Galešić Ljubanović, MD PhD
1.2. Associate teachers	Ivica Horvatić, MD PhD Miroslav Tišljar, MD PhD Matija Crnogorac, MD Petar Šenjug, MD
1.3. Graduate programme	Medical Biochemistry integrated study programme
1.4. Status of the course	Obligatory
1.5. Year of study, Semester	2nd Year, 4th Semester
1.6. Credit value (ECTS)	9
1.7. Type of instruction (number of hours L+E+S+e-learning)	60+0+45
1.8. Expected enrolment in the course	25
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2.
2. COURSE DESCRIPTION	
2.1. Course objectives	Course will provide students with basic knowledge regarding anatomical and physiological organization of human tissues, organs and organism as a whole. Providing this knowledge, students will be able to understand interrelation of anatomical structure, function and regulatory mechanisms necessary for the normal function of human organism.
2.2. Enrolment requirements and required entry competences for the course	Passed course Cellular biology and genetics is required.
2.3. Learning outcomes at the level of the study programme to which the course contributes	Evaluation of clinically significant biochemical, biological and molecular markers. Clinical aspects and interpretation of laboratory findings and consequently contributing to prevention and detection of the diseases, determining the cause of the diseases, determining the proper therapy and tracking the effects of the therapy.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	At the end of the course the student will be able to: 1. Describe anatomy of human organs and organ systems; 2. Define functions and describe physiology of human organs and organ systems; 3. Explain basic homeostasis mechanisms necessary for the normal function of human organism; 4. Establish association of physiological changes to the patophysiological basis of diseases.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	**LECTURES:** • Introduction to the Physiology; Basics of Histology. • Physiology of cell membranes, nerves and muscles. • Anatomy and physiology of the heart. • Vascular system anatomy. • Physiology of the circulation 1: basic principles; functions of arterial and venous system; microcirculation and lymphatic system; local and humoral control of tissue blood flow. • Physiology of the circulation 2: nervous regulation of the circulation and rapid control of arterial pressure; role of the kidneys in long-term control of the arterial pressure; cardiac output, venous return and their regulation; muscle blood flow and cardiac output during exercise. • Body fluids and kidneys 1: body fluids compartments; anatomy and histology of the kidney; production of the urine; urine concentration and dilution.

	• Body fluids and kidneys 2: regulation of the extracellular fluid osmolarity and sodium concentration; renal regulation of potassium, calcium, phosphate, and magnesium; integration of renal mechanisms for control of the blood volume and extracellular fluids; acid-base regulations. • Blood cells, immunity and blood coagulation 1: red blood cells, leukocytes, granulocytes, monocyte-macrophage system; inflammation, immunity and allergy. • Blood cells, immunity and blood coagulation 2: blood type, transfusion, tissue and organ transplantation; hemostasis and blood coagulation. • Respiratory system 1: anatomy of the respiratory system; pulmonary ventilation and circulation. • Respiratory system 2: physical principles of gas exchange; diffusion of oxygen and carbon dioxide through respiratory membrane and transport in blood and tissue fluids, regulation of respiration. • Osteomuscular anatomy I (bones). • Osteomuscular anatomy II (joints and muscles) • Central nervous system anatomy. • Peripheral nervous system anatomy. • The nervous system: general principles and sensory physiology; the chemical senses. • Special senses: anatomy and physiology of the eye and ear; sense of vision and hearing. • Motoric and integrative neurophysiology. • The limbic system and hypothalamus; vegetative nervous system; adrenal medulla; cerebral blood flow, cerebrospinal fluid. • Digestive system 1: anatomy of digestive organs; general principles of gastrointestinal functions; motility, propulsion and mixing of food. • Digestive system 2: secretion functions, digestion and absorption in gastrointestinal tract. • Metabolism of carbohydrates, lipids and proteins; liver as an organ, regulation of feeding; vitamins and minerals; energetic and metabolic rate; temperature regulation. • Endocrine system 1: introduction to endocrinology; anatomy and physiology of hypothalamus, pituitary gland and thyroid. • Endocrine system 2: adrenocortical hormones; pancreatic hormones: insulin and glucagon; parathyroid hormone; calcitonin; calcium and phosphate metabolism and vitamin D. • Male and female reproductive organ anatomy. • Reproductive and hormonal functions of the male. • Reproductive and hormonal functions of the female before pregnancy. • Human embrional and fetal development; hormonal functions during pregnancy and lactation SEMINARS: • Introduction to the Physiology; Basic of Histology; Physiology of cell membranes, nerves and muscles. • Anatomy of the cardiovascular system; physiology of the heart. • Physiology of the circulation: basic principles; functions of arterial and venous system; microcirculation and lymphatic system; local and humoral control of tissue blood flow; nervous regulation of the circulation and rapid control of arterial pressure; role of the kidneys in long-term control of the arterial pressure; cardiac output, venous return and their regulation; muscle blood flow and cardiac output during exercise. • Body fluids and kidneys: body fluids compartments; anatomy and histology of the kidney; production of the urine; urine concentration and dilution; regulation of the extracellular fluid osmolarity and sodium concentration; renal regulation of potassium, calcium, phosphate, and magnesium; integration of renal mechanisms for control of the blood

<table>
<tr><td></td><td colspan="4">volume and extracellular fluids; acid-base regulations.
• Blood cells, immunity and blood coagulation: red blood cells, leukocytes, granulocytes, monocyte-macrophage system; inflammation, immunity and allergy; blood type, transfusion, tissue and organ transplantation; hemostasis and blood coagulation
• Respiratory system: anatomy of the respiratory system; pulmonary ventilation and circulation; physical principles of gas exchange; diffusion of oxygen and carbon dioxide through respiratory membrane and transport in blood and tissue fluids, regulation of respiration.
• Osteomuscular anatomy (bones, joints and muscles).
• Central and peripheral nervous system anatomy.
• The nervous system: general principles and sensory physiology; the chemical senses; anatomy and physiology of the eye and ear; sense of vision and hearing; motoric and integrative neurophysiology; the limbic system and hypothalamus; vegetative nervous system; adrenal medulla; cerebral blood flow, cerebrospinal fluid.
• Digestive system: anatomy of digestive organs; general principles of gastrointestinal functions; motility, propulsion and mixing of food; secretion functions, digestion and absorption in gastrointestinal tract
• Metabolism of carbohydrates, lipids and proteins; liver as an organ, regulation of feeding; vitamins and minerals; energetic and metabolic rate; temperature regulation; introduction to endocrinology; anatomy and physiology of hypothalamus, pituitary gland and thyroid
• Endocrine system: adrenocortical hormones; pancreatic hormones: insulin and glucagon; parathyroid hormone; calcitonin; calcium and phosphate metabolism and vitamin D; Male and female reproductive organ anatomy.
• Reproductive and hormonal functions of the male; reproductive and hormonal functions of the female before pregnancy.</td></tr>
<tr><td>2.6. Type of instruction</td><td colspan="2"><u>lectures</u>
<u>seminars</u>
workshops
exercises
online in entirety
mixed e-learning
mixed m-learning</td><td colspan="2">field work
independent study
multimedia and the internet
work with the mentor
(other)</td></tr>
<tr><td>2.7. Student responsibilities</td><td colspan="4">Regular attendance to lectures and active participation during seminars.</td></tr>
<tr><td rowspan="8">2.8. 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)</td><td>Class attendance</td><td>2,5</td><td>Seminar essay</td><td>1,5</td></tr>
<tr><td>Experimental work</td><td></td><td>Oral exam</td><td>2,5</td></tr>
<tr><td>Essay</td><td></td><td>Project</td><td></td></tr>
<tr><td>Tests</td><td></td><td>Practical training</td><td></td></tr>
<tr><td>Written exam</td><td>2,5</td><td>(Other--describe)</td><td></td></tr>
<tr><td>Research</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>Report</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>2.9. Grading and evaluation of student work over the course of instruction and at a final exam</td><td colspan="4">Student work is graded and evaluated during and at the end of each seminar.
Written exam will be held after completion of the lectures and seminars, and enclosures the whole Course content (120 questions). 71 correct answers are needed for passing the written exam. The students who passed the written exam, than take the oral exam.</td></tr>
<tr><td>2.10. Required literature (available at the library and via other media)</td><td colspan="2">Title</td><td>Number of copies at the library</td><td>Availability via other</td></tr>
</table>

			media
	Guyton AC, Hall JE. Medicinska fiziologija, 12. izdanje, Medicinska naklada. Zagreb, 2012.		
	Jalšovec D: Anatomija: osnove građe tijela čovjeka za studente 1.izdanje. ZT Zagraf, Zagreb 2013.		
2.11. Optional literature	Keros P, Pećina M, Ivančić-Košuta M. Temelji anatomije čovjeka. Naprijed, Zagreb, 1999.		
2.12. Methods of monitoring quality that ensure acquisition of exit competences	Exit competences 1-4 will be evaluated during seminars and written exam.		
2.13. Comments			

HISTORY OF PHARMACY

1. COURSE DECRIPTION – GENERAL INFORMATION		
1.1. Course teacher	Assistant Professor Suzana Inić, PhD	
1.2. Associate teachers	-	
1.3. Graduate programme	Pharmacy integrated study programme	
1.4. Status of the course	Elective	
1.5. Year of study, Semester	3rd, 6th	
1.6. Credit value (ECTS)	1,5	
1.7. Type of instruction (number of hours L+E+S+e-learning)	15+0+0	
1.8. Expected enrolment in the course	20	
1.9. 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 acquire the knowledge of world and Croatian pharmacy during the history in the context of the development of society in general in different historical framework	
2.2. Enrolment requirements and required entry competences for the course	Attending the 6th semester	
2.3. Learning outcomes at the level of the study programme to which the course contributes		
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After the student has passed the exam he/she will be able to: 1. describe the development of medicine and pharmacy in history 2. describe the history of pharmacy studies in Croatia 3. recognize the founders of modern Croatian pharmacy 4. explain the contribution of the founders of Croatian pharmacy to the development of modern pharmacy	
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES: •Prehistoric medicine, Assyrian/Babylonian Medicine, Medicine of Ancient Egypt, Jewish medicine, Medicine of ancient India and China • The ancient Greek medicine, Greek natural philosophy, Medicine of ancient Rome • Medieval medicine and pharmacy, Byzantine and Arabic medicine, European medieval medicine: the monastic medicine, Medical School at Salerno, scholastic medicine, folk medicine books (*Ljekaruše*) • Pharmacy as a separate profession: Edict of Salerno; Alchemy, Pharmacy in the 15th and 16th centuries • Pharmacy in the 17th century: Iatrophysics and Iatrochemistry, Pharmacy in the 18th century: phlogiston theory; pharmacy legislation, pharmacopoeia, the oldest pharmacy in Croatia • Pharmacy in the 19th and 20 centuries: bacteriology, isolation of alkaloids, chemotherapy, vitamins, history of pharmacy studies in Croatia • The founders of modern pharmacy in Croatia: Gustav Janeček, Julije Domac, Antun Vrgoč	
2.6. Type of instruction	**lectures** seminars workshops exercises online in entirety	field work independent study multimedia and the internet work with the mentor (other)

	mixed *e*-learning mixed *m*-learning			
2.7. Student responsibilities				
2.8. 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	0,5	Seminar essay	
	Experimental work		Oral exam	1
	Essay		Project	
	Tests		Practical training	
	Written exam		(Other--describe)	
	Research		(Other--describe)	
	Report		(Other--describe)	
2.9. Grading and evaluation of student work over the course of instruction and at a final exam	oral exam			

2.10. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	lectures are available on website		web

2.11. Optional literature

- Glesinger, Povijest medicine, Školska knjiga, Zagreb, 1987.
- D. Kuštrak, Farmakognozija, fitofarmacija, Golden marketing-Tehnička knjiga, Zagreb, 2005.
- V. Grdinić, Ljekarništvo na tlu Hrvatske, MH, Zagreb, 1996.
- V. Grdinić, Ilustrirana povijest hrvatskoga ljekarništva, HFD, MH, Zagreb, 1997.
- S. Inić i N. Kujundžić, Julije Domac, život i djelo 1853-1928, HFD I FBF, Zagreb, 2012.
- D.L. Cowen and W.H. Helfand, Pharmacy an illustrated history, Harry N. Abrams, Inc., New York, 1990.

2.12. Methods of monitoring quality that ensure acquisition of exit competences	Learning outcomes are checked by the oral exam
2.13. Comments	

IMMUNOCHEMISTRY

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Ass. prof. Marija Grdić Rajković, PhD
1.2. Associate teachers	Prof. Karmela Barišić, PhD
1.3. Graduate programme	Medical Biochemistry study programme
1.4. Status of the course	Compulsory
1.5. Year of study, Semester	4th
1.6. Credit value (ECTS)	2,5
1.7. Type of instruction (number of hours L+E+S+e-learning)	15+8+7
1.8. Expected enrolment in the course	25
1.9. 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	To learn chemical processes in immunology, basic principles of immunoassays, as well as range and implementation of immunoassays in clinical medicine.
2.2. Enrolment requirements and required entry competences for the course	Passed Clinical chemistry and Immunology
2.3. Learning outcomes at the level of the study programme to which the course contributes	Implementation of basic knowledge in immunoassays in laboratory medicine, in defining, analysis and suggestions about investigation procedures, quality assurance and implementation on new laboratory procedures in detection of diseases and monitoring of therapy.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	Students will be able to: 1. Explain the antigen-antibody reaction; 2. Explain the principles of immunoassays; 3. Describe production of antibodies; 4. Describe the reagents for immunoassays; 5. Identify the interferences in immunoassays; 6. Describe the principles of investigations of cellular immunity; 7. Know the work on auto automated immuno- analysers.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES: 1. Introductory lecture; Antigen; Antibody. 2. Antigen-antibody reaction; Complement; Immunisation. 3.Unlabelled immunoassays; Labelled immunoassays. 4. Investigation of cellular immunity; Immunoassays - new strategy; Production of antibodies. 5. Reagents in immunoassays; Standardization. 6. Interferences in immunoassays. SEMINARS: 1. Antigens of EBV- virus; specific antibodies; Screening methods; confirmative methods; evaluation of electrophoretic pattern; Immunoelectrophoresis; Immunofixation. 2. Comparison of methods for tumour markers; Deficit IgA; Standardization of flow cytometry; Subclasses of IgG; Determination of referent values; Characteristics of IgD. 3. Insulin antibodies; Interferences; Methods for CRP; Multiplex methods; Determination of thrombopoietin; Diagnostic efficiency of CRP determination in acute inflammation and hsCRP in chronic

	inflammation; Validation of methods for drug monitoring. EXERCISES: 1. Immunoturbidimetry, Imunotrubidimetry on latey particles; Hook effect; Interferences of endogenous and exogenous antibodies; Practice on auto automated analyser AU 400. 2. Immunoassays in solutions; labeled methods (FIA- tIgE, sIgE); Automatisation of immunoassays; Practice on auto automated analyser ImmunoCAP 100. 3. Practice on auto automated analyser Architect and Immunlite (feritin; TSH, T4, fT4); *Ex vivo* investigation of cellular immunity – IFN-gamma released from T-			
2.6. Type of instruction	**lectures** **seminars** workshops **exercises** online in entirety mixed *e*-learning mixed *m*-learning		field work independent study multimedia and the internet work with the mentor (other)	
2.7. Student responsibilities				
2.8. 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	0.5	Seminar essay	
	Experimental work		Oral exam	
	Essay		Project	
	Tests		Practical training	**0.5**
	Written exam	1.5	(Other--describe)	
	Research		(Other--describe)	
	Report		(Other--describe)	
2.9. Grading and evaluation of student work over the course of instruction and at a final exam	Regulary contribution on Lectures, Seminars; Exercises; Expercises are performed in small groups (up to 5 students) in clinical laboratory.			
2.10. Required literature (available at the library and via other media)	**Title**		**Number of copies at the library**	**Availability via other media**
	Dodig S. Immunochemistry (University handbook), Medicinska naklada, Zagreb 2014			
	Andreis I, Čulo F, Marušić M, Taradi M: Imunologija, (University handbook), Medicinska naklada, Zagreb, 2004.			
	Štraus B, Stavljenić-Rukavina A, Plavšić F.: Analytical techniques in clinical laboratory, (University handbook), Medicinska naklada, Zagreb, 1997. Čepelak I, Dodig S, Štraus B, Labar B: Medical - biochemical guidelines, (University handbook), Medicinska naklada, Zagreb, 2004.			
2.11. Optional literature				
2.12. Methods of monitoring quality that ensure acquisition of exit competences	Learning outcomes 1-6 are checked by written exam and during seminars. LO 7 is tested during laboratory practice.			
2.13. Comments				

IMMUNOLOGY

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Professor Jerka Dumić
1.2. Associate teachers	
1.3. Graduate programme	Medical Biochemistry
1.4. Status of the course	Obligatory
1.5. Year of study, Semester	3th year; 6th semester
1.6. Credit value (ECTS)	4
1.7. Type of instruction (number of hours L+E+S+e-learning)	30+0+15+0
1.8. Expected enrolment in the course	25
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2nd level; **e-learning – it is not a part of teaching hours, but it is used in studying since it contains case studies, problems with explanations, links on different useful web pages**
2. COURSE DESCRIPTION	
2.1. Course objectives	To acquire the basic knowledge in cellular and molecular immunology, mechanisms of the development of the diseases related to immune system (immunodeficiency, hypersensitivity, and autoimmunity), principles and application of immunochemical tests in diagnostics, testing of immune functions and application of immunotherapies.
2.2. Enrolment requirements and required entry competences for the course	Attended Pathophysiology with pathology
2.3. Learning outcomes at the level of the study programme to which the course contributes	The application of knowledge in immunology and immunopathology in laboratory diagnostics, in defining, analysing and proposing actions related to the research, production and quality assurance and implementation of new laboratory methods for the detection and monitoring of diseases and the effect of therapy.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After passing the exam student will be able to: 1. Identify the components of the immune system. 2. Describe the cellular basis of the normal development of innate and acquired immunity and identify outcomes of impaired development and deficiencies. 3. Compare the mechanisms of activation of innate and adaptive immunity and explain how the outcomes of innate immunity activate acquired immunity. 4. Describe how the innate and acquired immunity inhibit bacterial, fungal and viral infections as well as the consequences of inefficiency suppression. 5. Describe mechanisms and outcomes of regulation of the immune system. 6. Identify key mechanisms that lead to the development of immunological disorders (hypersensitivity, autoimmunity, and immunodeficiency) and the principles for therapeutic modulation of the immune system. 7. Describe the basic immunological principles that are the basis of therapeutic approaches including biotherapeutics. 8. Explain the principles of immunochemical tests, and tests of immune function. 9. Identify the advantages and disadvantages of new immunodiagnostic approaches as well as their rational application.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES: • Review of the components and reactions of the immune system. (2) • Immunobiology: The components of the immune system - cells, tissues and organs. (2) • Immunobiology: The components of the immune system - complement and antibodies. (2) • Immunobiology: MHC class molecules, T cell receptors, cytokines and chemokines. (2) • Immunobiology: Innate immunity. (2)

<table>
<tr><td></td><td colspan="4">

Immunobiology: Acquired immunity. (2)
The regulation of the immune system: central and peripheral tolerance. (2)
The regulation of the immune system: homeostasis of the immune system. (2)
Immunopathology: The immune response against viral, bacterial and fungal infections. (2)
Immunopathology: The immune response against the protozoa and helminths. (2)
Immunopathology: Hypersensitivity and autoimmunity. (2)
Immunopathology: Immunodeficiency; The immune system and cancer. (2)
Immunotherapy: Allogeneic transplantation. (2)
Immunotherapy: Immunomodulation - Advanced immunotherapy; Vaccination. (2)
Immunochemistry and testing of various immune functions. (2)

SEMINARS:

Components of the immune system; Innate and acquired immunity. (3)
Communication and signaling between the components of the immune system. (3)
Diagnosis: HIV, influenza, HPV, tuberculosis, sepsis. (2)
Diagnosis: candidiasis, malaria, laišmanijaze, trypanosomosis. (2)
Diagnosis: Allergies and autoimmune diseases. (2)
Immunotherapy. (3)

</td></tr>
<tr><td>2.6. Type of instruction</td><td colspan="2">lectures
seminars
workshops
exercises
online in entirety
mixed e-learning*
mixed m-learning</td><td colspan="2">field work
independent study
multimedia and the internet
work with the mentor
(other)
* e-learning – it is not a part of teaching hours, but it is used in studying since it contains case studies, problems with explanations, links on different useful web pages</td></tr>
<tr><td>2.7. Student responsibilities</td><td colspan="4">The students are required to attend classes that take place in the form of lectures and seminars. To be entitled to achieve the credits and grades, students are required to take the written and oral exam and pass them both successfully.</td></tr>
<tr><td rowspan="8">2.8. 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)</td><td>Class attendance</td><td>0.5</td><td>Seminar essay</td><td>1</td></tr>
<tr><td>Experimental work</td><td></td><td>Oral exam</td><td>2</td></tr>
<tr><td>Essay</td><td></td><td>Project</td><td></td></tr>
<tr><td>Tests</td><td></td><td>Practical training</td><td></td></tr>
<tr><td>Written exam</td><td>0,5</td><td>(Other--describe)</td><td></td></tr>
<tr><td>Research</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>Report</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>2.9. Grading and evaluation of student work over the course of instruction and at a final exam</td><td colspan="4">The students are evaluated according to the performance in the written (40%) and oral examination (60%), which can be accessed only after the attended lectures. On the final exam students are required to demonstrate knowledge of all areas covered by the program of the course, at the level of skilled information management and synthesis of materials</td></tr>
<tr><td rowspan="3">2.10. Required literature (available at the library and via other media)</td><td colspan="2">Title</td><td>Number of copies at the library</td><td>Availability via other media</td></tr>
<tr><td colspan="2">J. Dumić Imunologija Powerpoint presentations (within the e-learning)</td><td></td><td></td></tr>
<tr><td colspan="2">Andreis I, Batinić D, Čulo F, Grčević D, Marušić M, Taradi M, Višnjić D. Imunologija (7. izdanje), Medicinska naklada, Zagreb, 2010</td><td></td><td></td></tr>
</table>

	Male D., Brostoff J., Roth D.B., Roitt I. Immunology (7th ed.), 2006		
2.11. Optional literature	Abbas, AK, Lichtman, AH, Pillai, S. Cellular and Molecular Immunology (7th ed.), 2011		
2.12. Methods of monitoring quality that ensure acquisition of exit competences	Learning outcomes are checked by written and oral exam.		
2.13. Comments			

IMMUNOLOGY

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Professor Jerka Dumić
1.2. Associate teachers	
1.3. Graduate programme	Pharmacy
1.4. Status of the course	Obligatory
1.5. Year of study, Semester	4th year; 8th semester
1.6. Credit value (ECTS)	2.5
1.7. Type of instruction (number of hours L+E+S+e-learning)	30+0+0+0
1.8. Expected enrolment in the course	120
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2nd level; **e-learning – it is not a part of teaching hours, but it is used in studying since it contains case studies, problems with explanations, links on different useful web pages**
2. COURSE DESCRIPTION	
2.1. Course objectives	To acquire the basic knowledge of the cellular and molecular immunology, mechanisms of the development of the diseases related to immune system (immunodeficiency, hypersensitivity, and autoimmunity), principles and application of immunochemical tests in diagnostics, testing of immune functions and application of immunotherapies.
2.2. Enrolment requirements and required entry competences for the course	Attended Pharmacology course.
2.3. Learning outcomes at the level of the study programme to which the course contributes	Application of knowledge in immunology needed to define, analyse and propose actions related to research, development and production and analysis and quality control of medicines.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After passing the exam student will be able to: 1. Identify the components of the immune system; 2. Describe the cellular basis of the normal development of innate and acquired immunity and identify outcomes of impaired development and deficiencies; 3. Compare the mechanisms of activation of innate and adaptive immunity and explain how the outcomes of innate immunity activate acquired immunity; 4. Describe how the innate and acquired immunity inhibit bacterial, fungal and viral infections as well as the consequences of inefficiency suppression; 5. Describe mechanisms and outcomes of regulation of the immune system; 6. Identify key mechanisms that lead to the development of immunological disorders (hypersensitivity, autoimmunity, and immunodeficiency) and the principles for therapeutic modulation of the immune system; 7. Describe the basic immunological principles that are the basis of therapeutic approaches including biotherapeutics. 8. Explain the principles of immunochemical tests, and tests of immune function; 9. Identify the advantages and disadvantages of new immunodrugs.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES: • Review of the components and reactions of the immune system. (2) • Immunobiology: The components of the immune system - cells, tissues and organs. (2) • Immunobiology: The components of the immune system - complement and antibodies. (2) • Immunobiology: MHC class molecules, T cell receptors, cytokines and chemokines. (2) • Immunobiology: Innate immunity. (2) • Immunobiology: Acquired immunity. (2)

<table>
<tr><td></td><td colspan="4">

The regulation of the immune system: central and peripheral tolerance. (2)
The regulation of the immune system: homeostasis of the immune system. (2)
Immunopathology: The immune response against viral, bacterial and fungal infections. (2)
Immunopathology: The immune response against the protozoa and helminths. (2)
Immunopathology: Hypersensitivity and autoimmunity. (2)
Immunopathology: Immunodeficiency; The immune system and cancer. (2)
Immunotherapy: Allogeneic transplantation. (2)
Immunotherapy: Immunomodulation - Advanced immunotherapy; Vaccination. (2)
Immunochemistry and testing of various immune functions. (2)

</td></tr>
<tr><td>2.6. Type of instruction</td><td colspan="2">lectures
seminars
workshops
exercises
online in entirety
mixed e-learning*
mixed m-learning</td><td colspan="2">field work
independent study
multimedia and the internet
work with the mentor
(other)
* e-learning – it is not a part of teaching hours, but it is used in studying since it contains case studies, problems with explanations, links on different useful web pages</td></tr>
<tr><td>2.7. Student responsibilities</td><td colspan="4">The students are required to attend classes that take place in the form of lectures. To be entitled to achieve the credits and grades, students are required to take the written and oral exam and pass them both successfully.</td></tr>
<tr><td rowspan="8">2.8. 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)</td><td>Class attendance</td><td>0.5</td><td>Seminar essay</td><td></td></tr>
<tr><td>Experimental work</td><td></td><td>Oral exam</td><td>1</td></tr>
<tr><td>Essay</td><td></td><td>Project</td><td></td></tr>
<tr><td>Tests</td><td></td><td>Practical training</td><td></td></tr>
<tr><td>Written exam</td><td>0,5</td><td>(Other--describe)</td><td></td></tr>
<tr><td>Research</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>Report</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>2.9. Grading and evaluation of student work over the course of instruction and at a final exam</td><td colspan="4">The students are evaluated according to the performance in the written (40%) and oral examination (60%), which can be accessed only after the attended lectures. On the final exam students are required to demonstrate knowledge of all areas covered by the program of the course, at the level of skilled information management and synthesis of materials</td></tr>
<tr><td rowspan="4">2.10. Required literature (available at the library and via other media)</td><td colspan="2">Title</td><td>Number of copies at the library</td><td>Availability via other media</td></tr>
<tr><td colspan="2">J. Dumić Imunologija Powerpoint presentations (within the e-learning)</td><td></td><td></td></tr>
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<tr><td>2.11. Optional literature</td><td colspan="4">Abbas, AK, Lichtman, AH, Pillai, S. Cellular and Molecular Immunology (7th ed.), 2011</td></tr>
<tr><td>2.12. Methods of monitoring quality that ensure acquisition of exit competences</td><td colspan="4">Learning outcomes are checked by written and oral exam.</td></tr>
<tr><td>2.13. Comments</td><td colspan="4"></td></tr>
</table>

INNOVATIVE DRUG DELIVERY SYSTEMS

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Associate Professor Jasmina Lovrić, PhD Assistant Professor Ivan Pepić, PhD
1.2. Associate teachers	Associate Professor Anita Hafner, PhD Associate Professor Mario Jug, PhD Associate Professor Željka Vanić, PhD
1.3. Graduate programme	Pharmacy
1.4. Status of the course	Elective course
1.5. Year of study, Semester	4th year, 7th semester
1.6. Credit value (ECTS)	2.5
1.7. Type of instruction (number of hours L+E+S+e-learning)	15+15+0+0
1.8. Expected enrolment in the course	50
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2nd level
2. COURSE DESCRIPTION	
2.1. Course objectives	Students will learn about the physiology and pathophysiology of different routes of administration (parenteral, oral, sublingual, buccal, nasal, pulmonary, ocular, dermal, transdermal, vaginal) ensuring fundamental approach to the design of innovative drug delivery systems. Students will understand the relationship between the properties of each route of administration, and innovative drug delivery system technology. Students will gain the knowledge necessary for assessment of therapeutic outcome, approval and marketing procedures of drug delivery systems. In addition, students will learn about the expected savings related to the national medicines policy based on improved therapeutic outcomes and patient compliance.
2.2. Enrolment requirements and required entry competences for the course	Enrolment requirements: Drug formulation course completed Exam: passed examination in Drug formulation Entry competences include knowledge and skills in the design, manufacture and quality control of conventional dosage forms, their biopharmaceutical evaluation, packaging and storage requirements, and dispensing to the patients.
2.3. Learning outcomes at the level of the study programme to which the course contributes	• The application of basic knowledge of chemistry and physics necessary for defining, analysing and proposing procedures related to research, development and production of innovative drug delivery systems. • Selection of appropriate technology in the manufacture of innovative drug delivery systems.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After completing the course student will be able to 1. Explain the specific physiology and pathophysiology of different routes of drug administration. 2. Consider drug transport across biological barriers of each routes of administration based on technological and biopharmaceutical properties of drug delivery system. 3. Explain the biopharmaceutical properties of drug delivery systems and their impact on bioavailability and pharmacokinetic profile of incorporated drug. 4. List and explain the advantages of the use of innovative drug delivery systems over conventional dosage forms. 5. Select the most suitable drug delivery system in order to achieve optimal therapeutic effect and patient compliance. 6. Indicate the specifics of the approval procedure of drug delivery systems and to estimate the expected savings related to national medicines policy.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES: • Guidelines for the research and development of innovative drug delivery systems

	• Parenteral drug delivery systems • Oral drug delivery systems • (Trans)dermal drug delivery systems • Sublingual and buccal drug delivery systems • Vaginal drug delivery systems • Ocular drug delivery systems • Nasal and pulmonary drug delivery systems SEMINARS: • Approved parenteral drug delivery systems: indication, advantages and regulatory aspect • Approved oral drug delivery systems: indication, advantages and regulatory aspect • Approved (trans)dermal drug delivery systems: indication, advantages and regulatory aspect • Approved buccal drug delivery systems: indication, advantages and regulatory aspect • Approved vaginal drug delivery systems: indication, advantages and regulatory aspect • Approved ocular drug delivery systems: indication, advantages and regulatory aspect • Approved nasal and pulmonary drug delivery systems: indication, advantages and regulatory aspect

2.6. Type of instruction	**lectures** **seminars** workshops exercises online in entirety mixed *e*-learning mixed *m*-learning	field work independent study multimedia and the internet work with the mentor (other)
2.7. Student responsibilities	Regular attendance of lectures and seminars.	

2.8. 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**	1	Seminar essay	
	Experimental work		Oral exam	
	Essay		Project	
	Tests		Practical training	
	Written exam	1.5	(Other--describe)	
	Research		(Other--describe)	
	Report		(Other--describe)	
2.9. Grading and evaluation of student work over the course of instruction and at a final exam	Continuous assesment (ISVU system) – written final exam.			

2.10. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	Nanoparticulates as drug carriers, I V. Torchilin, Imperial Collage Press, 2006.	5	
	Physiological Pharmaceutics, Barriers to drug absorption, Second Edition, Neena Washington, Clive Washington, Clive G Wilson, Taylor & Francis, 2001.		
	Applied Biopharmaceutics & Pharmacokinetics, Fifth Edition, Leon Shargel, Andrew Yu, Susanna Wu-Pong; McGraw-Hill, 2005.		
	Drug delivery and targeting: for pharmacists and		

	pharmaceutical sciences, First Edition, Anya M. Hillery, Andrew W. Lloyd, Taylor & Francis, 2001		
	Pharmaceutics-drug delivery and targeting, Second Editon, Yvonne Perrie, Thomas Rades, Pharmaceutical Press, 2012.		
2.11. Optional literature	Recent scientific papers.		
2.12. Methods of monitoring quality that ensure acquisition of exit competences	Assessment of learning outcomes by the evaluation of mini-project based on student selected topic in the field of drug delivery and written exam; harmonization of teaching and evaluation approaches and methodology with the obtained results.		
2.13. Comments			

INTRODUCTION TO COMPLEMENTARY AND ALTERNATIVE MEDICINE

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Jadranka Vuković Rodríguez Renata Jurišić Grubešić
1.2. Associate teachers	Ivan Kosalec Živka Juričić
1.3. Graduate programme	Integrated - Pharmacy
1.4. Status of the course	Optional
1.5. Year of study, Semester	3.-5.
1.6. Credit value (ECTS)	3,0
1.7. Type of instruction (number of hours L+E+S+e-learning)	P10+S18(seminars + debates)+2(*m*-learning)
1.8. Expected enrolment in the course	40
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2.
2. COURSE DESCRIPTION	
2.1. Course objectives	The aim of the course is to familiarize students with the basic principles and modalities of complementary and alternative medicine (CAM), with special emphasis on safety and therapeutic efficacy. Using critical approach, students will analyze the potential fruitful cooperation between CAM and conventional medicine. Through various forms of teaching (interactive seminars, debates, *m*-learning), the goal is to introduce students to scientific evidence-based research about the safety and specific therapeutic effect of CAM, as well as the different approaches to quality control of therapeutic preparations used by CAM. Students will be able to identify all of the key reasons why CAM should be subject to ethical principles and the relevant legislation, in the same way as conventional therapy. Furthermore, the goal is to elucidate to students, not just the actual benefits of CAM, but also the potential risks of this therapeutic approach. The knowledge gained in the course Introduction to Complementary and Alternative Medicine will enable students to acquire additional competencies relevant to the implementation of pharmaceutical care and, in general, extend the capabilities of their professional activities.
2.2. Enrolment requirements and required entry competences for the course	None
2.3. Learning outcomes at the level of the study programme to which the course contributes	- Applying expert knowledge and skills in advising on CAM and implementation of pharmaceutical care, respecting the actual legislation, current health policy and proper health guidelines and principles of pharmaceutical ethics and deontology. - Critical evaluation and application of scientific knowledge in order to find the optimal treatment plan for each individual. - Informing and consultation about the action and the correct application of CAM therapeutics and monitoring the course and outcome of therapy. - Identify clinically significant drug interactions and CAM therapeutics, and treatment in order to avoid them. - Applying basic knowledge of CAM needed to define, analyze and propose methods of analysis and quality control of medicinal products used by the CAM. - Assessing and proposing the application of new technologies and

	improving existing to improve therapy. - Using different information technologies and relevant databases to extend the professional knowledge and skills.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	1. Describe the basic principles and modalities of CAM; 2. Explain characteristics and effects of CAM in the treatment of various diseases; 3. Identify and analyze the similarities and differences, and the advantages and disadvantages of CAM and conventional medicine; 4. Define and explain the evidence-based outcomes of CAM; 5. Evaluate and propose analytical approaches to quality control of CAM therapeutics; 6. Identify and explain clinically significant interactions KAM-conventional therapies; 7. Identify, analyze and independently propose solutions of ethical dilemmas in the application of CAM; 8. Compare the valid legislation in conventional medicine and CAM; Investigate and critically analyze the relevant literature on the new findings in the field of CAM.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES: • Traditional, Complementary and alternative medicine - definitions and characteristics • The classification and categorization of complementary therapies (Eng. 'Big five' Terapies): alternative medical therapy, biological therapy, energy therapy, the interaction of body and mind, manipulative physical therapy • Traditional medicine in the world • Traditional Chinese medicine (TCM): philosophy of the East, Qi, binary theory, the theory of five phases; The diagnosis in TCM • Complementary therapies of the West: naturopathy, herbal remedies, homeopathy, nutritional medicine • The analytical approach to quality assurance and control of TCM and CAM therapeutics • Interactions of CAM therapeutics and conventional therapy • evidence-based CAM • Legislation in CAM • Ethical principles and CAM: informed consent, ethical principle of harmlessness, scientific-based design research, therapeutic myths and misconceptions • The integration of complementary and conventional medicine: modern research • CAM in university programs; KAM, pharmacist and society; CAM in the age of modern medicine. SEMINARS, DEBATES and WORKSHOPS Multidisciplinary seminar on CAM modalities (different topics: Naturopathy, Homeopathy, Traditional Chinese medicine, Aromatherapy, Ayurveda, Crystalotherapy, etc.). Project: Evidenced-based KAM in the treatment of disease (case study) Debate: Ethical considerations and problems in KAM (case study) Workshop 1: KAM and the placebo effect; KAM and clinical studies (case study) Workshop 2: *m*-learning: The views and opinions of students about KAM

<table>
<tr><td>2.6. Type of instruction</td><td colspan="2">lectures
seminars
workshops
mixed m-learning</td><td colspan="2">independent study</td></tr>
<tr><td>2.7. Student responsibilities</td><td colspan="4">Class attendance; Seminar attendance; Active participation in small-group activities; Preparation of the seminar; Development of the final project.</td></tr>
<tr><td rowspan="7">2.8. 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)</td><td>Class attendance</td><td>0.3 (10%)</td><td>Seminar essay</td><td>0.3 (10%)</td></tr>
<tr><td>Experimental work</td><td></td><td>Oral exam</td><td></td></tr>
<tr><td>Essay</td><td></td><td>Project</td><td>0.9 (30%)</td></tr>
<tr><td>Tests</td><td></td><td>Practical training</td><td></td></tr>
<tr><td>Written exam</td><td>0.9 (30%)</td><td>m-learning</td><td>0.15 (5%)</td></tr>
<tr><td>Research</td><td></td><td>Debate</td><td>0.45 (15%)</td></tr>
<tr><td>Report</td><td></td><td></td><td></td></tr>
<tr><td>2.9. Grading and evaluation of student work over the course of instruction and at a final exam</td><td colspan="4">Seminars; Case study; Preparation and presentation of the final project; Debate; Written exam</td></tr>
<tr><td rowspan="4">2.10. Required literature (available at the library and via other media)</td><td colspan="2">Title</td><td>Number of copies at the library</td><td>Availability via other media</td></tr>
<tr><td colspan="2">1. Marc S. Micozzi, Fundamentals of Complementary and Alternative Medicine Elsevier Health Sciences, 2011.
2. WHO traditional medicine strategy: 2014–2023. World Health Organization, Geneva, 2013. European Pharmacopoeia, 6. izdanje, EDQM, Strasbourg, 2008.</td><td></td><td></td></tr>
<tr><td colspan="2">3. European Pharmacopoeia, 6. izdanje, EDQM, Strasbourg, 2008.</td><td></td><td></td></tr>
<tr><td colspan="2">4. Stockley’s Drug Interactions,
Karen Baxter (Ed.), Pharmaceutical Press,
London, 2008.</td><td></td><td></td></tr>
<tr><td>2.11. Optional literature</td><td colspan="4">1. WHO Quality control methods for herbal materials, World Health Organization, Geneva, 2011.
2. WHO guidelines on safety monitoring of herbal medicines in pharmacovigilance systems, World Health Organization, Geneva, 2004.
3. Essentials of Chinese Medicine, Volume 1, Foundations of Chinese Medicine, Editors: Zhanwen Liu, Liang Liu, Springer-Verlag London, 2009.
4. Directive 2004/24/EC amending, as regards traditional herbal medicinal products, Directive 2001/83/EC on the Community code relating to medicinal products for human use.
5. Pravilnik o stavljanju u promet te o označavanju i oglašavanju tradicionalnih biljnih lijekova, NN br. 89/10.</td></tr>
<tr><td>2.12. Methods of monitoring quality that ensure acquisition of exit competences</td><td colspan="4">Learning outcomes 1-4 are checked by written exam, learning outcomes 5-9 are checked by the presentation of a seminar paper, analysis of CAM cases, presentation of the final project and through debate.</td></tr>
<tr><td>2.13. Comments</td><td colspan="4"></td></tr>
</table>

INTRODUCTION TO PHARMACY

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Professor Sanda Vladimir-Knežević Associate Professor Renata Jurišić Grubešić Associate Professor Željka Vanić
1.2. Associate teachers	
1.3. Graduate programme	Integrated study programme
1.4. Status of the course	Obligatory course
1.5. Year of study, Semester	1st year, 1st semester
1.6. Credit value (ECTS)	1.5
1.7. Type of instruction (number of hours L+E+S+e-learning)	15+0+0
1.8. Expected enrolment in the course	130
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2
2. COURSE DESCRIPTION	
2.1. Course objectives	To present the historical development of the study of pharmacy at the University of Zagreb, Croatia, as well as the pharmacy as a profession in Croatia; to introduce the structure of the present Pharmacy programme at the Faculty of Pharmacy and Biochemistry and the content of major pharmaceutical professional courses, also the characteristics of the pharmaceutical science and practice, the role of pharmacy in the healthcare system, the pharmacists' social role, mission, and competences, as well as their employment opportunities.
2.2. Enrolment requirements and required entry competences for the course	None
2.3. Learning outcomes at the level of the study programme to which the course contributes	This course is an introduction to the study of pharmacy and its content does not contribute to the specific learning outcomes for the Study programme.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After passing the course the student will be able to: 1. Describe the social role and the mission of pharmacists. 2. Explain the competences of community and hospital pharmacists 3. Indicate the basic characteristics of pharmacy as a science and profession. 4. Describe the development of drug form. 5. Explain the role of pharmaceutical marketing.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES: • Introduction to the pharmaceutical science and profession. • Social roles, tasks and competencies of pharmacists. • Role of pharmacists in primary healthcare. • Pharmaceutical marketing. • Pharmacognosy. Drugs of natural origin. • From active substance to drug formulation. • Analysis and control of medicines.
2.6. Type of instruction	**lectures** seminars workshops exercises online in entirety mixed *e*-learning mixed *m*-learning field work independent study multimedia and the internet work with the mentor (other)
2.7. Student responsibilities	Class attendance

<table>
<tr><td rowspan="7">2.8. 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)</td><td>Class attendance</td><td>0.5</td><td>Seminar essay</td><td></td></tr>
<tr><td>Experimental work</td><td></td><td>Oral exam</td><td></td></tr>
<tr><td>Essay</td><td></td><td>Project</td><td></td></tr>
<tr><td>Tests</td><td></td><td>Practical training</td><td></td></tr>
<tr><td>Written exam</td><td>1.0</td><td>(Other--describe)</td><td></td></tr>
<tr><td>Research</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>Report</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>2.9. Grading and evaluation of student work over the course of instruction and at a final exam</td><td colspan="4">Written exam</td></tr>
<tr><td rowspan="4">2.10. Required literature (available at the library and via other media)</td><td colspan="2">Title</td><td>Number of copies at the library</td><td>Availability via other media</td></tr>
<tr><td colspan="2">S. Vladimir-Knežević, R. Jurišić Grubešić, Ž. Vanić. Introduction to Pharmacy (teachers' materials)</td><td></td><td>The e-learning platform Merlin</td></tr>
<tr><td colspan="2"></td><td></td><td></td></tr>
<tr><td colspan="2"></td><td></td><td></td></tr>
<tr><td>2.11. Optional literature</td><td colspan="4">-</td></tr>
<tr><td>1.3. Methods of monitoring quality that ensure acquisition of exit competences</td><td colspan="4">All the outcomes are checked by written exam.</td></tr>
<tr><td>2.12. Comments</td><td colspan="4"></td></tr>
</table>

INTRODUCTION TO THE STUDY OF MEDICAL BIOCHEMISTRY

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Ass. prof. Marija Grdić Rajković, PhD
1.2. Associate teachers	Prof. Jozsef Petrik, PhD Prof. Roberta Petlevski, PhD Prof. Nada Vrkić, PhD Prof.Zlata Flegar-Meštrić, PhD
1.3. Graduate programme	Medical Biochemistry study programme
1.4. Status of the course	Compulsory
1.5. Year of study, Semester	1st
1.6. Credit value (ECTS)	1.5
1.7. Type of instruction (number of hours L+E+S+e-learning)	15+0+0
1.8. Expected enrolment in the course	25
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2
2. COURSE DESCRIPTION	
2.1. Course objectives	Students will acquire knowledge on the role of medical biochemist as a professional and a scientist in the health care system, as well as on study program, general goals and aims, study syllabus, interconnection between courses and type of learning objectives.
2.2. Enrolment requirements and required entry competences for the course	None.
2.3. Learning outcomes at the level of the study programme to which the course contributes	Course is an introduction into study program, so learning outcomes are not meant to contribute to any course in particular, rather to the awareness of the position and duties of the professionals with the degree in the health care system.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After completing the course students will be able to: 1. Outline basic characteristics of medical biochemistry as a profession and a science; 2. Recognize tasks and responsibilities of medical biochemist in the health care system; 3. Explain competencies and proficiencies of medical biochemists and distinguish acquired technical, organisational, information and research skills; 4. Describe principal study courses important for the profession; 5. Determine role of medical-biochemical laboratory in the primary health care and describe practical procedures on the pathway from prescription ordered by the MD to obtaining laboratory results by the patient.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES Medical biochemistry as a part of biomedical sciences. Students' rights and duties, Rules and regulations of the study. Syllabus of Medical biochemistry study programme. How laboratory work is organized, pathway from prescription ordered by the MD to obtaining laboratory results by the patient. Chronicle of profession and founding fathers of medical biochemistry in Croatia and Europe. Practical example of setting appropriate laboratory tests (students learning experiment).

	Student societies at the Faculty.			
2.6. Type of instruction	**lectures** seminars workshops exercises online in entirety mixed *e*-learning mixed *m*-learning		field work independent study multimedia and the internet work with the mentor (other)	
2.7. Student responsibilities	Regular class attendance			
2.8. 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	0,5	Seminar essay	
	Experimental work		Oral exam	
	Essay		Project	
	Tests		Practical training	
	Written exam	1,0	(Other--describe)	
	Research		(Other--describe)	
	Report		(Other--describe)	
2.9. Grading and evaluation of student work over the course of instruction and at a final exam	Achievements at the written exam.			

2.10. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**

2.11. Optional literature	
2.12. Methods of monitoring quality that ensure acquisition of exit competences	Learning outcomes are tested at the written exam.
2.13. Comments	

ISOLATION OF BIOACTIVE NATURAL PRODUCTS

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Professor Sanda Vladimir-Knežević, PhD; Assistant Professor Biljana Blažeković, PhD
1.2. Associate teachers	Higher Assistant Maja Bival Štefan, PhD; Assistant Marija Kindl, PhD
1.3. Graduate programme	Pharmacy integrated study program
1.4. Status of the course	Elective
1.5. Year of study, Semester	3rd, 6th
1.6. Credit value (ECTS)	2.5
1.7. Type of instruction (number of hours L+E+S+e-learning)	15 L +5 E + 10 S
1.8. Expected enrolment in the course	30
1.9. 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	Introduce the modern methods of bioactive natural products isolation in laboratory and industrial scales. Acquire basic knowledge and skills in natural product isolation. Understand the role of natural products in drug discovery, development and manufacturing. Introduce the modern medicines of natural origin derived from microorganisms, medicinal plants and animals as well as marine organisms.
2.2. Enrolment requirements and required entry competences for the course	Pharmacognosy 1 course completed.
2.3. Learning outcomes at the level of the study programme to which the course contributes	• Demonstration of observational, analytical and critical skills in development and implementation of practical problem solution in drug production process and drug control • Selection and application of technological processes and analytical methods and quality assurance in drug production process
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	Upon completion of this course, the student will be able to: 1. Define the most important modern drugs of natural origin 2. Define the basic principles of natural product isolation 3. Define the methods for identification of natural compounds 4. Understand and describe the basic methods / procedures for the extraction, separation and purification of bioactive natural compounds in laboratory and industrial scales 5. Apply the basic methods of natural product extraction and separation from the complex mixture in laboratory scale 6. Apply simple methods for authentication of isolated natural compounds.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES: • The role of bioactive natural products in drug discovery • Modern drugs of natural origin • Bioassay guided isolation of natural substances • Distillation techniques for isolation of volatile substances • Essential oil isolation • Volatile and non-volatile solvent extraction • Supercritical fluid extraction • Ultrasonic extraction • Microwave-assisted extraction • Separation methods for natural products • Application of chromatographic techniques in natural product isolation • Chemical characterization of natural products • The basic principles of isolation of flavonoids, cardiac glycosides, saponins and alkaloids.

<table>
<tr><td></td><td colspan="4">

Isolation of marine natural products
Modern bioassays in natural product research.

SEMINARS:

Continuous and discontinuous types of solvent extraction
Herbal extract procesing in laboratory and industrial scales (purification, concentrating and drying)
Separation of extracted bioactive natural products in laboratory scale
Isolation and authentication of digoxin, arbutin, rutin, hesperidin, aescin, chinine, hyosciamine and berberine.

EXERCISES:

Isolation of caffeine from Theae folium
Isolation of rutin from Sambuci flos.

</td></tr>
<tr><td>2.6. Type of instruction</td><td colspan="2">lectures
seminars
workshops
exercises
online in entirety
mixed e-learning
mixed m-learning</td><td colspan="2">field work
independent study
multimedia and the internet
work with the mentor
(other)</td></tr>
<tr><td>2.7. Student responsibilities</td><td colspan="4">Attending lectures, seminars and exercises.</td></tr>
<tr><td rowspan="8">2.8. 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)</td><td>Class attendance</td><td>0.2</td><td>Seminar essay</td><td></td></tr>
<tr><td>Experimental work</td><td>0.3</td><td>Oral exam</td><td>1</td></tr>
<tr><td>Essay</td><td></td><td>Project</td><td></td></tr>
<tr><td>Tests</td><td>1</td><td>Practical training</td><td></td></tr>
<tr><td>Written exam</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>Research</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>Report</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>2.9. Grading and evaluation of student work over the course of instruction and at a final exam</td><td colspan="4">Written and oral exams.</td></tr>
<tr><td rowspan="4">2.10. Required literature (available at the library and via other media)</td><td>Title</td><td colspan="2">Number of copies at the library</td><td>Availability via other media</td></tr>
<tr><td>S. Vladimir-Knežević: Lecture and seminar presentations; Exercises for the course „Bioactive Natural Product Isolation“</td><td colspan="2"></td><td>The e-learning platform Merlin</td></tr>
<tr><td>G. Samuelsson. Drugs of natural origin. A textbook of pharmacognosy. Svedish Pharmaceutical Press: Stockholm 2009.</td><td colspan="2">1</td><td></td></tr>
<tr><td></td><td colspan="2"></td><td></td></tr>
<tr><td>2.11. Optional literature</td><td colspan="4">Canell RJP. How to approach the isolation of a natural product. (https://catbull.com/alamut/Bibliothek/How_to_Approach_the_Isolation_of_a_Product.pdf)</td></tr>
<tr><td>2.12. Methods of monitoring quality that ensure acquisition of exit competences</td><td colspan="4">Learning outcomes are validated through written and oral exams.</td></tr>
<tr><td>2.13. Comments</td><td colspan="4"></td></tr>
</table>

LABORATORY INFORMATICS

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Prof. Nada Vrkić, PhD
1.2. Associate teachers	Asisstant prof. Mario Štefanović, PhD Nora Nikolac, PhD Ivana Ćelap, BSc
1.3. Graduate programme	Pre diplomic
1.4. Status of the course	Elective
1.5. Year of study, Semester	5th (10th semester)
1.6. Credit value (ECTS)	2.5
1.7. Type of instruction (number of hours L+E+S+e-learning)	15+5+10
1.8. Expected enrolment in the course	20
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	
2. COURSE DESCRIPTION	
2.1. Course objectives	• To introduce possibilities of information technology to the students • qualify students to independently use information technology in the needs of modern laboratories in everyday professional and scientific work
2.2. Enrolment requirements and required entry competences for the course	9th semester enrolled
2.3. Learning outcomes at the level of the study programme to which the course contributes	The knowledge and competence in information technologies in order to achieve self-reliance and use of information technology adaptive to individual needs, the needs of the working process and self-help in everyday work. To qualify students to the expansion and improvement of knowledge through further self-education.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	
2.5. Course content broken down in detail by weekly class schedule (syllabus)	**1. Introduction to Computer Science (4h P + S + 4h 2h V)** a. hardware / software components (computer architecture) b. Operating Systems • MS-DOS, Windows (XP, 7, 8, 10), Unix, Linux, MacOS, Android, Java ... • The operating system, security, data transfer between devices, file share, hidden items, extensions c. Information systems and its components, computer network • server, firewall, switch, computer networking, IP addresses, WiFi, Bluetooth, connectivity devices, telephone, analyzers • Remote secure access to a computer (VPN, remote desktop connection, TeamViewer) d. Data protection • Restrictions of the user rights • Backup, archiving • Antivirus and anti-spyware programs **2. Informatics software (4h P + S + 4h 2h V)** • Text processors (MS Word, Notepad, Open Office), styles, formatting, tables, images, track changes, captions, references, index terms, table of content • spreadsheets (MS Excel: calculation formulas, pivot tables, filter, sort, charts, custom printing tables, links, import / export) • Presentation Software (MS Power Point presentation design, sketching drawings, formatting) • Databases (Introduction to Databases, relations, types of databases, MS SQL, MySQL, MS Access, etc.).

	3. Internet, e-mail (2h P + S + 1h 1h V) a. Internet domain and opening domain, Internet addresses, Internet security b. Creating and setting up websites, FTP access, types of websites, platforms (static, dynamic website, htm, php, asp), CMS, basic HTML commands c. Principles of search keywords, wildcards, advanced Google search, online databases (OVID, PubMed, SCI) d. Communication applications (Skype), teleconferencing **4. Information Systems in Healthcare (2h P)** a. The data in the primary health care (electronic medical records, e-card) b. Integrated health information system; Medical Classification (ICD) c. CIHI master data of the patient, additional insurance, social security numbers, identification of the insured, Internet access services) d. Calculation of laboratory services, billing system, prospective payment system, DTP, DTS . **5. Computerisation Laboratory (2h P + 1h S)** a. Laboratory Information System, Hospital Information System b. Computer support and monitoring of laboratory accreditation process **6. Evidence based medicine, medical and scientific resources on the Internet, telemedicine (1h P)**

2.6. Type of instruction	**lectures** **seminars** **workshops** **exercises** online in entirety mixed *e*-learning mixed *m*-learning	field work independent study multimedia and the internet work with the mentor (other)

2.7. Student responsibilities	Attend lectures, seminars and exercises.			
2.8. 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	0.5	Seminar essay	
	Experimental work		Oral exam	1
	Essay		Project	
	Tests		Practical training	
	Written exam	1	(Other--describe)	
	Research		(Other--describe)	
	Report		(Other--describe)	
2.9. Grading and evaluation of student work over the course of instruction and at a final exam	Oral exam, Written exam			

2.10. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	Lectures, scripts and additional materials will be available online		YES

2.11. Optional literature	1. http://www.dummies.com/how-to.html - Online tečajevi 2. eJHI- electronic Journal of Health Informatics (open access journal) 3. O'Donoghue, John, et al. "Modified early warning scorecard: the role of data/information quality within the decision making process." Electronic Journal Information Systems Evaluation Volume 14.1 (2011). 4. "35.240.80: IT applications in health care technology". ISO. Retrieved 2008-06-15.

	5. Bates, D. W. (2000). Using information technology to reduce rates of medication errors in hospitals. British Medical Journal. 320 (7237), 788-791. doi:10.1136/bmj.320.7237.788 6. Haux, Reinhold (2010). "Medical informatics: Past, present, future". International journal of medical informatics 79 (9):599-610. doi:10.1016/j.ijmedinf.2010.06.003.PMID 20615752.
2.12. Methods of monitoring quality that ensure acquisition of exit competences	Outcomes 1-3 by written examination, the results of 4-5 by seminar classes
2.13. Comments	

LABORATORY POINT-OF-CARE TESTING

1. COURSE DECRIPTION – GENERAL INFORMATION				
1.1. Course teacher	assoc prof Dunja Rogić, PhD			
1.2. Associate teachers	Ivana Baršić, spec. in med. biochemistry and lab. medicine			
1.3. Graduate programme	integrated study of medical biochemistry			
1.4. Status of the course	elective			
1.5. Year of study, Semester	5th year, 9th semester			
1.6. Credit value (ECTS)	1.5			
1.7. Type of instruction (number of hours L+E+S+e-learning)	6+6+3			
1.8. Expected enrolment in the course	10-15			
1.9. 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	The course is designed to introduce the student to the principles of organization and implementation of point-of-care laboratory testing (POCT)			
2.2. Enrolment requirements and required entry competences for the course	Enrolment requirement: audited course: Special Areas of Clinical Biochemistry			
2.3. Learning outcomes at the level of the study programme to which the course contributes	Application of observational, analytical and critical skills in development and implementation of solutions for practical isues in POCT diagnostics			
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After passing this course exam, students will be able to: 1) define the significance of POCT in the context of health care improvement 2) list possible point-of-care laboratory tests 3) describe common characteristics of POC tests 4) have knowledge of the organization of the POCT service in clinical institutions, and of the role of a medical biochemist.			
2.5. Course content broken down in detail by weekly class schedule (syllabus)	Lectures and seminars: - Historical development of POCT; the purpose and reason for its implementation, cost-benefit analysis. Correlation of different types of outcomes with POCT introduction, possibilities of health care improvement through POCT. - Biochemistry, hematology and coagulation tests that may be performed as POCT. - Technological solutions regarding instruments. Basic common characteristics of POCT technologies. Manipulation and technical maintenance of instruments, analytical quality control. - Education of clinical staff for POCT implementation. Importance of preanalytical procedures. POCT in primary health care. - Organization of POCT service in clinical institutions. Central supervision of networked instruments - advantages and shortcomings. The role of a medical biochemist as a consultant. POC tests as a link between laboratory professionals and clinicians.			
2.6. Type of instruction	lectures seminars workshops exercises online in entirety mixed *e*-learning mixed *m*-learning		field work independent study multimedia and the internet laboratory work with the mentor (other)	
2.7. Student responsibilities	Regular attendance and active participation in classes.			
2.8. Screening	Class attendance	0.5	Seminar essay	

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)	Experimental work		Oral exam	
	Essay		Project	
	Tests		Practical training	
	Written exam	1	(Other--describe)	
	Research		(Other--describe)	
	Report		(Other--describe)	
2.9. Grading and evaluation of student work over the course of instruction and at a final exam	Student's activity is evaluated over the course of instruction. Final grade is determined on the basis of achievement in the written exam.			

2.10. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	Baršić I, ur. Pretrage uz bolesnika - izazov za laboratorijsku medicinu. Zagreb: Medicinska naklada i Hrvatska komora medicinskih biokemičara, 2016.		
	Čvorišćec D, Čepelak I, editors. Štrausova medicinska biokemija. Zagreb: Medicinska naklada, 2009.		

2.11. Optional literature	Strandberg K, Thamlitz R, Simonsson P. A systematic approach to point-of-care blood gas analyses - the Malmo experience. Point-of-care 2003;2:220-224. NACB Laboratory Medicine Practice Guidelines: Evidence-based practice for POCT. The National Academy of Clinical Biochemistry Published Laboratory Medicine Practice Guidelines: Homepage: www.aacc.org
2.12. Methods of monitoring quality that ensure acquisition of exit competences	Outcomes are tested through written exam.
2.13. Comments	

MAGISTRAL PRESCRIPTION FORMULATION

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Associate Professor Željka Vanić, PhD Associate Professor Mario Jug, PhD
1.2. Associate teachers	Zora Rukavina, MPharm Marina Juretić, MPharm Sabina Keser, MPharm
1.3. Graduate programme	Pharmacy
1.4. Status of the course	Obligatory course
1.5. Year of study, Semester	4th year, 8th semester
1.6. Credit value (ECTS)	4.5
1.7. Type of instruction (number of hours L+E+S+e-learning)	0+40+5+0
1.8. Expected enrolment in the course	130
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2nd level
2. COURSE DESCRIPTION	
2.1. Course objectives	Students will gain expert knowledge and skills related to magistral prescriptions, compounding, packaging, labelling and dosage control, while respecting the current legal framework, health policy and guidelines, and professional ethical principles in community and hospital pharmacy. This course will provide bases for: Student practice II, Pharmaceutical care and Professional Training for Pharmacists
2.2. Enrolment requirements and required entry competences for the course	Enrolment: Drug formulation-completed lecturers and laboratory Requirement for exam: Drug formulation-passed examination
2.3. Learning outcomes at the level of the study programme to which the course contributes	• Professional skills in recognizing and avoiding of clinically significant prescription errors and interactions with pharmaceuticals in prescription pharmacy • Application of expert knowledge and skills in preparation of personal medicine by applying the rules of good laboratory and manufacturing practice, as well as relevant European and ISO directives. • Application of expert knowledge and skills to provide patient advice on proper administration of drugs
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After completing this course the student will be able to: 1. Define magistral prescription formulations and describe good dispensing practices and related legislation. 2. Analyze the validity of magistral prescription with respect to dosing and pharmaceutically relevant interactions and its compliance with legal framework, health policy and guidelines as well as with relevant European and ISO directives. 3. Dispense personal medications, packed in suitable containers appropriately labelled according to the rules of good laboratory and dispensing practices, as well as advice patients regarding the proper drug usage. 4. To list and describe basic principles regarding the dosage regimens adjustments to individual patient needs (age, body weight, pathology), as well as regarding the preparation of compounded products by customization

<table>
<tr><td></td><td colspan="4">of commercially available drug products.</td></tr>
<tr><td>2.5. Course content broken down in detail by weekly class schedule (syllabus)</td><td colspan="4"><u>Seminars:</u>
• Principles of pharmacy practise, magistral prescriptions, compounding, dispensing, dosing, legal framework
• Magistral drug dosage forms
• Calculation in magistral formulation
• Dosology
• Individualization of drug therapy - dosage regimens adjustments to individual patient needs (age, body weight, pathology) and preparation of compounded products from commercially available drugs.
<u>Laboratory:</u>
• Powders
• Ointments
• Liquid oral dosage forms
• Admixtures and veterinary drug formulations
• Drops for ophthalmic, nasal, otic and oral applications</td></tr>
<tr><td>2.6. Type of instruction</td><td colspan="2">lectures
<u>seminars</u>
workshops
<u>exercises</u>
online in entirety
mixed e-learning
mixed m-learning</td><td colspan="2">field work
independent study
multimedia and the internet
laboratory
work with the mentor
(other)</td></tr>
<tr><td>2.7. Student responsibilities</td><td colspan="4">Regular seminar attendance and completed laboratory exercises</td></tr>
<tr><td rowspan="8">2.8. 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)</td><td>Class attendance</td><td>0.5</td><td>Seminar essay</td><td></td></tr>
<tr><td>Experimental work</td><td></td><td>Oral exam</td><td></td></tr>
<tr><td>Essay</td><td></td><td>Project</td><td></td></tr>
<tr><td>Tests</td><td></td><td>Practical training</td><td>3</td></tr>
<tr><td>Written exam</td><td>1</td><td>(Other--describe)</td><td></td></tr>
<tr><td>Research</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>Report</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>2.9. Grading and evaluation of student work over the course of instruction and at a final exam</td><td colspan="4">Monitoring and evaluation of experimental work and final test.</td></tr>
<tr><td rowspan="2">2.10. Required literature (available at the library and via other media)</td><td colspan="2">Title</td><td>Number of copies at the library</td><td>Availability via other media</td></tr>
<tr><td colspan="2">R. Senjković, V. Petričić, M. Bećirević, Oblikovanje lijekova (praktikum), Liber, Zagreb, 1997.</td><td>0</td><td>Merlin, e-learning system</td></tr>
<tr><td>2.11. Optional literature</td><td colspan="4">Bećirević Laćan, Mira; Begović-Dolinić, Vlasta; Buhač, Ines; Colnago, Franjka; Jurišić, Blaženka; Medić-Šarić, Marica; Nevečerel, Mirjana; Smolčić-Bubalo, Asja; Šušteršić, Tanja; Vrsalović, Mirjana, Formulae Magistrales Croaticae, Hrvatska ljekarnička komora, Zagreb, 2010.</td></tr>
<tr><td>2.12. Methods of monitoring quality that</td><td colspan="4">Assessment of learning outcomes by evaluation of practical work in laboratory</td></tr>
</table>

ensure acquisition of exit competences	(learning outcome 3) as well as by evaluation of written examination (learning outcomes 1-4); Analysis of assessment results to improve the quality of teaching.
2.13. Comments	

MEDICINAL CHEMISTRY – SELECTED TOPICS

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Assistant Professor Ivana Perković, PhD
1.2. Associate teachers	Professor Branka Zorc, PhD Associate Professor Zrinka Rajić Džolić, PhD
1.3. Graduate programme	Integrated study of pharmacy
1.4. Status of the course	elective
1.5. Year of study, Semester	4th year, 7th semester
1.6. Credit value (ECTS)	2,5
1.7. Type of instruction (number of hours L+E+S+e-learning)	15+0+15
1.8. Expected enrolment in the course	60
1.9. 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	The course intends to give students insight into the drug development and to view medicinal chemistry in a broader context. During the course the students learn about all phases of drug development process (from idea to the market) with the emphasis on the importance of the pharmacokinetics, pharmacodynamics and metabolism in relation to the development of new drugs as well as the basics of combinatorial and parallel synthesis. Students will learn about the concept of prodrugs and targeted therapeutics.
2.2. Enrolment requirements and required entry competences for the course	Enrolment requirements: enrolment in 7th semester , finished lectures: Medicinal Chemistry 2. Required entry competences for the course: knowledge about therapeutic classes of drugs obtained in Medicinal chemistry 1 and 2 (structure, activity and mechanism of action)
2.3. Learning outcomes at the level of the study programme to which the course contributes	**Expert knowledge on the development of pharmaceuticals:** apply knowledge in Medicinal chemistry to define, analyse and propose procedures related to the research, development and production **Pharmaceutical care of patients:** work as part of a health care team to provide appropriate care to patients, including informing and advising patients on the effects and proper application of pharmaceuticals, as well as monitoring the treatment course and outcomes, with emphasis on prodrugs/target specific drugs.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After completion of the course the student is expected to be able to: 1. Demostrate familiarity with the drug development process (from idea to the market) 2. Apply the principles for interactions between small molecules and biological macromolecules to predict binding interactions 3. Understand the importance of screening and the difference between in vitro and in vivo assays 4. Explain the importance of pharmacokinetics, pharmacodynamics and metabolism in relation to the development of new drugs 5. Explain the basic principles of solid phase synthesis 6. Understand the principles of targeted therapy 7. Define methods for the preparation of prodrugs 8. Seek relevant information in relation to the problem. 9. Demonstrate the capacity to read and understand relevant scientific papers and present them in a power point presentation to their fellow students.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES: Drug discovery: finding a lead Drug design: optimizing target interactions

	Drug design: optimizing access to the target Getting the drug to market Nomenclature Prodrugs Combinatorial and parallel synthesis Targeted therapeutics SEMINARS: Students present the data from scientific papers given by the teacher (Nature Reviews Drug Discovery and other) to their fellow students

2.6. Type of instruction	**lectures** **seminars** workshops exercises online in entirety mixed *e*-learning mixed *m*-learning	field work **independent study** multimedia and the internet work with the mentor (other)
2.7. Student responsibilities	Students are expected to be present on lectures and seminar. On seminars students are expected to present the data from scientific papers to their fellow students.	

2.8. 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	0,5	Seminar essay	0,5
	Experimental work		Oral exam	1
	Essay		Project	
	Tests		Practical training	
	Written exam	0,5	(Other--describe)	
	Research		(Other--describe)	
	Report		(Other--describe)	

2.9. Grading and evaluation of student work over the course of instruction and at a final exam	Evaluation of presented seminars. Grading of written and oral exams.

2.10. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	Zrinka Rajić Džolić: Selected topics from medicinal chemistry, internal script		Available at the Department of Medicinal chemistry for photocopy or at Merlin

2.11. Optional literature	Graham L. Patrick, An Introduction to Medicinal Chemistry", 5th Ed. ISBN-10: 0199697396 - ISBN-13: 978-0199697397
2.12. Methods of monitoring quality that ensure acquisition of exit competences	Learning outcomes 1-7 are evaluated by written and oral exams and outcome 8,9 during seminar presentation.
2.13. Comments	

MEDICINAL CHEMISTRY 1

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Associate Professor Zrinka Rajić Džolić, PhD
1.2. Associate teachers	Professor Branka Zorc, PhD Assistant Professor Monika Barbarić, PhD Kristina Pavić, MPharm. Hrvoje Rimac, MPharm. Maja Beus, MPharm.
1.3. Graduate programme	Pharmacy
1.4. Status of the course	Obligatory
1.5. Year of study, Semester	3rd year, 5th semester
1.6. Credit value (ECTS)	9
1.7. Type of instruction (number of hours L+E+S+e-learning)	45+60+7
1.8. Expected enrolment in the course	130
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2
2. COURSE DESCRIPTION	
2.1. Course objectives	For each therapeutic class described in Medicinal Chemistry 1, the student will have knowledge of: (1) General structural features of agents belonging to the therapeutic class (2) Relevant physicochemical properties (3) Relevant chemical reactions/synthetic pathways for selected drugs (4) Structural influences on mechanism of pharmacologic action (structure-activity relationship) (5) Structural influences on pharmacologic/toxicological/therapeutic profiles. The gained knowledge is the basis for the following courses: Medicinal chemistry 2, Drug Metabolism, Pharmacology and Pharmaceutical Analysis.
2.2. Enrolment requirements and required entry competences for the course	Enrolment requirements: Organic Chemistry passed Required entry competences for the course: knowledge of Organic Chemistry
2.3. Learning outcomes at the level of the study programme to which the course contributes	• Knowledge of the connection between the structural features of the drugs and their physico-chemical characteristics, mechanism of action and use. • Application the gained knowledge about the terapeutic classes of drugs. • Counseling and giving information to patiens about the drug action.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	Student will be able to: 1) recognize the drug structure and predict its pharmacologic action 2) recognize the drug physico-chemical and stereochemical features 3) determine the pharmacophore 4) describe the mechanism of action, use and mode of application of the selected drugs on the basis of their structure 5) describe and perform synthesis of the drugs and determine the reaction yield.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	Lectures: • Introduction to Medicinal Chemistry. • Drug discovery and development • Drugs for the therapy of anemia and iron chelators • Calcium salts and osteoporosis therapy • Diagnostic agents • Acidotic and alcalotic agents • Drugs acting on gastrointestinal tract (Digestives; Antiflatulent agents;

	Adsorbent agents, Antidiarrhoic agents; Laxatives; Acida, Antacids, Anti-ulcer agents – H_2 antagonists and proton pump inhibitors) • Antiallergic drugs (H_1 inverse agonists) • Anticancer agents (Introduction, Drugs acting directly on nucleic acids; Drugs acting on enzymes: antimetabolites; Hormone-based therapies; Drugs acting on structural proteins; Inhibitors of signalling pathways; Miscellaneus enzyme inhibitors; Miscellaneus anticancer agents; Photodynamic therapy) • Immunomodulatory drugs • Antiseptics and Desintectants • Antiviral agents (Introduction, Antiviral agents which act against DNA viruses; Antiviral agents which act against RNA viruses: HIV, flu virus and hepatitis C; Miscellaneous agents) • Antibacterial agents (synthetic antibacterials and antibiotics) – introduction • Synthetic antibacterials (Quinolones and fluoroquinolones; Nitroheteroaromatic agents; Sulphonamides, Metenamine) • Antibiotics (β-lactam antibiotics; penicillins; cephalosporins, β-lactamase inhibitors, oxacephems,carbapenems, monobactams; Different antibiotics which inhibit cell wall synthesis; Antibiotics which act on the plasma membrane structure; Antibiotics which inhibit protein synthesis; Miscellaneous antibiotics) • Antimycobacterial agents • Antifungal agents • Antiparazitic agents (antiprotozoal agents, anthelmintics, scabicides and pediculocides) Seminars: • Development of H_2 antagonists as anti-ulcer drugs • Drug synthesis: stoichiometry and the reaction mechanisms Laboratory exercises: • Acetylsalicylic acid • Benzocaine • Phenytoin • Caffeine • Hydrochlorothiazide • Bismuth subgallate • Sodium chloride • Calcium carbonate • Azithromycine • Dicumarol • Nicotinamide • Diethyl ether • Stereochemistry • Ascorbic acid • Quinine	
2.6. Type of instruction	lectures x seminars x workshops exercises x online in entirety mixed *e*-learning mixed *m*-learning	field work independent study multimedia and the internet work with the mentor (other)
2.7. Student responsibilities	Regulary class attendance (lectures, seminars and laboratory excersizes), the passed	

<table>
<tr><td></td><td colspan="5">test after laboratory exercizes.</td></tr>
<tr><td rowspan="7">2.8. 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)</td><td>Class attendance</td><td>2.5</td><td>Seminar essay</td><td colspan="2"></td></tr>
<tr><td>Experimental work</td><td></td><td>Oral exam</td><td colspan="2">3</td></tr>
<tr><td>Essay</td><td></td><td>Project</td><td colspan="2"></td></tr>
<tr><td>Tests</td><td>0.5</td><td>Practical training</td><td colspan="2"></td></tr>
<tr><td>Written exam</td><td>3</td><td>(Other--describe)</td><td colspan="2"></td></tr>
<tr><td>Research</td><td></td><td>(Other--describe)</td><td colspan="2"></td></tr>
<tr><td>Report</td><td></td><td>(Other--describe)</td><td colspan="2"></td></tr>
<tr><td>2.9. Grading and evaluation of student work over the course of instruction and at a final exam</td><td colspan="5">After the laboratory exercises students take the test.
The passed test is the condition for the written exam.
The passed written exam is the condition for the oral exam.</td></tr>
<tr><td rowspan="4">2.10. Required literature (available at the library and via other media)</td><td colspan="2">Title</td><td>Number of copies at the library</td><td colspan="2">Availability via other media</td></tr>
<tr><td colspan="2"></td><td></td><td colspan="2"></td></tr>
<tr><td colspan="2"></td><td></td><td colspan="2"></td></tr>
<tr><td colspan="2"></td><td></td><td colspan="2"></td></tr>
<tr><td>2.11. Optional literature</td><td colspan="5"></td></tr>
<tr><td>2.12. Methods of monitoring quality that ensure acquisition of exit competences</td><td colspan="5">1. Thomas L. Lemke, David A. Williams, Victoria F. Roche, S. William Zito, Foye's Principles of Medicinal Chemistry, 7th Ed.,Lippincott Williams & Wilkins, 2012 (30 copies in the library).
2. Graham L. Patrick, "An Introduction to Medicinal Chemistry", 5th Ed. Oxford University Press 2013.</td></tr>
<tr><td>2.13. Comments</td><td colspan="5">Learning outcomes 1-4 are checked by the written and oral exam, while learning outcome 5 is checked by the test after the laboratory exercises.</td></tr>
</table>

MEDICINAL CHEMISTRY 2

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Professor Branka Zorc, PhD
1.2. Associate teachers	Associate Professor Zrinka Rajić Džolić, PhD Kristina Pavić, MPharm. Maja Beus, MPharm.
1.3. Graduate programme	Pharmacy
1.4. Status of the course	Obligatory
1.5. Year of study, Semester	3rd year, 6th semester
1.6. Credit value (ECTS)	5
1.7. Type of instruction (number of hours L+E+S+e-learning)	45+0+8
1.8. Expected enrolment in the course	130
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2
2. COURSE DESCRIPTION	
2.1. Course objectives	For each therapeutic class described in Medicinal Chemistry 2, the student will have knowledge of: (1) General structural features of agents belonging to the therapeutic class (2) Relevant physicochemical properties (3) Relevant chemical reactions/synthetic pathways for selected drugs (4) Structural influences on mechanism of pharmacologic action (structure-activity relationship) (5) Structural influences on pharmacologic/toxicological/therapeutic profiles. The gained knowledge is the basis for the following courses: Drug Metabolism, Pharmacology and Pharmaceutical Analysis.
2.2. Enrolment requirements and required entry competences for the course	Enrolment requirements: Organic Chemistry passed Required entry competences for the course: knowledge of Organic Chemistry
2.3. Learning outcomes at the level of the study programme to which the course contributes	• Knowledge of the connection between the structural features of the drugs and their physico-chemical characteristics, mechanism of action and use. • Application the gained knowledge about the terapeutic classes of drugs. • Counseling and giving information to patiens about the drug action.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	Student will be able to: 1) recognize the drug structure and predict its pharmacologic action 2) recognize the drug physico-chemical and stereochemical features 3) determine the pharmacophore 4) describe the mechanism of action, use and mode of application of the selected drugs on the basis of their structure 5) describe and perform synthesis of the drugs and determine the reaction yield.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	Lectures: Introduction to Medicinal Chemistry Drug Affecting the Central Nervous System: General anesthetics, Local anesthetics, Analgesics (Opiates and related analgesics, Nonsteroidal antiinflammatory drugs), Antitussives, Hypnotics, Anticonvulsant/antiepileptic agents, Antiparkinson drugs, Antipsychotic drugs, Antidepressants, Anxiolytic agents, Central nervous system stimulants, Alcoholism therapy Drug Affecting the Peripheral Nervous System: Biochemical aspects of chemical neurotransmission, Chemical neurotransmitters Drugs affecting cholinergic neurotransmission (cholinergic agonists, cholinergic antagonists, acetylcholinesterase inhibitors, neuromuscular blocking agents) Adrenergic drugs (Adrenergic agonists, Adrenergic antagonists, Drugs affecting

<table>
<tr><td></td><td colspan="4">norepinephrine/epinephrine biosynthesis, Drug affecting storage vesicles, Bronchodilators)
Other Therapeutic Classes:
Antihypertensive drugs, Diuretics, Antianginals, Cholesterol, Antilipidemic drugs, Bile acids, Cardiac glycosides, Antiarrhytmic drugs, Anticoagulants, Coagulants, Fibrinolytics, Antipsoriatic drugs, Antidiabetic drugs, Adrenocorticoids, Sex Hormons, Thyroid Drugs, Vitamins and coenzymes

SEMINARS:
Peptidomimetics, insulin, erythropoetin, melatonin, antidepressants, introduction to drug discovery, vitamin k, photodynamic therapy, doping in sport, q10, glucosamine, therapy of alopecia</td></tr>
<tr><td>2.6. Type of instruction</td><td colspan="2">lectures x
seminars x
workshops
exercises x
online in entirety
mixed e-learning
mixed m-learning</td><td colspan="2">field work
independent study
multimedia and the internet
work with the mentor
(other)</td></tr>
<tr><td>2.7. Student responsibilities</td><td colspan="4">Regulary class attendance (lectures, seminars and laboratory excersizes), the passed test after laboratory exercizes.</td></tr>
<tr><td rowspan="8">2.8. 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)</td><td>Class attendance</td><td>0.5</td><td>Seminar essay</td><td>1</td></tr>
<tr><td>Experimental work</td><td></td><td>Oral exam</td><td>2</td></tr>
<tr><td>Essay</td><td></td><td>Project</td><td></td></tr>
<tr><td>Tests</td><td></td><td>Practical training</td><td></td></tr>
<tr><td>Written exam</td><td>1.5</td><td>(Other--describe)</td><td></td></tr>
<tr><td>Research</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>Report</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>2.9. Grading and evaluation of student work over the course of instruction and at a final exam</td><td colspan="4">After the laboratory exercises students take the test.
The passed test is the condition for the written exam.
The passed written exam is the condition for the oral exam.</td></tr>
<tr><td rowspan="4">2.10. Required literature (available at the library and via other media)</td><td colspan="2">Title</td><td>Number of copies at the library</td><td>Availability via other media</td></tr>
<tr><td colspan="2">Branka Zorc: Farmaceutska kemija, odabrana poglavlja</td><td>20</td><td></td></tr>
<tr><td colspan="2">Branka Zorc: Farmaceutska kemija (lectures, pdf)</td><td></td><td></td></tr>
<tr><td colspan="2"></td><td></td><td></td></tr>
<tr><td>2.11. Optional literature</td><td colspan="4"></td></tr>
<tr><td>2.12. Methods of monitoring quality that ensure acquisition of exit competences</td><td colspan="4">1. Thomas L. Lemke, David A. Williams, Victoria F. Roche, S. William Zito, Foye's Principles of Medicinal Chemistry, 7th Ed.,Lippincott Williams & Wilkins, 2012 (30 copies in the library).
2. Graham L. Patrick, "An Introduction to Medicinal Chemistry", 5th Ed. Oxford University Press 2013.</td></tr>
<tr><td>2.13. Comments</td><td colspan="4">Learning outcomes 1-4 are checked by the written and oral exam, while learning outcome 5 is checked by the test after the laboratory exercises.</td></tr>
</table>

NAME OF COURSE MEDICINAL CHEMISTRY

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Assoc. Professor, Milena Jadrijević-Mladar Takač, PhD
1.2. Associate teachers	-
1.3. Graduate programme	Integrated study of pharmacy
1.4. Status of the course	Elective
1.5. Year of study, Semester	5th Year, 9th Semester
1.6. Credit value (ECTS)	3.5
1.7. Type of instruction (number of hours L+E+S+e-learning)	30L + 15S + e-learning
1.8. Expected enrolment in the course	20
1.9. 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. pharmacological	The primary objective of Pharmaceutical chemistry in the Integrated study of pharmacy is to introduce students to the major concepts of medicinal chemistry that support research, development and clinical use of medicine, the design and the application of pro-drugs, structural and physico-chemical properties relevant to the pharmacological effects (SAR) and side effects (ADRs) of drugs in clinical use. Throughout the introduction to the main therapeutic groups and their subgroups students will gain knowledge about chemistry, pharmacological effects, side effects and indications of the most important medicines that are in clinical use.
2.2. Enrolment requirements and required entry competences for the course	Attended Organic chemistry as well as the basic knowledge in organic and inorganic chemistry, cell biology, physiology, anatomy and biochemistry are needed.
2.3. Learning outcomes at the level of the study programme to which the course contributes	Basic knowledge of pharmaceutical aspects of medicines that are in clinical use and mechanisms of diseases caused by medicines will be of benefit to students which will be employed after graduation in research and development (R&D) in pharmaceutical compnies. This knowledge will also contributes in preparing students for their counseling role to patients in health care system as well as to their positive interactions not only with patients, but also with health care and other professionals in the health care system.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After passing the course, students will be able to: o know the most relevant therapeutic groups of medicines and the classification within each group, o recognise the chemical structure and the functional moieties relevant to pharmacological and side effects of certain medicines, o know the mechanisms of pharmacological effect and side effects of medicines from the most important therapeutic groups, o identify medicines that can induce toxic effects and diseases, and o use acquired knowledge in other similar disciplines of the course.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	Part I - Introduction to medicinal chemistry: Historical background and development. Drugs. Drug classification. Drug use. Rp and OTC drugs. New drug R&D methodologiess. Structure Activity Relationship (SAR). Adverse Drug Reactions (ADRs) Part II - Drugs in therapy for disturbances of water, electrolyte and acid/base regulation. Acids. Bases; Drugs used in gastrointestinal disorders: Antacids. Antiemetics. Antiulcer drugs. Antidiarrheal drugs. Laxatives. Contrast media: Radioactive isotopes in medical diagnosis, contrast imaging agents. Part III - Plasma blood substituents and plasma expanders; Antianemia drugs; Drugs in prevention and therapy of infective diseases: Antiseptics. Disinfectants. Preservatives. Acids, esters and phenole dermatological products. Urinary tract antiseptics. Antibacterial drugs: 1st generation of gyrase inhibitors, older drugs; 2nd

	generation of gyrase inhibitors, newer drugs – fluoroquinolone antibiotics. Sulfonamides and related drugs. History. Pro-drug approach development. Chemistry and mechanism of action. Sulfonamides classification. Combined sulfonamides. Indications and clinical use. Sulfones. Indication, clinical use and ADRs. Part IV - Antibiotics: Introduction. Beta-lactam antibiotics and other cell wall synthesis inhibitors: 1 Penicillins – chemistry and mechanism of action. Biosynthesis. Stability. Classification. Indications and clinical use. Side effects. Propenicillins. Therapeutic combinations. Suicide antibiotics; 2. Cephalosporins. Chemistry and mechanism of action. Indication, clinicl use and ADRs. Pro-drugs; 3. Carbapenems. 4. Monobactams; and Glycopeptide antibiotic (vancomycin) and other cell wall synthesis inhibitors (daptomycin, fosfomycin, bacitracin, cycloserin) Part V - Bacterial protein synthesis inhibitors: Chloramphenicol. Tetracyclines. MLSK antibiotics. Macrolides: erythronolides (erythromycin and congeners), azalides (azithromycin). Lincosamides. Streptogramins. Ketolides; Aminoglycosides: Streptomicyn group. Neomycin group. Kanamycin-Gentamycin group. Structural features. Chemistry. Indication and clinical use. Side effects. Rifamycins. Pyranoside antibiotics. Antibiotics with peptide structure. Glycopeptides. Fosfomycin. Antituberculotics: 1st line and 2nd line. Chemistry and mechanism of actions. Indication, clinical use and ADRs. Part VI - Antimycotics: polyene antibiotics, griseofulvin and synthetic antimycotics. Chemotherapy of protozoal diseases: Antimalarial drugs. Antitripanosomal drugs. Drugs against leichmaniases, trichomoniasis, amebiasis and toxoplasmosis. Anthelmintic drugs. Structural features and classification. Indication, clinical use and ADRs. Part VII - Antiviral drugs: The most common viral infections. Chemotherapy of viral diseases. Classification of antiviral drugs. Chemistry and mechanisms of action. Indication, clinical use and ADRs. HIV Chemotherapy. Interferons. Cytokins. Part VIII - Anticancer Drugs (Antineoplastics): Chemotherapy of malignant tumors. Drug classification. Chemistry and mechanism of action. Indication, clinical use and ADRs. Hormons and hormon antagonists in antineoplastic therapy. Part IX – NSAIDs, acetaminophen and drugs used in rheumatoid arthritis and gout: Pain and chemotherapy of pain. Classification of NSAIDs. COX-1 and COX-2 isoenzyme inhibition. Chemistry and mechanism of action. SAR. Indication, clinical use, ADRs; Antirheumatics. Gout therapy. Opioid analgesics: agonists and antagonists. Addiction. Toxicity. Indication, clinical use and ADRs. Antitussives. Antimigraine drugs; Anesthetics: general and local. Part X – Drugs that act in central nervous system: Muscle relaxants (spasmolytics, CNS acting) and non-centrally acting neuromuscular blokers. Antiepileptics. Chemistry. Classification. Antiparkinsonian drugs (centrally-active anticholinergics, L-dopa, ergot alkaloids). Sedative-hypnotic drugs. Neuroleptics (Major tranquilizers, Antipsyhotics). Antidepressants. Tranquilizers (Minor tranquilizers or ataractics). Psychotropics (Stimulants or Psychoanaleptics). Drugs of abuse. Psychodysleptics (Psycholytics, Psychotomimetics or Hallucinogens). Chemistry and mechanism of action. QSAR. Indications, clinical use and ADRs. Part XI – Autonomic nerve system drugs. Drugs affecting the parasympathetic nervous system: Cholinoreceptor-activating (direct) and cholinesterase-inhibiting drugs (indirect); Cholinoreceptor blockers and cholinesterase regenerators. Classification. Chemistry and mechanism of action. Indication, clinical use and ADRs. Drugs affecting the symphatetic nervous system: sympathomimetics, adrenoreceptor

	blockers and antisympathetic agents. Part XII - Cardiovascular drugs: Antihypertensives (direct, centrally-acting, beta blockers, alpha-1 blockers, ACE inhibitors, calcium channel blockers, ganglioblockers). Diuretics (thiazides, sulfonamides, LOOP diuretics, carbonic anhydrase inhibitors, osmotic diuretics). Drugs used in treatment of angina pectoris, heart failure and antiarrhytmic drugs. Classification. Chemistry and mechanism of actions. Indication, clinical use and ADRs. Part XIII – Endocrine drugs (A): Hormones and drugs used in endocrine disease that affecting hormonal system: hypothalamic and pituitary hormones; thyroid and antithyroid drugs; corticosteroids (glucocorticosterids and mineralocorticoids) and antagonists, tissue hormones; Chemistry and physiological activity, mechanism of action, indication, clinical use, ADRs; Part XIV –Endocrine drugs (B): Gonadal hormones and inhibitors (1. estrogens, antiestrogens; 2. progestins, antiprogestins; hormonal contraception, 3. androgens (testosteron) and antiandrogens (receptor antagonists, 5-α-reductase inhibitors, synthesis inhibitors). Pancreatic hormones, antidiabetic agents & glucagon: hypoglycemics (insulin and oral sulfonylurea and biguanide hypoglycemics), antihypoglycemics (glucagon). Chemistry and physiological activity, mechanism of action, indications, clinical use, SAR and ADRs; Part XV - Eicosanoids (leukotrienes, prostacyclin, prostaglandins, thromboxanes); Vitamins (avitaminose, hypovitaminose and hypervitaminose therapy). Chemistry and indications. SEMINARS: Introduction to Seminars: Adverse Drug Reactions (ADRs) Session A: Drug-induced Cardiovascular Diseases/*Triggers for discussion:* S-1 Drug-induced Hypertension Session B: Drug-induced Allergic/Immunlogic Diseases/*Triggers for discussion:* S-2 Drug-induced Photosensitivity; S-3 Drug-induced Oral Manifestations of Systemic Drugs Session D: Drug-induced Neurological Diseases/*Triggers for discussion*: S-4 Drug-induced Visual Disturbances; Session E: Session F: Drug-induced Haematological Disorders/*Triggers for discussion*: S-5 Drug-Induced Anemia Session F: Drug-induced Endocrine Diseases/*Triggers for discussion*: S-6 Drug-induced Thyroid Disorders Sesion G: Drug-induced Respiratory Diseases/*Triggers for discussion*: S-7 Drug-induced Asthma and Bronchospasm Session I: Drug-induced Psychiatric Disease/*Triggers for discussion*: S-8 Drug-Induced Psychosis; Drug-induced Depression Session J: Miscellaneous/*Triggers for discussion*: S-9 Drug induced Cognitive Disoders Session J: Miscellaneous/*Triggers for discussion*: S-10 Drug-Induced Auditory, Nose and Throat Disorders; S-11 Teratogenicity An Introduction to Medicinal Chemistry (Graham L. Patrick)/Oxford University Press,

	http://global.oup.com/uk/orc/chemistry/patrick5e/student/mcqs/MCQ MCQ Test 1 - Drugs and drug targets - an overview MCQ Test 5 – Receptors and signal transduction MCQ Test 15 – Getting the drug to market Test 18 – Quantitative structure-activity relationship (QSAR) MCQ Test 19 - Antibacterial drugs MCQ Test 20 – Antiviral agents MCQ Test 21 Anti cancer agents MCQ Test 22 – Cholinergic, anticholinergic and anticholinesterases Selected topics from The Biomedical & Life Sciences Collection (http://www.hstalks.com/biosci) – *Triggers for interactive discussions*

2.6. Type of instruction	lectures seminars workshops exercises online in entirety mixed *e*-learning mixed *m*-learning	field work independent study multimedia and the internet work with the mentor (other)

2.7. Student responsibilities	Compulsory: class attendance, MCQ tests, oral exam. Optional: Preparation of seminar topics (seminar abstract in Word document 1A4 page, PowerPoint presentation, 15-20 slides), and the presentation of seminar topics to all students.

2.8. 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	0.5	Seminar essay	0.5
	Experimental work		Oral exam	1.5
	Essay		Project	
	Tests		Practical training	
	Written exam		MCQ Test 1	0.5
	Research		MCQ Test 2	0.5
	Report		(Other--describe)	

2.9. Grading and evaluation of student work over the course of instruction and at a final exam	Compulsory: class attendance, MCQ Test 1 and MCQ Test 2, oral exam. Optional: Preparation of seminar topics (seminar abstract in Word document 1A4 page, PowerPoint presentation, 15-20 slides), and the presentation of seminar topics to all students.

2.10. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	Medicinal chemistry, Handouts of presentations 2016/17, M. Jadrijević-Mladar Takač	1 (Department of pharmaceutical chemistry)	available at Merlin system
	Medicinal Chemistry, G. Patrick, BIOS Scientific Publishers Ltd., 2001;	1 (Department of pharmaceutical chemistry)	
	Foye's Principles of Medicinal Chemistry, T. L. Lemke & D. A. Wiliams (Eds), Volters Kluver, Lippincot Wiliams and Wilkins, New York, 2008.	1 (Department of pharmaceutical chemistry)	https://app.box.com/s/82w4inro8g9b1sdsve3geeq64u8va5ky

2.11. Optional literature	Antitargets, Prediction and Prevention of Drug Side Effects, R. J. Vaz & T. Klabunde (Eds.), Wiley-VCH Series: Methods and Principles in Medicinal Chemistry, Wiley-VCH GmBH & Co. KGaA, Weinheim, 2008.

	Drug-Induced Disease. Prevention, Detection and Management, 2nd Ed., J. E Tisdale & D. A Miller (Eds.) ASHSP, ASHSP, Bethesda, 2010. Drug Action – Basic Principles and Therapeutic Aspects, E. Muchler & H. Derendorf, Medpharm, Stutgart, 1995. Martindale – Extra Pharmacopoeia, current Ed; Joseph P Remington, Alfonso R Gennaro, Remington's Pharmaceutical Sciences, 18th Ed., Mack Pub. Co., 1990, Easton, Pa.
2.12. Methods of monitoring quality that ensure acquisition of exit competences	Examination by MCQ Test 1 and MCQ Test 2, preparation and presentation of seminar topic, and student survey
2.13. Comments	

MICROBIOLOGY WITH PARASITOLOGY

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Assoc. Prof. Ivan Kosalec, PhD Assoc. Prof. Maja Šegvić Klarić, PhD
1.2. Associate teachers	Daniela Jakšić Despot, MPharm
1.3. Graduate programme	Medical Biochemistry integrated study programme
1.4. Status of the course	Compulsory
1.5. Year of study, Semester	2nd year, IV semester
1.6. Credit value (ECTS)	8
1.7. Type of instruction (number of hours L+E+S+e-learning)	60+30+0+0
1.8. Expected enrolment in the course	130 students
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2nd level of e-learning (not included in standard hours, but it is used in teaching)
2. COURSE DESCRIPTION	
2.1. Course objectives	Students will learn: the basics of microbial biology (structure, replication, metabolism, biofilm formation, etc.); the host-pathogen interactions and its drug, vaccine or biocide modulation; etiology of bacterial, fungal and viral infectious diseases; targets of antimicrobial drugs, systemic view of the role of microbes in the life of the host (human), the importance of prevention and the wider systemic role (environmental, anthropozoonoses) of microbes in order to prevent infectious diseases.
2.2. Enrolment requirements and required entry competences for the course	Passed exam in Cell Biology with Genetics
2.3. Learning outcomes at the level of the study programme to which the course contributes	• The application of knowledge and skills related to the broader environmental role of infectious agents of bacterial, viral, fungal and parasitic etiology in laboratory diagnostics procedures, evaluating the clinical relevance of biochemical and molecular biology indicators, detecting sources of laboratory analysis errors and result variability, interpreting laboratory analysis results from an analytical and clinical point of view. • Active participation in prevention of infectious diseases and health care as well as in public health initiatives.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	At the end of the course students will be able to: 1. Describe and differentiate biological properties of medically important bacteria, viruses, fungi and parasites as well as their role in host (human). 2. List the main etiological agents of infectious diseases. 3. Identify the main pathogenic, commensal, opportunistic and saprophytic microbial species. 4. Explain and relate mechanisms of virulence and microbial pathogenesis. 5. Relate systemically the role of anthropozoonoses and prevention of their transmission. 6. Describe the properties of antimicrobial drugs and relate the mechanisms of antimicrobial resistance. 7. List the types of vaccines and argue the importance of active immunization for the prevention of infectious diseases.
a. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES • The introduction to course content and its importance in biomedicine and public health. • The history of microbiology. Functional division of microbiology. Basics of microbial taxonomy. Microscope and types of microscopy. • Differences in the structure of prokaryotic and eukaryotic cells. Morphology of bacteria and fungi. • Biology of viruses and prions.

- Bacterial metabolism and genetics: growth, sources of nutrients and energy, the specificity of bacterial metabolism, bacterial chromosome, mutation and recombination of genes, role of plasmids and bacteriophages.
- QS and biofilm. Methods of isolation, cultivation and identification of microorganisms in medical microbiology.
- Infection: microbial virulence, sources and routes of transmission, host-pathogen interactions, types of infection and consequences.
- Basics of immunology: immune system, antigens and antibodies. The immune response to microorganisms. Active and passive immunization, types of vaccines, vaccination schedule in Croatia.
- Antimicrobial drugs: classification, mechanism of action, resistance, methods of testing antimicrobial activity.
- Sterilization and disinfection: methods and procedures; properties of disinfectants, antiseptics and preservatives and control of their effectiveness.
- European Pharmacopoeia methods for microbiological quality control of drugs, efficiency of preservatives and other biological tests.
- Species of genera *Staphylococcus, Streptococcus, Enterococcus.*
- Species of genera *Corynebacterium, Listeria, Erysipelothrix, Lactobacillus, Gardnerella*.
- Species of genera Bacillus, Clostridium and other anaerobic bacteria.
- Actinomycetes; Species of genera: *Mycobacterium, Neisseria, Moraxella, Acinetobacter.*
- Primary pathogenic and opportunistic enterobacteria.
- Species of genera *Pseudomonas, Vibrio, Campylobacter, Helicobacter.*
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- Species of genera *Mycoplasma, Ureaplasma, Chlamydia, Rickettsia, Coxiella.*
- Respiratory viruses, Mumps,Measles, Rubella, and other childhood exanthems, Enteroviruses, Hepatitis viruses.
- Herpesviruses, Viruses of diarrhea, Arthropod-borne viruses and other zoonotic viruses, Retroviruses, Papovaviruses, Prions
- Medically important fungi: Ascomycota, Basidiomycota, Zygomycota, primary and opportunistic mycoses. Mycotoxins and mycotoxicoses.
- Parasites from phylum Protozoa. Parasites from phylum Platodes and Nemathelmintes. Arthropoda.
- News in Medical Microbiology.

EXERCISES

- Introduction to the organization, measures of protection and work in the microbiology lab. Preparing the slides for microscopy, staining methods in microbiology, microbial cell size measurement, types of growth media in microbiology.
- Micromorphological and physiological properties of some Gram-positive bacteria (*Staphylococcus aureus, Enterococcus faecalis); Neisseria gonorrhoeae* - methylene blue stained smear of uretra.
- Micromorphological, physiological and antigenic properties of some Gram-positive spore-forming bacteria (*Bacillus anthracis, Bacillus cereus, Clostridium* spp.); Methods of cultivation of anaerobic bacteria; *Corynebacterium. diphtheriae* - Lubiński stain procedure for methacromatic granules; Physiological, micromorphological and staining properties of mycobacteria (*M. bovis* BCG strain).
- Antimicrobial susceptibility testing (diffusion and dilution, detection of beta-lactamase); determination of the antibiotic concentration in a sample using diffusion method.
- Application of selective and differential media for the isolation of some Gram-negative bacteria (Enterobacteriaceae); physiological characteristics of

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• Microbiological quality control tests of non-sterile pharmaceutical products according to the European Pharmacopoeia.
• Methods of cultivation and identification of medically important fungi (yeasts, dermatophytes, molds)
• Methods for virus propagation and detection of viral cytopathic effect.
• Morphological characteristics and diagnostically important stages of parasites (Protozoa: Trypanosoma gambiense, Leishmania donovani, Giardia lamblia, Trichomonas vaginalis, Entamoeba coli, Cryptosporidium parvum, Plasmodium falciparum; Platodes and Cestodes: Fasciola, Taenia saginata, Hymenolepis nana, Echinococcus granulosus).
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MICROBIOLOGY WITH PARASITOLOGY

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<tr><td colspan="2"></td><td></td><td></td></tr>
<tr><td>2.11. Optional literature</td><td colspan="4">e-articles: Croatian National Institute of Public Health, European Centre for Disease Prevention and Control (ECDC), World Health Organisation (WHO), European Medicines Agency (EMA)</td></tr>
<tr><td>2.12. Methods of monitoring quality that ensure acquisition of exit competences</td><td colspan="4">Learning outcomes 1-7 are evaluated by oral exam and outcome 3 by test after completed exercises.</td></tr>
<tr><td>2.13. Comments</td><td colspan="4"></td></tr>
</table>

MODERN BIOCHEMICAL TECHNIQUES

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Assistant Professor Sandra Šupraha Goreta Associate Professor Sanja Dabelić
1.2. Associate teachers	Professor Jerka Dumić Associate Professor Olga Gornik
1.3. Graduate programme	Integrated study of Medical Biochemistry
1.4. Status of the course	elective
1.5. Year of study, Semester	3rd year, 5th semester
1.6. Credit value (ECTS)	2.5
1.7. Type of instruction (number of hours L+E+S+e-learning)	15+0+15+0
1.8. Expected enrolment in the course	30
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	Level 2 (possibility of e-learning according to the student's personal affinity to use teaching materials and problem based examples for knowledge improvement, not included in standard hours)
2. COURSE DESCRIPTION	
2.1. Course objectives	Students will learn about theoretical background, advantages and disadvantages of analytical methods and procedures and their application in biomedicine.
2.2. Enrolment requirements and required entry competences for the course	Enrolled 5th semester; Passed exams of the course Biological Chemistry and attended course Biochemistry. Input competences: it is required that the students who has enrolled course Modern biochemical techniques, are capable to: - Apply knowledge of chemistry, biology and biochemistry acquired so far in high school and during academic education, - Describe the structure of biological molecules / macromolecules and structure-function relationship, - Describe and explain the basic principles and mechanisms of inheritance.
2.3. Learning outcomes at the level of the study programme to which the course contributes	• Applying knowledge on biochemical and molecular biological techniques, required for analysing and planning procedures related to drug research and development. • Assessment and application of scientific knowledge and available data with a purpose to solve problems.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After successfully completing the course, students will be able to: 1. Explain the principles of spectroscopic, chromatographic, immunochemical and electrophoretic techniques and methods for analysis of biological macromolecules in complex biological systems. 2. Describe and distinguish biochemical techniques of protein analysis and purification. 3. Propose an appropriate technique or sequence of analytical techniques required for collecting the desired experimental data. 4. Knowing the advantages and limitations of selected bioanalytical method for the detection of the abnormal structure / localization / activity of biological macromolecules that lead to the development of the disease or are used for the diagnosis / treatment of diseases. 5. Enumerate and identify the application of modern biochemical techniques in medicine, pharmacy and laboratory medicine. 6. To interpret the data obtained by selected bioanalytical method especially applicable in the diagnosis, research and pharmacy.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	Lectures: • Introductory lecture; Introduction to the course. Types of biochemical research. Sources and preparation of biological material. Cell and tissue cultures. The homogenization of biological samples.

	• Spectroscopic methods; the principles of spectroscopic methods. The mechanism of fluorescence. Fluorescence techniques. The basic elements of the system for fluorescence measurement. • Sedimentation techniques: centrifugation and precipitation. Differential centrifugation. Isopicnic centrifugation. Zonal centrifugation. Precipitation with organic solvents. Affinity precipitation. • Chromatographic techniques; Chromatographic methods according to the type of interaction. Chromatography in column. High performance liquid chromatography (HPLC). Gas-liquid chromatography. Purification and separation of proteins. • Electrophoretic techniques; Protein electrophoresis. Electrophoresis of nucleic acids. SDS denaturing polyacrylamide gel electrophoresis. Isoelectric focusing. Capillary electrophoresis. • Immunochemical techniques; Reactions antigen-antibody. Antibody classes. Polyclonal and monoclonal antibodies. • Isolation, purification and characterization of antibodies. Immunoenzyme (ELISA) and immunofluorescence methods (FIA). Immunohistochemistry. Immunodiffusion. The principle and application of immunoprecipitation. Conjugation of antibodies. Immunoblot (Western) analysis. • Modern methods of DNA analysis. Genetic information. Types of DNA analysis; sequence analysis and gene expression analysis. The techniques of isolation of DNA and RNA. Electrophoresis of nucleic acids. Southern blot hybridization technique. Polymerase chain reaction. Analysis of single-stranded conformational polymorphism (SSCP analysis). Determination of the sequence of nucleotides in the DNA molecule (DNA sequencing). • DNA analysis in diagnosis and therapy. Interpretation of electropherograms obtained by automatic sequencing. Application of DNA analysis in forensics. • Principles of mass spectrometry. The use of mass spectrometry; Examples of protein analysis. SEMINARS: • Application of electrophoretic methods. Problem related to electrophoretic methods. • Immunoassays and their potential for quantitative and qualitative analysis of biological material. Flow cytometry, principle and examples of its application in science, laboratory diagnostics and medicine. • Biological drugs. Methods of production of biological medicines. The use of biological medicines in clinical practice. Production of monoclonal antibodies and their application in treatment of autoimmune and malignant diseases. • The use of the internet and bioinformatics in modern science. Practical problems related to bioinformatics and databases useful for biochemistry, pharmacy and medicine. • Production and purification of proteins. Application of chromatography in the technology of production of medicines. Therapeutic monitoring of the effectiveness of the drug. Practical problems related to chromatographic methods.
2.6. Type of instruction	**lectures** **seminars** workshops exercises online in entirety **mixed *e*-learning** mixed *m*-learning field work independent study multimedia and the internet work with the mentor (other)
2.7. Student responsibilities	The students are required to attend classes that take place in the form of lectures and practical classes (exercises).

<table>
<tr><td></td><td colspan="4">The students, for the achievement of credits and grades in specified courses, are required to take the written and oral exam and pass them both successfully.</td></tr>
<tr><td rowspan="7">2.8. 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)</td><td>Class attendance</td><td>0.5</td><td>Seminar essay</td><td></td></tr>
<tr><td>Experimental work</td><td></td><td>Oral exam</td><td>1.0</td></tr>
<tr><td>Essay</td><td>0.5</td><td>Project</td><td></td></tr>
<tr><td>Tests</td><td></td><td>Practical training</td><td></td></tr>
<tr><td>Written exam</td><td>0.5</td><td>(Other--describe)</td><td></td></tr>
<tr><td>Research</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>Report</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>2.9. Grading and evaluation of student work over the course of instruction and at a final exam</td><td colspan="4">The students are evaluated according to the performance in the written (40%) and oral examination (60%), which can be accessed only after the attended lectures. On the final exam students are required to demonstrate knowledge of all areas covered by the program of the course, at the level of skilled information management and synthesis of materials.</td></tr>
<tr><td rowspan="4">2.10. Required literature (available at the library and via other media)</td><td>Title</td><td>Number of copies at the library</td><td colspan="2">Availability via other media</td></tr>
<tr><td>Berg, JM, Tymoczko, JL, Stryer, L. Biokemija (Školska knjiga, Zagreb, 6th ed.), 2013, ISBN 9789530309289</td><td>30</td><td colspan="2">YES</td></tr>
<tr><td>Dabelić S, Šupraha Goreta S, Dumić J. Powerpoint presentations of Modern biochemical techniques (within the e-learning)</td><td>0</td><td colspan="2"></td></tr>
<tr><td></td><td></td><td colspan="2"></td></tr>
<tr><td>2.11. Optional literature</td><td colspan="4">Nelson, DL, Cox, MM. Lehninger Principles of Biochemistry (W. H. Freeman, New York, 4th ed.), 2004, ISBN-13: 978-0716743392
Cooper, GM, Hausman, RE. Stanica: molekularni pristup (Medicinska naklada, Zagreb, 3rd ed.), 2004, ISBN: 953-176-248-1</td></tr>
<tr><td>2.12. Methods of monitoring quality that ensure acquisition of exit competences</td><td colspan="4">Outcomes 1-6 are checked by written and oral exam.</td></tr>
<tr><td>2.13. Comments</td><td colspan="4"></td></tr>
</table>

MODERN BIOCHEMICAL TECHNIQUES

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Assistant Professor Sandra Šupraha Goreta Associate Professor Sanja Dabelić
1.2. Associate teachers	Professor Jerka Dumić Associate Professor Olga Gornik
1.3. Graduate programme	Integrated study of Pharmacy
1.4. Status of the course	elective
1.5. Year of study, Semester	3rd year, 5th semester
1.6. Credit value (ECTS)	2.5
1.7. Type of instruction (number of hours L+E+S+e-learning)	15+0+15+0
1.8. Expected enrolment in the course	30
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	Level 2 (possibility of e-learning according to the student's personal affinity to use teaching materials and problem based examples for knowledge improvement, not included in standard hours)
2. COURSE DESCRIPTION	
2.1. Course objectives	Students will learn about theoretical background, advantages and disadvantages of analytical methods and procedures and their application in biomedicine.
2.2. Enrolment requirements and required entry competences for the course	Enrolled 5th semester; Passed exams of the course Biological Chemistry and attended course Biochemistry. Input competences: it is required that the students who has enrolled course Modern biochemical techniques, are capable to: - Apply knowledge of chemistry, biology and biochemistry acquired so far in high school and during academic education, - Describe the structure of biological molecules / macromolecules and structure-function relationship, - Describe and explain the basic principles and mechanisms of inheritance.
2.3. Learning outcomes at the level of the study programme to which the course contributes	• Applying knowledge on biochemical and molecular biological techniques, required for analysing and planning procedures related to drug research and development. • Assessment and application of scientific knowledge and available data with a purpose to solve problems.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After successfully completing the course, students will be able to: 1. Explain the principles of spectroscopic, chromatographic, immunochemical and electrophoretic techniques and methods for analysis of biological macromolecules in complex biological systems. 2. Describe and distinguish biochemical techniques of protein analysis and purification. 3. Propose an appropriate technique or sequence of analytical techniques required for collecting the desired experimental data. 4. Knowing the advantages and limitations of selected bioanalytical method for the detection of the abnormal structure / localization / activity of biological macromolecules that lead to the development of the disease or are used for the diagnosis / treatment of diseases. 5. Enumerate and identify the application of modern biochemical techniques in medicine, pharmacy and laboratory medicine. 6. To interpret the data obtained by selected bioanalytical method

	especially applicable in the diagnosis, research and pharmacy.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	Lectures: • Introductory lecture; Introduction to the course. Types of biochemical research. Sources and preparation of biological material. Cell and tissue cultures. The homogenization of biological samples. • Spectroscopic methods; the principles of spectroscopic methods. The mechanism of fluorescence. Fluorescence techniques. The basic elements of the system for fluorescence measurement. • Sedimentation techniques: centrifugation and precipitation. Differential centrifugation. Isopicnic centrifugation. Zonal centrifugation. Precipitation with organic solvents. Affinity precipitation. • Chromatographic techniques; Chromatographic methods according to the type of interaction. Chromatography in column. High performance liquid chromatography (HPLC). Gas-liquid chromatography. Purification and separation of proteins. • Electrophoretic techniques; Protein electrophoresis. Electrophoresis of nucleic acids. SDS denaturing polyacrylamide gel electrophoresis. Isoelectric focusing. Capillary electrophoresis. • Immunochemical techniques; Reactions antigen-antibody. Antibody classes. Polyclonal and monoclonal antibodies. • Isolation, purification and characterization of antibodies. Immunoenzyme (ELISA) and immunofluorescence methods (FIA). Immunohistochemistry. Immunodiffusion. The principle and application of immunoprecipitation. Conjugation of antibodies. Immunoblot (Western) analysis. • Modern methods of DNA analysis. Genetic information. Types of DNA analysis; sequence analysis and gene expression analysis. The techniques of isolation of DNA and RNA. Electrophoresis of nucleic acids. Southern blot hybridization technique. Polymerase chain reaction. Analysis of single-stranded conformational polymorphism (SSCP analysis). Determination of the sequence of nucleotides in the DNA molecule (DNA sequencing). • DNA analysis in diagnosis and therapy. Interpretation of electropherograms obtained by automatic sequencing. Application of DNA analysis in forensics. • Principles of mass spectrometry. The use of mass spectrometry; Examples of protein analysis. SEMINARS: • Application of electrophoretic methods. Problem related to electrophoretic methods. • Immunoassays and their potential for quantitative and qualitative analysis of biological material. Flow cytometry, principle and examples of its application in science, laboratory diagnostics and medicine. • Biological drugs. Methods of production of biological medicines. The use of biological medicines in clinical practice. Production of monoclonal antibodies and their application in treatment of autoimmune and malignant diseases. • The use of the internet and bioinformatics in modern science.

<table>
<tr><td></td><td colspan="4">Practical problems related to bioinformatics and databases useful for biochemistry, pharmacy and medicine.
• Production and purification of proteins. Application of chromatography in the technology of production of medicines. Therapeutic monitoring of the effectiveness of the drug. Practical problems related to chromatographic methods.</td></tr>
<tr><td>2.6. Type of instruction</td><td colspan="2"><u>lectures</u>
<u>seminars</u>
workshops
exercises
online in entirety
<u>mixed e-learning</u>
mixed m-learning</td><td colspan="2">field work
independent study
multimedia and the internet
work with the mentor
(other)</td></tr>
<tr><td>2.7. Student responsibilities</td><td colspan="4">The students are required to attend classes that take place in the form of lectures and practical classes (exercises).
The students, for the achievement of credits and grades in specified courses, are required to take the written and oral exam and pass them both successfully.</td></tr>
<tr><td rowspan="8">2.8. 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)</td><td>Class attendance</td><td>0.5</td><td>Seminar essay</td><td></td></tr>
<tr><td>Experimental work</td><td></td><td>Oral exam</td><td>1.0</td></tr>
<tr><td>Essay</td><td>0.5</td><td>Project</td><td></td></tr>
<tr><td>Tests</td><td></td><td>Practical training</td><td></td></tr>
<tr><td>Written exam</td><td>0.5</td><td>(Other--describe)</td><td></td></tr>
<tr><td>Research</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>Report</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>2.9. Grading and evaluation of student work over the course of instruction and at a final exam</td><td colspan="4">The students are evaluated according to the performance in the written (40%) and oral examination (60%), which can be accessed only after the attended lectures. On the final exam students are required to demonstrate knowledge of all areas covered by the program of the course, at the level of skilled information management and synthesis of materials.</td></tr>
<tr><td rowspan="4">2.10. Required literature (available at the library and via other media)</td><td colspan="2">Title</td><td>Number of copies at the library</td><td>Availability via other media</td></tr>
<tr><td colspan="2">Berg, JM, Tymoczko, JL, Stryer, L. Biokemija (Školska knjiga, Zagreb, 6th ed.), 2013, ISBN 9789530309289</td><td>30</td><td>YES</td></tr>
<tr><td colspan="2">Dabelić S, Šupraha Goreta S, Dumić J. Powerpoint presentations of Modern biochemical techniques (within the e-learning)</td><td>0</td><td></td></tr>
<tr><td colspan="2"></td><td></td><td></td></tr>
<tr><td>2.11. Optional literature</td><td colspan="4">Nelson, DL, Cox, MM. Lehninger Principles of Biochemistry (W. H. Freeman, New York, 4th ed.), 2004, ISBN-13: 978-0716743392
Cooper, GM, Hausman, RE. Stanica: molekularni pristup (Medicinska naklada, Zagreb, 3rd ed.), 2004, ISBN: 953-176-248-1</td></tr>
<tr><td>2.12. Methods of monitoring quality that ensure acquisition of exit competences</td><td colspan="4">Outcomes 1-6 are checked by written and oral exam.</td></tr>
<tr><td>2.13. Comments</td><td colspan="4"></td></tr>
</table>

MOLECULAR BASIS OF DISEASES AND THERAPY

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Professor Karmela Barišić Professor Jerka Dumić
1.2. Associate teachers	
1.3. Graduate programme	Pharmacy
1.4. Status of the course	Elective
1.5. Year of study, Semester	4th year; 8th semester
1.6. Credit value (ECTS)	2.5
1.7. Type of instruction (number of hours L+E+S+e-learning)	15+0+15+0
1.8. Expected enrolment in the course	60
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2nd level; **e-learning – it is not a part of teaching hours, but it is used in studying since it contains case studies, problems with explanations, links on different useful web pages**
2. COURSE DESCRIPTION	
2.1. Course objectives	To acquire knowledge and understand the mechanisms of genesis and development of inherited and acquired diseases on the molecular level, as the basis of a rational approach to the development of new therapies. To understand and consider the principles of new therapeutic strategies such as gene therapy and stem cells therapy.
2.2. Enrolment requirements and required entry competences for the course	Enrolment requirements for this subject – Molecular Biology with Genetic Engineering completed, passed examination in Pathophysiology and Pathology
2.3. Learning outcomes at the level of the study programme to which the course contributes	Application of knowledge in molecular pathophysiology needed to define, evaluate and propose actions related to research and drug development, as well as for the introduction and application of new therapeutic procedures in clinical practice. Critical assessment and application of scientific knowledge and data available to solve certain problems.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After passing the exam student will be able to: 1. Distinguish different mechanisms of disease (cell death, inflammation, infection, neoplasia); 2. Explain the molecular basis of various diseases; 3. Describe the meaning of the human genome / transcriptome / epigenome in understanding the disease; 4. Present experimental therapeutic approaches; 5. Explain the role of pharmacogenomics and personalized medicine; 6. Search scientific literature and interpret the results.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES: • Molecular mechanisms of diseases (cell death, acute and chronic inflammation, infection and host response, neoplasia) (1) • The human genome / transcriptome / epigenome – the basis for understanding diseases (1) • Molecular basis of cardiovascular diseases, haemostatic and thrombotic diseases (2) • Molecular basis of lung diseases (2) • Molecular basis of diseases of the gastro-intestinal tract, liver and exogenous pancreas (2) • Molecular basis of diseases endocrine system (2) • Molecular basis of diseases reproductive system (2) • Molecular basis of dermatological diseases (1) • Experimental therapeutic approaches (2) SEMINARS

<table>
<tr><td></td><td colspan="4">

Clinical proteomics and molecular pathology (1)
Integrative systems biology - based understanding of the disease (1)
Molecular Basis of Aging (2)
Molecular basis of cancer (2)
Molecular basis of chronic obstructive pulmonary disease and asthma (2)
Molecular basis of inflammatory bowel disease and irritable bowel syndrome (2)
Diabetes (2)
Molecular basis of selected diseases of the nervous system (1)
Molecular diagnostics / Pharmacogenomics and personalized medicine (2)

</td></tr>
<tr><td>2.6. Type of instruction</td><td colspan="2">lectures
seminars
workshops
exercises
online in entirety
mixed e-learning*
mixed m-learning</td><td colspan="2">field work
independent study
multimedia and the internet
work with the mentor
(other)
* e-learning – it is not a part of teaching hours, but it is used in studying since it contains case studies, problems with explanations, links on different useful web pages</td></tr>
<tr><td>2.7. Student responsibilities</td><td colspan="4">The students are required to attend classes that take place in the form of lectures and seminars. To be entitled to achieve the credits and grades, students are required to prepare seminar and to take the oral exam and pass it successfully.</td></tr>
<tr><td rowspan="8">2.8. 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)</td><td>Class attendance</td><td>0.5</td><td>Seminar essay</td><td>1</td></tr>
<tr><td>Experimental work</td><td></td><td>Oral exam</td><td>1</td></tr>
<tr><td>Essay</td><td></td><td>Project</td><td></td></tr>
<tr><td>Tests</td><td></td><td>Practical training</td><td></td></tr>
<tr><td>Written exam</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>Research</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>Report</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td colspan="4"></td></tr>
<tr><td>2.9. Grading and evaluation of student work over the course of instruction and at a final exam</td><td colspan="4">During the course, each student's progress is monitored continuously, and the final score assesses the total commitment of student during the lectures, seminars and oral examination. Students are required to prepare the seminar to present it to the rest of the students. The seminar work includes a project approach to a particular topic, independently search scientific and professional literature and preparing the essay, its presentation and discussion.</td></tr>
<tr><td rowspan="4">2.10. Required literature (available at the library and via other media)</td><td colspan="2">Title</td><td>Number of copies at the library</td><td>Availability via other media</td></tr>
<tr><td colspan="2">K. Barišić and J. Dumić. Molekulske osnove bolesti i terapije Powerpoint presentations (within the e-learning)</td><td></td><td></td></tr>
<tr><td colspan="2">Coleman W. B. and Tsongalis G.J. Molecular Pathology; The molecular Basis of Human Disease (2009) Elsevier Inc (Academic Press) ISBN: 978-0-12-374419-7.</td><td></td><td></td></tr>
<tr><td colspan="2">Recent scientific and professional literature</td><td></td><td></td></tr>
<tr><td>2.11. Optional literature</td><td colspan="4"></td></tr>
<tr><td>2.12. Methods of monitoring quality that ensure acquisition of exit competences</td><td colspan="4">Continuous monitoring of student work during lectures, seminars, and project preparation, and assessment of the project presentation and oral exam. Outcomes 1-5 are checked by oral examination, while the outcome no. 6 during presentation of the project.</td></tr>
<tr><td>2.13. Comments</td><td colspan="4"></td></tr>
</table>

MOLECULAR DIAGNOSTICS

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Prof Karmela Barišić
1.2. Associate teachers	Assistant Prof Marija Grdić Rajković Andrea Čeri, mag med biochem Andrea Hulina, mag med biochem
1.3. Graduate programme	Medical Biochemistry
1.4. Status of the course	compulsory
1.5. Year of study, Semester	4, 7
1.6. Credit value (ECTS)	5
1.7. Type of instruction (number of hours L+E+S+e-learning)	30 + 15 + 15
1.8. Expected enrolment in the course	20
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2
2. COURSE DESCRIPTION	
2.1. Course objectives	Course objectives are to familiarise students with principles and development of molecular diagnostic methods, their use in research, diagnosis and monitoring of diseases.
2.2. Enrolment requirements and required entry competences for the course	Enrolment requirements: completed Haematology II and Molecular Biology with Genetic Engineering and passed exam in General Clinical Biochemistry.
2.3. Learning outcomes at the level of the study programme to which the course contributes	• Defining, analysing and choosing procedures connected to research, manufacturing and quality assurance and implementation of molecular diagnostic procedures for detection and follow-up of medical conditions and efficiency of the therapy. • Development and implementation of solutions for practical problems of molecular diagnostics by means of observational, analytical and critical skills. • Critical evaluation and implementation of scientific findings and available data in order to improve the field, solving molecular diagnostic problems, implementation of new technologies and improvement of the existing ones.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	On completion of this course, the student will be able to: 1. critically read, interpret and communicate original research literature in molecular diagnostics; 2. describe technics used in molecular diagnostics; 3. explain and practically apply principles and methods used in diagnostics of hereditary diseases; 4. analyse theoretical and experimental limitations for a defined molecular diagnostic problem; 5. interpret results of a specific molecular diagnostic test; 6. describe the ethical aspects in relation to genetic counselling; 7. define quality criteria for the clinical use of molecular diagnostics; 8. define the optimal method for a specific molecular diagnostic problem; 9. use available databases; 10. participate in the interdisciplinary collaboration with the health sector / health industry on the development of molecular diagnostics.
2.5. Course content broken down in detail	LECTURES AND SEMINARS

<table>
<tr><td>by weekly class schedule (syllabus)</td><td colspan="4">

Molecular genetics for diagnostics of hereditary diseases (PCR for specific mutation tests, tests for general mutations, DNA sequencing)
Methods for characterization of gene expression (micro arrays and quantitative PCR)
Laboratory management, quality control, validation, variation sources, distinctive property and test sensitivity for molecular diagnostics
Forensic analyses
Molecular diagnostics in haematology
Molecular diagnostics in transfusion medicine
Molecular methods in epigenome analysis
Ethical aspects of genetic testing and consultations

Molecular diagnostics in monogenic diseases (cystic fibrosis, Huntington’s disease, Duchenne muscular dystrophy, fragile X chromosome syndrome)
Pharmacogenetics and pharmacogenomics
Use of available databases on human genome, transcriptome, polymorphisms, genetic variations and diseases

EXERCISES
isolation of nucleic acids, gel electrophoresis, PCR-RFLP analysis, real-time PCR, use of databases, statistical analyses
</td></tr>
<tr><td>2.6. Type of instruction</td><td colspan="2">lectures
seminars
workshops
exercises
online in entirety
mixed e-learning
mixed m-learning</td><td colspan="2">field work
independent study
multimedia and the internet
work with the mentor
laboratory</td></tr>
<tr><td>2.7. Student responsibilities</td><td colspan="4">Regular attendance of all parts of the course, active participation in solving cases from clinical practice, writing the seminar paper (researching literature, essay writing and oral presentation)</td></tr>
<tr><td rowspan="8">2.8. 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)</td><td>Class attendance</td><td>1.0</td><td>Seminar essay</td><td>1.0</td></tr>
<tr><td>Experimental work</td><td></td><td>Oral exam</td><td>1.0</td></tr>
<tr><td>Essay</td><td>1.0</td><td>Project</td><td>0.5</td></tr>
<tr><td>Tests</td><td></td><td>Practical training</td><td>0.5</td></tr>
<tr><td>Written exam</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>Research</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>Report</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td colspan="4"></td></tr>
<tr><td>2.9. Grading and evaluation of student work over the course of instruction and at a final exam</td><td colspan="4">Each student’s advancement is continually monitored over the course. The final grade comprises overall endeavour of a student during lectures, seminars, exercises and oral exam. Students are required to write a seminar paper which is presented to other students. The seminar paper requires a project approach to a specific topic, an independent research of scientific and specialist literature, writing of the essay, oral presentation along with the discussion on the topic.</td></tr>
<tr><td rowspan="4">2.10. Required literature (available at the library and via other media)</td><td colspan="2">Title</td><td>Number of copies at the library</td><td>Availability via other media</td></tr>
<tr><td colspan="2">DE Bruns, ER Ashwood, CA Burtis, Fundamentals of Molecular diagnostics, Saunders Elsevier, 2007.</td><td>5</td><td></td></tr>
<tr><td colspan="2">Štrausova medicinska biokemija, ur. D. Čvorišćec, I. Čepelak, Medicinska naklada, Zagreb 2009.</td><td>20</td><td></td></tr>
<tr><td colspan="2"></td><td></td><td></td></tr>
<tr><td>2.11. Optional literature</td><td colspan="4">1. Materials from lectures and seminars</td></tr>
</table>

	2. Felgenhauer K Laboratory Diagnosis of Neurological Diseases. In: Thomas L, ed., Clinical Laboratory Diagnostics – Use And Assessment of Clinical Laboratory Results: Frankfurt: TH Books, 1998: 1308-1326
2.12. Methods of monitoring quality that ensure acquisition of exit competences	• Continuous monitoring of students' performance during lectures, seminars, project and essay preparation, solving cases from clinic practice, laboratory performance, evaluation of the presentation (essay) and oral exam • Survey after the end of the course
2.13. Comments	

NUTRITION BIOCHEMISTRY

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Assistant Professor Lovorka Vujić, PhD
1.2. Associate teachers	Associate Professor Dubravka Vitali Čepo, PhD Kristina Radić, M.Pharm Martina Teskera, M.Nutr
1.3. Graduate programme	Integrated study of medicinal biochemistry
1.4. Status of the course	Compulsory
1.5. Year of study, Semester	4th year, 8th semester
1.6. Credit value (ECTS)	5
1.7. Type of instruction (number of hours L+E+S+e-learning)	30+30+0+0
1.8. Expected enrolment in the course	15 - 25
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	1
2. COURSE DESCRIPTION	
2.1. Course objectives	Introduction to chemistry, metabolism, and physiological roles of nutrients: proteins, carbohydrates, fats, vitamins, and minerals. Learning the basics of food chemistry and recognizing main food sources for particular nutrients. Apprehension of terms like bioavailability, biological value, and essentiality. Introduction to methodology of determining nutritional status and changes of biochemical markers associated with specific nutrition deficits. Comprehension of etiology, diagnostics, and therapy of leading metabolic disorders: obesity, diabetes, dyslipidemia, and other (genetic) disorders in the metabolism of certain nutrients.
2.2. Enrolment requirements and required entry competences for the course	Enrolment requirements: passed Biochemistry exam Entry competences: knowledge of basic physiology and anatomy with enhanced understanding of digestive system. Comprehension of basic biochemical processes within organism (glycolysis, gluconeogenesis, citric acid cycle, synthesis and breakdown of carbohydrates, fats and proteins, DNA).
2.3. Learning outcomes at the level of the study programme to which the course contributes	Knowledge obtained through this course will contribute to: • expertise related to the diagnosis and monitoring of various diseases and treatments • development of students' cognitive skills (communication skills, capacity for teamwork) • development of informational skills (using databases for the purpose of research and self-education)
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After passed exam students should be able to: 1. list the most important dietary sources for certain classes of nutrients 2. list all the parameters that determine the biological value and bioavailability of different nutritional categories and suggest ways to improve the biological value/bioavailability 3. explain metabolic pathways of various macro- and micronutrients 4. identify and explain symptoms caused by a deficiency of essential nutrients/energy 5. list and describe biochemical markers that indicate a deficiency of certain nutrients 6. describe the etiology and identify biochemical markers of the most common metabolic disorders 7. perform and explain analytical methods for the determination of macro/micronutrients in food
2.5. Course content broken down in detail	LECTURES:

<table>
<tr><td>by weekly class schedule (syllabus)</td><td colspan="4">

Basics of food chemistry. Homeostatic regulation of nutritional status. Recommended daily intake of nutrients (ADI, RDA, DRI). Biological efficiency/bioavailability of nutrients. Digestive system - anatomy and physiology. Digestive processes.
Proteins. Physical and chemical properties. Food sources of protein and amino acids. Chemical structure of proteins, biological roles. Protein digestion and metabolism. Proteins in the blood - diagnostic significance. Essential amino acids: chemistry, metabolism. Amino acids in the blood - diagnostic significance. Disorders of amino acid metabolism. Branched chain amino acids - hormonal/signaling role; therapeutic significance. Protein malnutrition: causes, consequences, biochemical markers.
Carbohydrates (carbs). Physiological classification of carbohydrates. Digestible carbohydrates: main food sources, chemistry, digestion, metabolism. Carbs as energy sources. Glucoregulation. Carbs metabolism (diabetes, lactose intolerance, fructose intolerance: biochemical markers, etiology, and therapy). Non-digestible carbohydrates: non-digestible carbohydrates in foods, physical and chemical properties and classification; physiological effects.
Lipids. Classification of lipids (triglycerides, fatty acids, cholesterol, phospholipids) and their food sources. Trans fat - food sources and toxicological significance. The physiological roles of lipids, absorption, metabolism. Regulation of lipid status. Evaluation of lipid status. Lipid disorders: etiology, biochemical markers, therapy.
Energy requirements and energy transport. Basal metabolism and additional energy demands - definition, measurement (direct and indirect calorimetry). Calorigenic effect of food. Healthy weight regulation (energy intake and expenditure). Food intake regulation (hunger and satiety). Biochemical markers of obesity. Obesity and inflammation.
Vitamins. Water-soluble vitamins: chemistry, food sources, absorption (bioavailability), metabolism, physiological significance. Fat-soluble vitamins: chemistry, food sources, absorption, metabolism, physiological significance. Regulation of vitamin status. Avitaminosis: biochemical markers.
Essential minerals. Daily requirements; calcification. Food sources. Absorption, transport, metabolism, elimination. Bioavailability of minerals: anti-nutritional factors in foodstuffs; interactions. Biochemical markers of mineral status. Mineral deficiency – symptoms and consequences. Disorders metabolism of minerals.

EXERCISE:
• Determination of amino acids
• Determination of metals
• Determination of riboflavin
• Determination of L-ascorbic acid
• Determination of carotene
</td></tr>
<tr><td>2.6. Type of instruction</td><td colspan="2"><u>lectures</u>
seminars
workshops
<u>exercises</u>
online in entirety
mixed e-learning
mixed m-learning</td><td colspan="2">field work
independent study
multimedia and the internet
work with the mentor
(other)</td></tr>
<tr><td>2.7. Student responsibilities</td><td colspan="4">Lecture attendance.
Attendance and active participation during exercises. Passing the final test related to exercises.</td></tr>
<tr><td rowspan="2">2.8. Screening of student’s work (specify the proportion of ECTS credits for each</td><td>Class attendance</td><td>0.5</td><td>Seminar essay</td><td></td></tr>
<tr><td>Experimental work</td><td>0.7</td><td>Oral exam</td><td></td></tr>
</table>

<table>
<tr><td rowspan="5">activity so that the total number of ECTS credits is equal to the credit value of the course)</td><td>Essay</td><td></td><td>Project</td><td></td></tr>
<tr><td>Tests</td><td>0.8</td><td>Practical training</td><td></td></tr>
<tr><td>Written exam</td><td>3.0</td><td>(Other--describe)</td><td></td></tr>
<tr><td>Research</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>Report</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>2.9. Grading and evaluation of student work over the course of instruction and at a final exam</td><td colspan="4">Test related to exercises is graded as well as activity and preparedness during class and exercises. Final exam is oral.</td></tr>
<tr><td rowspan="4">2.10. Required literature (available at the library and via other media)</td><td colspan="2">Title</td><td>Number of copies at the library</td><td>Availability via other media</td></tr>
<tr><td colspan="2">Lecture synopsis</td><td></td><td>Merlin</td></tr>
<tr><td colspan="2">Course materials for exercises</td><td></td><td>Merlin</td></tr>
<tr><td colspan="2"></td><td></td><td></td></tr>
<tr><td>2.11. Optional literature</td><td colspan="4">1. Nutritional Biochemistry, Academic press, Inc., New York, London, 1999.
2. The vitamins: Fundamental aspects in nutrition and health, Academic press, Inc., New York, London, 1999.
3. Nutritional and toxicological significance of enzyme inhibitors in foods, Plenum press, New York, London, 1986.
4. Handbook of vitamins; Nutritional, biochemical and clinical aspects
5. Basic Nutrition and Diat Therapy, C.V. Mosby; 11th CD-Ro edition, 2000.
6. Functional Foods: Designer Foods, Pharmfoods, Nutraceuticals, Plenum US; 1 edition 1994.
7. Nutrition and Diet Therapy, F. A. Davis Company; 3rd edition 2001.</td></tr>
<tr><td>2.12. Methods of monitoring quality that ensure acquisition of exit competences</td><td colspan="4">Learning outcomes 1 to 6 are acquired through lectures, and tested in oral exam. Learning outcome 7 is tested trough exercises and with final test.</td></tr>
<tr><td>2.13. Comments</td><td colspan="4"></td></tr>
</table>

NUTRITION THERAPY

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Associate Professor Dubravka Vitali Čepo
1.2. Associate teachers	Kristina Radić, MPharm Martina Teskera, MNutr
1.3. Graduate programme	Integrated study of pharmacy
1.4. Status of the course	Elective
1.5. Year of study, Semester	5th Year, 9th Semester
1.6. Credit value (ECTS)	2.5
1.7. Type of instruction (number of hours L+E+S+e-learning)	15+8+7+0
1.8. Expected enrolment in the course	30-50
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	1
2. COURSE DESCRIPTION	
2.1. Course objectives	Students will learn methods for assessments of patient's nutritional status; get to know the mechanisms by which various changes of nutritional status affect health outcomes; will be introduced to the specifics of nutrition and supplementation needed for different age groups and in different physiological states. Furthermore, students will be acquainted with basic diagnostic tools and medical nutrition therapy guidelines (including supplementation) of the most common health disorders with particular emphasis set on understanding the underlying mechanisms and importance of possible food-drug and supplement-drug interactions. Students will be trained to use relevant scientific/professional databases for enhancing and updating their knowledge about the quality of dietary supplements, their dosage, safety, evidence-based efficacy and clinically significant interactions with medications.
2.2. Enrolment requirements and required entry competences for the course	Passed exam: Physiological and Biochemical Aspects of Nutrition. Student competences: Knowledge of the etiology and pathophysiology of diabetes, cardiovascular disease, obesity, malnutrition and allergies. Knowledge of basic biochemical processes in the body. Knowledge of food chemistry and nutritional biochemistry. Understanding of DRI values.
2.3. Learning outcomes at the level of the study programme to which the course contributes	• Development of professional skills necessary for conducting pharmaceutical care. • Development of communication skills that will ensure a positive interaction with patients and colleagues. • Informing and counseling patients about the proper use of drugs, identifying and avoiding drug interactions; counseling on disease prevention and health preservation. • Use of information technology and databases in order to improve professional knowledge and self-education.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After passing the course, students will be able to : 1. Assess the patient's general nutritional status on the basis of interviews and / or laboratory findings as well as to apply other methods to evaluate nutritive status. 2. Interpret dietary supplement labels and search relevant literature sources and recommend supplements for appropriate indications (evidence-based approach) and in recommended dosage. 3. Identify and anticipate significant food - drug and dietary supplement-drug interactions; to understand the mechanisms of these interactions and to propose ways to avoid such interactions. 4. Advise patients (different age groups or specific physiological states such as pregnancy or lactation) on the appropriate diet and possible supplementation.

	5. Recommend medical nutrition therapy and use of dietary supplements in various pathological conditions (diabetes, cardiovascular disease, allergies, hypertension, anemia, etc.). 6. Explain the mechanisms by which changes in eating patterns affect the health maintenance, disease prevention and treatment and prevention of complications of certain diseases.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES: • Nutrition in the life cycle: nutrition during pregnancy and lactation. Nutritional status and conception; fetal origin hypothesis. Nutritional support during pregnancy and lactation: vitamins and minerals. Drugs and herbal supplements during pregnancy and lactation. Nutrition during infancy and childhood. Breastfeeding and formula feeding. Nutritional supplementation in childhood. Specific dietary patterns: toddlers and children. Nutrition in adolescence. Specific nutritive needs and dietary patterns. Nutrition in adult years. Dietary modifications and nutritional supplementation for the prevention of diseases. Nutrition in the elderly: specific dietary patterns, problems with feeding, malnutrition, nutritional supplementation. • Food-drug interactions: mechanism of interactions. Impact of food on drug metabolism. Impact of drug therapy on nutritional status. Interaction of drugs with herbal/nutritional supplements (basics). • Diagnosis of (pre)diabetes and monitoring of glycemic control: basic biochemical parameters. Nutrition therapy for pre- diabetes. Nutrition therapy in diabetes. Classic and contemporary approach to meal planning in insulin-dependent diabetes (basic techniques in carbohydrate counting; using of meal replacements). Types of insulin and insulin sensitivity. Nutrition therapy of diabetes complications (hypoglycemia, ketoacidosis, micro- and macro- vascular complications, and neuropathy). Dietary supplements and diabetes. • Nutrition therapy in cardiovascular disease (CVD). Nutrition and atherosclerosis. Basic biochemical parameters. Importance of body weight maintenance for maintenance of blood pressure and in CVD. Metabolic syndrome and Mediterranean diet. Nutritional supplementation in CVD. • Nutrition therapy of anemia, the most important nutritional anemia. Diagnostics and nutrition therapy of iron-deficiency anemia. Dietary supplementation in sideropenic anemia. Megaloblastic anemia. Diagnostics, nutrition therapy, and prevention. SEMINARS: • Nutritional supplements: quality and safety; evidence-based indications and types of evidences; dosage and safety of usage, clinically significant interactions with drugs and food. Relevant information source of dietary supplements. • Case study: choosing the best supplement, rational use of dietary supplement, and therapeutic algorithms. PRACTICUM: • Assessment of nutritional status: height, weight, waist to hip ratio, percentage of body fat, basal metabolism needs. • Assessment of risk for cardiovascular disease (Framingham study). Blood pressure measurement. • Estimation of serum antioxidant potential – correlation with nutritional habits. • Measuring of blood glucose – interpretation of obtained results. Usage of glucometer.

<table>
<tr><td>2.6. Type of instruction</td><td colspan="2"><u>lectures</u>
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<u>exercises</u>
online in entirety
mixed e-learning
mixed m-learning</td><td colspan="2">field work
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multimedia and the internet
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<tr><td>2.7. Student responsibilities</td><td colspan="4">Attendance in lectures. Attendance and active participation in seminars, and seminar essay. Attendance and active participation in lab practicum. Passing final test in exercise.</td></tr>
<tr><td rowspan="7">2.8. 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)</td><td>Class attendance</td><td>0.5</td><td>Seminar essay</td><td>0.25</td></tr>
<tr><td>Experimental work</td><td>0.25</td><td>Oral exam</td><td></td></tr>
<tr><td>Essay</td><td></td><td>Project</td><td></td></tr>
<tr><td>Tests</td><td></td><td>Practical training</td><td></td></tr>
<tr><td>Written exam</td><td>1.5</td><td>(Other--describe)</td><td></td></tr>
<tr><td>Research</td><td></td><td>(Other--describe)</td><td></td></tr>
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<tr><td>2.9. Grading and evaluation of student work over the course of instruction and at a final exam</td><td colspan="4">During the course exercise test as well as activity and student’s preparedness is evaluated. Final test is written and oral.</td></tr>
<tr><td rowspan="4">2.10. Required literature (available at the library and via other media)</td><td colspan="2">Title</td><td>Number of copies at the library</td><td>Availability via other media</td></tr>
<tr><td colspan="2">Lectures’ synopsis (D Vitali Čepo)</td><td></td><td>Merlin</td></tr>
<tr><td colspan="2">Internal course material - Dijetoterapija praktikum (D Vitali Čepo, K Radić, M Teskera)</td><td></td><td>Merlin</td></tr>
<tr><td colspan="2"></td><td></td><td></td></tr>
<tr><td>2.11. Optional literature</td><td colspan="4">1. Marcia Nahikian Nelms, Sara Long Roth: Medical Nutrition Therapy: A Case Study Approach, 4th edition, Cenhage Learning, USA, 2014.
2. Pamela Mason: Dietary Supplements, 4th edition, Pharmaceutical Press, 2011.
3. Volker Schulz, Rudolf Hänsel, Mark Blumenthal, V. E. Tyler, T.C. Telger: Rational Phytotherapy: A Reference Guide for Physicians and Pharmacists, Springer, 2004.
4. https://fnic.nal.usda.gov/
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6. http://www.consumerlab.com/</td></tr>
<tr><td>2.12. Methods of monitoring quality that ensure acquisition of exit competences</td><td colspan="4">Learning outcomes are evaluated through activity during the exercises, during the seminars, and written exam results.</td></tr>
<tr><td>2.13. Comments</td><td colspan="4"></td></tr>
</table>

NUTRITION THERAPY

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Associate Professor Dubravka Vitali Čepo
1.2. Associate teachers	Kristina Radić, MPharm Martina Teskera, MNutr
1.3. Graduate programme	Integrated study of medicinal biochemistry
1.4. Status of the course	Elective
1.5. Year of study, Semester	5th Year, 9th Semester
1.6. Credit value (ECTS)	2.5
1.7. Type of instruction (number of hours L+E+S+e-learning)	15+8+7+0
1.8. Expected enrolment in the course	10-15
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	1
2. COURSE DESCRIPTION	
2.1. Course objectives	Students will learn methods for assessments of patient's nutritional status; get to know the mechanisms by which various changes of nutritional status affect health outcomes; will be introduced to the specifics of nutrition and supplementation needed for different age groups and in different physiological states. Furthermore, students will be acquainted with basic diagnostic tools and medical nutrition therapy guidelines (including supplementation) of the most common health disorders with particular emphasis set on understanding the underlying mechanisms and importance of possible food-drug and supplement-drug interactions. Students will be trained to use relevant scientific/professional databases for enhancing and updating their knowledge about the quality of dietary supplements, their dosage, safety, evidence-based efficacy and clinically significant interactions with medications.
2.2. Enrolment requirements and required entry competences for the course	Passed exam: Physiological and Biochemical Aspects of Nutrition. Student competences: Knowledge of the etiology and pathophysiology of diabetes, cardiovascular disease, obesity, malnutrition and allergies. Knowledge of basic biochemical processes in the body. Knowledge of food chemistry and nutritional biochemistry. Understanding of DRI values.
2.3. Learning outcomes at the level of the study programme to which the course contributes	• Development of professional skills necessary for conducting pharmaceutical care. • Development of communication skills that will ensure a positive interaction with patients and colleagues. • Informing and counseling patients about the proper use of drugs, identifying and avoiding drug interactions; counseling on disease prevention and health preservation. • Use of information technology and databases in order to improve professional knowledge and self-education.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After passing the course, students will be able to : 1. Assess the patient's general nutritional status on the basis of interviews and / or laboratory findings as well as to apply other methods to evaluate nutritive status. 2. Interpret dietary supplement labels and search relevant literature sources and recommend supplements for appropriate indications (evidence-based approach) and in recommended dosage. 3. Identify and anticipate significant food - drug and dietary supplement-drug interactions; to understand the mechanisms of these interactions and to propose ways to avoid such interactions. 4. Advise patients (different age groups or specific physiological states such as pregnancy or lactation) on the appropriate diet and possible supplementation.

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mixed e-learning
mixed m-learning</td><td colspan="2">field work
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multimedia and the internet
work with the mentor
(other)</td></tr>
<tr><td>2.7. Student responsibilities</td><td colspan="4">Attendance in lectures. Attendance and active participation in seminars, and seminar essay. Attendance and active participation in lab practicum. Passing final test in exercise.</td></tr>
<tr><td rowspan="7">2.8. 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)</td><td>Class attendance</td><td>0.5</td><td>Seminar essay</td><td>0.25</td></tr>
<tr><td>Experimental work</td><td>0.25</td><td>Oral exam</td><td></td></tr>
<tr><td>Essay</td><td></td><td>Project</td><td></td></tr>
<tr><td>Tests</td><td></td><td>Practical training</td><td></td></tr>
<tr><td>Written exam</td><td>1.5</td><td>(Other--describe)</td><td></td></tr>
<tr><td>Research</td><td></td><td>(Other--describe)</td><td></td></tr>
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<tr><td>2.9. Grading and evaluation of student work over the course of instruction and at a final exam</td><td colspan="4">During the course exercise test as well as activity and student’s preparedness is evaluated. Final test is written and oral.</td></tr>
<tr><td rowspan="4">2.10. Required literature (available at the library and via other media)</td><td colspan="2">Title</td><td>Number of copies at the library</td><td>Availability via other media</td></tr>
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<tr><td>2.13. Comments</td><td colspan="4"></td></tr>
</table>

ORGANIC CHEMISTRY

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Prof. dr. sc. Olga Kronja Prof. dr. sc. Valerije Vrček Doc. dr. sc. Sandra Jurić Doc. dr. sc. Bernard Denegri
1.2. Associate teachers	Dr. sc. Mirela Matić Marijan Marijan, mag. chem.
1.3. Graduate programme	Pharmacy and Medical Biochemistry
1.4. Status of the course	Compulsory cours
1.5. Year of study, Semester	2 nd year, 3rd semester
1.6. Credit value (ECTS)	11 (Pharmacy), 11.5 (Medical Biochemistry)
1.7. Type of instruction (number of hours L+E+S+e-learning)	60+30+45
1.8. Expected enrolment in the course	150
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	
2. COURSE DESCRIPTION	
2.1. Course objectives	Understand the general principles of organic chemistry, the basis of stereochemistry, organic analysis (spectroscopy), key reaction mechanisms, as well as basic nucleophilic and electrophilic reactions.
2.2. Enrolment requirements and required entry competences for the course	
2.3. Learning outcomes at the level of the study programme to which the course contributes	The student will be able to analyze the properties of drugs based on the structure of active ingredients and also to predict an interaction with active site, based on the functionality of the compound. Also, based on knowledge of fundamental organic synthesis, he/she will be skilled to design the synthesis of new biological active compounds.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After competition the course, the student will competently describe the bonds in organic molecules, classify the organic compounds and name them. Also he/she will be able to recognize the sterochemical features of a given molecule and analyze the impact of the stereochemistry to reactivity, estimate the acidity/basicity of organic molecules and describe the electronic effects that determine them. Furthermore, the student will be able to determine the products of simple nucleophilic addition and substitution on the carbonyl group, nucleophilic substitution on saturated carbon, elimination and addition reactions and electrophilic substitution reactions. The student will be able to present the key reaction mechanism and indicate the structural and electronic features of the substrate that influence the reaction pathway. Finally, based on above, the student will be able to design the synthesis of simple organic compounds.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	<u>Lectures</u> Binding in organic molecules (3 hours) Classes and nomenclature of organic compounds (4 hours) Stereochemistry, shapes of molecules (3 hours) Stereochemistry, chirality and optical activity (4 hours) Spectroscopy, basis of NMR and IR (6 hours) Reaction mechanisms, Acidity and basicicty of organic compounds and structural feature that determine them (3 hours) Nucleophilic addition to carbonyl group, aldehydes and ketones (4 hours) Nucleophilic substitution on carbony groups, carboxylic acid derivatives (4 hours) Nucleophilic substitution on saturated carbon (4 hours) Elimination reactions , alkenes and alkynes (4 hours)

	Reaction of the -carbanions, condensation reactions (4 hours) Approach to organic synthesis (2 hours) Electrophilic additions to unsaturated carbon (2 hours) Conjugated additions (2 hours) Electrophilic aromatic substitutions (5 hours) Heterocyclic compounds (3 hours) Seminars Binding in organic molecules, classes and nomenclature of organic compounds (2 hours) Stereochemistry, chirality and optical activity (6 hours) Spectroscopy (2 hours) Characteristic reactions in organic chemistry and reaction mechanisms, Acid and base (1 hour) Aldehydes and ketones (2 hours) Carboxylic acid and derivatives (2 hours) Nucleophilic substitution on saturated carbon (2 hours) Elimination reactions, alkenes and alkynes (2 hours) Reaction of the carbanions - condensation reactions, Approach to organic synthesis (3 hours) Electrophilic additions (2 hours) Conjugated additions (2 hours) Aromatic compounds, Electrophilic aromatic substitutions (4 hours) Exercises Distillation (5 hours) Acetanilide, synthesis, isolation, identification (10 hours) Aniline, synthesis, isolation, identification (10 hours) Benzyl alcohol and benzoic acid, synthesis, isolation, identification (10 hours) Ethyl acetate, synthesis, isolation, identification (10 hours)
2.6. Type of instruction	lectures seminars workshops exercises online in entirety mixed *e*-learning mixed *m*-learning field work independent study multimedia and the internet work with the mentor (other)
2.7. Student responsibilities	Ordinarily attend on seminars and exercises

2.8. 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		Seminar essay	
	Experimental work	2	Oral exam	
	Essay		Project	
	Tests		Practical training	
	Written exam	9(9.5)	(Other--describe)	
	Research		(Other--describe)	
	Report		(Other--describe)	

2.9. Grading and evaluation of student work over the course of instruction and at a final exam	

2.10. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	S. H. Pine: "ORGANSKA KEMIJA", izdavač Školska knjiga, Zagreb 1994.		
	O. Kronja, S. Borčić: "PRAKTIKUM IZ ORGANSKE KEMIJE", Školska knjiga, 2004.		

2.11. Optional literature			
2.12. Methods of monitoring quality that ensure acquisition of exit competences	Tests, written and oral exam		
2.13. Comments			

ORGANIZATION AND MANAGEMENT OF MEDICAL BIOCHEMISTRY LABORATORY

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Ass. prof. Zlata Flegar-Meštrić, PhD
1.2. Associate teachers	Ass. prof. Mirjana Mariana Kardum-Paro, PhD Sonja Perkov, PhD
1.3. Graduate programme	Medical Biochemistry integrated study programme
1.4. Status of the course	Compulsory
1.5. Year of study, Semester	5th
1.6. Credit value (ECTS)	4,5
1.7. Type of instruction (number of hours L+E+S+e-learning)	30+0+15
1.8. Expected enrolment in the course	25
1.9. 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 acquire knowledge on the organization and quality management system of medical biochemistry laboratory with professional and economic requirements in accordance with legal regulations in health care system.
2.2. Enrolment requirements and required entry competences for the course	The condition for enrollment: Passed Clinical Biochemistry of organs and organs systems 2
2.3. Learning outcomes at the level of the study programme to which the course contributes	• Applying expert knowledge in laboratory diagnostic procedures, ensuring the quality of medical biochemistry laboratory, respecting the legislation in force, current health policy and guidelines and ethical principles of the profession. • Evaluation of methods and equipment and development and implementation of total quality management system using the rules of good professional practice, as well as the relevant EU directives and ISO norms. • Expression of management commitment to the development and implementation of strategic and business plans relevant to the profession. • The use of information technology and databases in order to improve professional knowledge and skills and self-education. • The application of the legal and ethical principles of the profession in individual and team work.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After passing the course the student will be able to: 1. Describe and define the role of medical biochemistry laboratory in accordance with the legal regulations in the Croatian health care; 2. Distinguish organizational and technical requirements of the international quality management standard for medical laboratories; 3. Identify problems and make decisions for the development and implementation of the quality management system in order to continually improve its effectivenes and ensure implementation of health and safety measures for the protection of laboratory personnel; 4. Assess the role and importance of information and communication technology (laboratory and hospital information system) in the implementation of total quality management system in the medical biochemistry laboratory.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	Lectures and seminars: • Health Care Law; Law on Medical Biochemistry; deontology and ethics in health care. • The role of the medical biochemistry laboratory in the health care system, organization, planning and management of the medical-biochemistry laboratory. • The introduction of the international quality management system:- Medical laboratories -requirements for quality and competence • The importance of laboratory and hospital information systems in the organization and management of the medical biochemistry laboratory.

<table>
<tr><td>2.6. Type of instruction</td><td colspan="3"><u>lectures</u>
<u>seminars</u>
<u>workshops</u>
exercises
online in entirety
mixed e-learning
mixed m-learning</td><td colspan="2">field work
independent study
multimedia and the internet
work with the mentor
(other)</td></tr>
<tr><td>2.7. Student responsibilities</td><td colspan="5">Regulary contribution on lectures, Seminars</td></tr>
<tr><td rowspan="7">2.8. 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)</td><td>Class attendance</td><td>1,5</td><td>Seminar essay</td><td>1</td></tr>
<tr><td>Experimental work</td><td></td><td>Oral exam</td><td></td></tr>
<tr><td>Essay</td><td></td><td>Project</td><td></td></tr>
<tr><td>Tests</td><td></td><td>Practical training</td><td></td></tr>
<tr><td>Written exam</td><td>2</td><td>(Other--describe)</td><td></td></tr>
<tr><td>Research</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>Report</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>2.9. Grading and evaluation of student work over the course of instruction and at a final exam</td><td colspan="5"></td></tr>
<tr><td rowspan="4">2.10. Required literature (available at the library and via other media)</td><td colspan="2">Title</td><td>Number of copies at the library</td><td>Availability via other media</td></tr>
<tr><td colspan="2">Čvorišćec D, Čepelak I, Štraus B. Štrausova medicinska biokemija. Zagreb: Medicinska naklada, 2009.</td><td></td><td></td></tr>
<tr><td colspan="2">Galjanić S, Vukasović I, Flegar-Meštrić Z. Acreditation of medical biochemistry laboratory. Course of continuous education
Of Croatian Chamber of Medical Biochemists , Zagreb: Medicinska naklada, 2010.</td><td></td><td></td></tr>
<tr><td colspan="2">Flegar-Meštrić Z: Harmonization of reporting the results of medical biochemistry tests: management of the postanalytical phase of laboratory processes. Course of continuous education
Of Croatian Chamber of Medical Biochemists , Zagreb: Medicinska naklada, 2014.</td><td></td><td></td></tr>
<tr><td>2.11. Optional literature</td><td colspan="5">- Law on Health Care. N.N. 121/2003.
- Law on Medical Biochemistry. N.N. 121/2003.
- HRN EN ISO 15189, Medical laboratories – Requirements for quality and competence
- V. Gašljević, Z. Flegar-Meštrić. Determination of measurement uncertainty in laboratory medicine, Croatian metrology society, Zagreb, 2010.</td></tr>
<tr><td>2.12. Methods of monitoring quality that ensure acquisition of exit competences</td><td colspan="5">The learning outcomes are checked in the framework of the final exam.</td></tr>
<tr><td>2.13. Comments</td><td colspan="5"></td></tr>
</table>

PATHOPHYSIOLOGY AND PATHOLOGY

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Assistant Professor Ivica Grgurević, MD, PhD Professor Milan Kujundžić, MD, PhD
1.2. Associate teachers	Assistant Professor Mario Tadić, MD, PhD Joško Mitrović, MD, PhD Tomas Matić, MD Tomislav Bokun, MD
1.3. Graduate programme	Pharmacy integrated study programme Biochemistry integrated study programme
1.4. Status of the course	Compulsory
1.5. Year of study, Semester	3 rd, first semestar
1.6. Credit value (ECTS)	7.5
1.7. Type of instruction (number of hours L+E+S+e-learning)	60 + 0 + 30
1.8. Expected enrolment in the course	150
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2 nd
2. COURSE DESCRIPTION	
2.1. Course objectives	Objectives of the course are to enable students to identify, understand and explain the causes and pathophysiologic mechanisms of the development of diseases and its complications, including clinical manifestations, as well as expected alterations in laboratory findings. The aforementioned knowledge is the base for understanding of drug acting mechanisms, eventually allowing students to acquire wide understanding on functioning of human body in sanity and disease, as well as the possibilities for the diagnosis and treatment of diseases. Acquired knowledge during the course constitutes the background for the continuation of undergraduate education and understanding of pharmacology and pharmacotherapy.
2.2. Enrolment requirements and required entry competences for the course	1. Undergraduate courses taken: i) Human physiology with anatomy, ii) Microbiology with parasitology. 2. Knowledge in human physiology and anatomy. 3. Experience in using text processing and presentation software (such as MS Office Package), as well as e-learning applications.
2.3. Learning outcomes at the level of the study programme to which the course contributes	1. Evaluation of the clinical significance of biochemical and molecular/biological parameters. 2. Interpretation of laboratory investigation results from the clinical aspect 3. Development of positive interaction with patients, colleagues and other healthcare professionals through person-to-person and written communication.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After passing the exam students will be able to: 1. Explain pathophysiologic basics of diseases development; 2. Explain mechanism of inflammation, cell death, tumour development, as well as to distinguish between different variants of cell death, immunologic reactions and tumours; 3. Define and describe major aetiology factors in pathophysiologic processes; 4. Illustrate major pathophysiologic processes at the level of cell, organ, and in the human body as a whole; 5. Define, analyse and explain how a pathophysiologic event in one organ relates

	and influences to other organs and human body as a whole; 6. Illustrate major pathomorphologic changes in diseased tissues and organs; 7. Analyse alterations in laboratory findings; 8. By knowing pathophysiologic processes, to define possible targets for drug actions; 9. Apply acquired theoretical knowledge for the recognition of diseases and its aetiology factors.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES AND SEMINARS: • Introduction to clinical pathophysiology. Cell death. Tumour genesis (l) • Tumour cachexia. Pathophysiology of pain. Gene regulation disorders (s) • Immune system. Inflammation. Autoimmune diseases (l) • Hypersensitivity reactions. Approach to patient with allergy (s) • Anaemia. Disorders of blood clotting (l) • Haematopoietic system. Leukaemia and lymphoma (s) • GI tract functions. GERD, gastritis and peptic ulcer disease. Inflammatory bowel disease (l) • Nausea and vomiting. Diarrhoea and constipation. Maldigestion and malapsorption (s) • Liver cirrhosis. Gallstone disease. Acute and chronic pancreatitis (l) • Liver failure. Portal hypertension. Viral hepatitis (s) • Heart and blood flow. Diseases of heart rate and rhythm. Valvular heart diseases (l) • Heart failure. Pulmonary hypertension (s) • Arterial hypertension. Coronary artery disease. Heart attack (l) • Diseases of pericardium. Shock. Diseases of arteries and veins (s) • Pathophysiology of infectious diseases. Sepsis. AIDS (l) • Problem solving of clinical scenarios (s) • Pathophysiology of endocrine system. Thyroid gland. Endocrine pancreas (l) Pathophysiology of the adrenal glands. Hypothalamus and hypophysis (s) • Diseases of bones. Rickets and osteomalacia (l) • Pathophysiology of diabetes mellitus. Hyperglycaemia, Hypoglycaemia. Hyperthyreosis. Hypothyreosis (s) • Disorders of renal functions. Acute and chronic renal failure. Hepatorenal syndrome (l) • Renal hypertension. Nephrotic syndrome. Nephrolithiasis (s) • Pathophysiology of respiration. Ventilation and perfusion. Restrictive and opstructive pulmonary diseases (l) • Acute and chronic respiratory insufficiency. Pulmonary oedema. Hypoxia and hyperoxia (s) • Pathophysiology of ionizing radiation. Noxiousness of chemicals. Noxious effects of physical and chemical factors on DNA (l) • Disorders of water and electrolytes. Acid-base disorders (s) • Disorders of consciousness. Cerebrovascular disease. Hydrocephalus (l) • Epilepsy. Neuromuscular diseases. Extrapyramidal disorders (s) • Basics of pathology (l) • Problem solving of clinical scenarios (s)
2.6. Type of instruction	**lectures** **seminars** workshops exercises online in entirety mixed *e*-learning mixed *m*-learning field work **independent study** multimedia and the internet work with the mentor (other)
2.7. Student responsibilities	Regular class attendance, active participation in seminars, active participation in solving of clinical scenarios.
2.8. Screening of student's work (specify	Class attendance: 2 — Seminar essay: 0.5

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)	Experimental work		Oral exam	1
	Essay		Project	
	Tests		Practical training	0.5
	Written exam	3,5	(Other--describe)	
	Research		(Other--describe)	
	Report		(Other--describe)	
2.9. Grading and evaluation of student work over the course of instruction and at a final exam	Partial exams and final written exam, seminar essay, active participation in solving of clinical scenarios.			

2.10. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	Kujundžić i suradnici: Klinička patofiziologija za studente Farmeceutsko-biokemijskog fakulteta. Zagreb, 2003.		
	Ivica Grgurević, Milan Kujundžić i sur.: Klinička patofiziologija za studente Farmeceutsko-biokemijskog fakulteta – u postupku izdavanja		

2.11. Optional literature	Kovač i suradnici: Klinička patofiziologija – etiopatogenetski čvorovi, 1.-4. dio, Medicinska naklada 2013. Kumar V, Abbas AK, Aster JC. Robbins & Cotran Pathologic Basis of Disease, 9th Edition. Elsevier 2014
2.12. Methods of monitoring quality that ensure acquisition of exit competences	Expected learning outcomes 1 to 8 are being acquired through lectures and seminars, and are evaluated through written exam. Expected learning outcome No. 9 is being acquired by problem solving of clinical scenarios.
2.13. Comments	

PERSONALIZED HEALTH CARE

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Professor Jerka Dumić
1.2. Associate teachers	Professor Gordan Lauc Associate Professor Gordana Maravić Vlahoviček Associate Professor Sanja Dabelić Associate Professor Olga Gornik Assistant Professor Sandra Šupraha Goreta
1.3. Graduate programme	Pharmacy
1.4. Status of the course	Elective
1.5. Year of study, Semester	3th, 4th, 5th year; 5th, 7th, 9th semester
1.6. Credit value (ECTS)	2
1.7. Type of instruction (number of hours L+E+S+e-learning)	15+0+5+0
1.8. Expected enrolment in the course	60
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2nd level; **e-learning – it is not a part of teaching hours, but it is used in studying since it contains case studies, problems with explanations, links on different useful web pages**
2. COURSE DESCRIPTION	
2.1. Course objectives	To understand the importance of interplay of genetic and external factors as the key determinant of health and disease and the effects of genetic factors on effectiveness and toxicity of therapeutic drugs. To evaluate the purpose, strengths and limitations of current and emerging genome technologies for clinical and personal applications. To be informed on ethical, economic, legal, and social issues related to pharmacogenomics and personalized medicine. To understand the role of pharmacists in the patient centred-care and personalized medicine.
2.2. Enrolment requirements and required entry competences for the course	Passed exam in Biological Chemistry.
2.3. Learning outcomes at the level of the study programme to which the course contributes	Creating, analysing and proposing the procedures related to research and development of drugs and in counselling about the pharmacotherapy and conducting od pharmaceutical care, respecting in the same time the legislative, actual health policies and guidelines as well as the principles of pharmaceutical ethics and deontology.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After passing the exam student will be able to: 1. Describe how genetics and genomics contribute to variability in drug metabolism and their role in drug therapy for the particular therapeutic areas as well as how genotype can be used to identify patients at risk for adverse drug reactions. 2. Use the available pharmacogenomics databases. 3. Describe the basic process for the development of "targeted therapies", from drug discovery, through clinical trials, to regulatory approval. 4. Explain the principles of genotype tests and how companion diagnostics contribute to the successfulness of personalized approach in prevention, treatment and prognosis of disease. 5. Illustrate how personalized medicine impacts therapeutic drug management. 6. Identify ethical, economic, legal and social issues that frequently arise with personalized medicine. 7. Describe how research and drug developments in personalised medicine, as well as personalized medicine in general, are presented in public, and the effects this may have on patients, policy & society overall, both locally and globally.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES: • Genes and inheritance. External risk factors: lifestyle, stress, environmental factors. Interplay of genetic and external factors – effects on health and disease,

<table>
<tr><td></td><td colspan="4">resistance and longevity. Genetics and physiology of aging.
• Complex genetics. Complex genetic diseases – cardiovascular diseases, cancer, diabetes, obesity, psychiatric diseases, inflammatory and autoimmune diseases, respiratory diseases, neurodegenerative diseases.
• Personalized medicine: prevention, therapy and prognosis. Pharmacogenetics and pharmacogenomics. Theranostics: diagnostic therapy for individual patients.
• Molecular diagnostics and genetic variability analysis – principles, application, purposes and social impacts. Molecular genetic epidemiology. Biobanks. Pharmacogenomics databases.
• Designer drugs and targeted therapies: the therapeutic potential of -omics.
• Nutrigenomics. Human Microbiome.
• Pharmacoeconomical approach in personalized health care.
• Personalized medicine and Pharmacogenomics: ethical, economic, legal and social issues. Complex genetic diseases: importance of public information and education.
SEMINARS:
• Ethical issues related to the availability and use of direct to consumer genetic testing for determining disease risk and related health outcomes.
• Role of pharmacist in health care and prevention of diseases: Patient-centred care – How to implement the knowledge on pharmacogenomics and theranostics in design, implementation, monitoring, evaluation, and adjustment of pharmacy care plans that are patient-specific; address health literacy, cultural diversity, and behavioural psychosocial issues; evidence-based and accomplished in collaboration with other health professionals.</td></tr>
<tr><td>2.6. Type of instruction</td><td colspan="2">lectures
seminars
workshops
exercises
online in entirety
mixed e-learning*
mixed m-learning</td><td colspan="2">field work
independent study
multimedia and the internet
work with the mentor
(other)
* e-learning – it is not a part of teaching hours, but it is used in studying since it contains case studies, problems with explanations, links on different useful web pages</td></tr>
<tr><td>2.7. Student responsibilities</td><td colspan="4"></td></tr>
<tr><td rowspan="8">2.8. 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)</td><td>Class attendance</td><td>0.5</td><td>Seminar essay</td><td>0,5</td></tr>
<tr><td>Experimental work</td><td></td><td>Oral exam</td><td>1</td></tr>
<tr><td>Essay</td><td></td><td>Project</td><td></td></tr>
<tr><td>Tests</td><td></td><td>Practical training</td><td></td></tr>
<tr><td>Written exam</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>Research</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>Report</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>2.9. Grading and evaluation of student work over the course of instruction and at a final exam</td><td colspan="4">Students are evaluated according to their active participation in the seminars, the quality of the essay and the results on the oral exam. On the final oral exam students are obliged to demonstrate the knowledge on all topics covered by the course on the level of skilful management of relevant information and synthesis of the thought matter.</td></tr>
<tr><td rowspan="2">2.10. Required literature (available at the library and via other media)</td><td colspan="2">Title</td><td>Number of copies at the library</td><td>Availability via other media</td></tr>
<tr><td colspan="2">J. Dumić et al. Personalized Health Care
Powerpoint presentations (as a part of e-learning)</td><td></td><td></td></tr>
</table>

	Jain KK Textbook of Personalized Medicine (2009) Springer ISBN: 978-1-4419-0768-4		
	Selection of newest scientific literature		
2.11. Optional literature			
2.12. Methods of monitoring quality that ensure acquisition of exit competences	Learning outcomes 2 and 5 will be monitored during seminars, while learning outcomes 1, 3, 4, 6 and 7 will be assessed with oral exam.		
2.13. Comments			

PHARMACEUTICAL ANALYSIS

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Biljana Nigović, full professor
1.2. Associate teachers	Renata Jurišić Grubešić, associated professor Ana Mornar Turk, associated professor Jadranka Vuković Rodriguez, associated professor Miranda Sertić, assistant professor
1.3. Graduate programme	integrated
1.4. Status of the course	obligatory
1.5. Year of study, Semester	4^{th}, 7^{th}
1.6. Credit value (ECTS)	10,5
1.7. Type of instruction (number of hours L+E+S+e-learning)	60+60+15
1.8. Expected enrolment in the course	130
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2.
2. COURSE DESCRIPTION	
2.1. Course objectives	Students will learn about the system of analytics and quality control of medicines; they will understand the development and validation of analytical methods for pharmaceutical samples according to the methodology of the European Pharmacopoeia; know modern analytical techniques for identification, purity testing and determination of pharmaceuticals. The acquired knowledge and skills provide a basis for electives courses Analytics in the development of pharmaceutical products and Quality assurance and registration of medicines.
2.2. Enrolment requirements and required entry competences for the course	Analytical chemistry I and II – exams passed Medicinal chemistry II – course attended
2.3. Learning outcomes at the level of the study programme to which the course contributes	1. Proposing procedures related to the analysis and quality control of medicines. 2. Applying analytical methods to ensure the quality of medicines in accordance with good laboratory practice and the relevant European directives.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	1. Describe and use pharmacopoeia monographs for the analysis of active pharmaceutical substances and excipients, and quality control of medicines. 2. Explain the analysis of pharmaceuticals using spectroscopic (IR, NIR, UV Vis, fluorescence, Raman spectroscopy, AES, AAS, ICP, NMR, MS, X-ray), chromatographic (HPLC, GC, TLC, HPTLC, gel and ion chromatography , GC-MS, LC-MS), electrophoretic, electrochemical and thermoanalytical techniques. 3. Compare the possibility of different analytical techniques and choose the appropriate technique to address specific problems in pharmaceutical analysis. 4. Define the sources and types of impurities in pharmaceuticals and choose the methods for their control in accordance with the relevant ICH guidelines and European directives. 5. Apply analytical methods for identification, purity testing and quantitative determination of pharmaceutical ingredients and calculate the content of impurities and the percentage of the declared content in pharmaceutical dosage forms. 6. Explain analysis of polymorphs, hydrates, enantiomers, and biological medicines by various analytical techniques and correlate their quality control in terms of bioavailability, stability of the pharmaceutical product and adverse drug effects. 7. Carry out validation of analytical method and define guidelines of good manufacturing practice and good laboratory practice.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES • Introduction to analytical studies of pharmaceuticals and legislation. • European Pharmacopoeia. National Pharmacopoeia. Pharmacopoeia

	monographs. Chemical Reference Standard, Biological Reference Preparations, and reagents. • Infrared spectroscopy (IR) in the identification of pharmaceutical substances as the fingerprint method. Interpretation of the IR spectra of the drug molecule. Identification of active pharmaceutical substances and excipients by chemical reactions according to the regulations of the European Pharmacopoeia. • Impurities in pharmaceutical substances: sources, types and control. • UV-Vis spectrophotometry: identification, purity testing, quantitative analysis and determination of physico-chemical properties of drugs. • Physical and chemical properties of drug molecules important in the selection and development of analytical methods. • The chromatographic parameters and separation efficiency. Quantitative analysis of pharmaceutical substances and pharmaceutical dosage forms using internal and external standard method, calibration and normalisation procedures. • Gas chromatography (GC): determination of volatile impurities and residual solvents, types of stationary phases and detectors, derivatization in GC analysis. • Pharmaceutical analysis using high performance liquid chromatography (HPLC). Reversed-phase and normal-phase chromatography. The effect of the drug's *molecular structure* on the *retention time*. Isocratic and gradient elution. HPLC analysis with the addition of ionic reagents. • The analysis of anions and cations by ion chromatography. HPLC analysis of peptide drugs. Gel chromatography in analysis of the biological medicines. Supercritical fluid chromatography. • Thin layer chromatography (TLC) in pharmacopoeia methods. High Performance TLC (HPTLC) in pharmaceutical analysis. • Validation of analytical procedures. Analytical parameters in the validation process. • Structural analysis of pharmaceuticals using NMR spectroscopy. • The application of mass spectrometry (MS) in pharmaceutical analysis: types of ionization, fragmentation of drug molecules, selective ion mass analyzer. • Hyphenated techniques in pharmaceutical analysis: LC-MS techniques in the characterization of drug impurities and metabolites, GC-MS technique in bioanalytics and identification of degradation products. • Determination of the physical constants of pharmaceutical substances and limit tests according to the regulations of the European Pharmacopoeia. • Atomic emission (AES) and atomic absorption spectroscopy (AAS) and inductively coupled plasma (ICP) emission spectroscopy/mass spectrometry for determination of metal content in the pharmaceutical substances by standard addition method and direct calibration. • Near-infrared spectroscopy (NIR): the determination of moisture and particle size, identification and determination of the content of active substance in the multicomponent dosage forms, the control of bend uniformity of compositions for pharmaceutical formulations. • Raman spectroscopy in pharmaceutical analysis. • Fluorescence spectrophotometry: application and examples of quantitative determination of pharmaceuticals. • Electrophoresis in pharmaceutical analysis. Capillary electrophoresis (CE): factors affecting the migration velocity and separation, types of CE, drug impurity profiling. • Electroanalytical methods in pharmacopoeial procedures of analysis. • Thermoanalytical methods in pharmaceutical analysis: thermogravimetry, differential thermal analysis, differential scanning calorimetry and thermal microscopy. • Analytical methods for studying and characterizing polymorphs, spectroscopic techniques, solid-state NMR and X-ray powder diffraction.

- Methods for the analysis of hydrate drug forms and the determination of water by Karl-Fischer titration.
- Methods for the analysis of enantiomers: polarimetry, circular dichroism, single crystal X-ray diffraction. Chiral chromatography and testing enantiomeric purity.
- Titrimetric methods of analysis in the pharmacopoeia procedures. Flow injection analysis.
- Determining the quality of excipients. Determination of total organic carbon in pharmaceutical water.
- Analysis of biological medicines: peptide mapping and amino acid analysis, immunoassays. Tests for sterility, pyrogenic substances and bacterial endotoxin in pharmaceutical preparations. Analysis of radiopharmaceuticals.
- Quality control of medicines. Pharmaceutical quality assurance. Good manufacturing practice. Good laboratory practice.

SEMINARS

- The calculation of limit values of inorganic contaminants in pharmaceutical substances.
- Quantitative determination of active pharmaceutical substances and excipients using titrimetric analytical methods according to pharmacopoeia regulations.
- Quantitative determination of active pharmaceutical substances and determination of the percentage of the declared content in pharmaceutical formulations using UV-VIS technique.
- Determination of validation parameters: accuracy, precision, limit of detection and limit of quantification.
- Calculation of capacity factor, column effectiveness, selectivity coefficient and permitted impurity content in chromatographic procedures of pharmaceutical analysis.
- Determination of the percentage of the declared content of active pharmaceutical substances in pharmaceutical dosage forms using calibration curve, internal and external standard by liquid and gas chromatography.
- Determination of chiral drug optical purity. Determination of drug impurities using potentiomery and standard addition method.
- Determination of metal content in the pharmaceuticals using standard addition method and direct calibration method of AAS and AES technique.

LABORATORY EXCERCISES

- Identification of excipients using selective chemical reactions and by determining the melting point.
- Identification of ephedrine and calcium pantothenate by specific optical rotation determination.
- Identification of active pharmaceutical substances (atropine, barbital, benzocaine, phenobarbital, furosemide, propranolol, nifedipine, morphine, quinine, codeine, amoxicillin, oxytetracycline, etc.) using IR, UV-Vis spectrophotometry and thin layer chromatography.
- Identification of active pharmaceutical substances in analgoantipyretic tablets by TLC.
- Identification of acetylsalicylic acid and ascorbic acid in tablets by HPLC.
- Testing of clarity and degree of opalescence for resorcinol and calcium gluconate solutions.
- Testing of proteolytic impurities in chloramphenicol, caffeine, zinc oxide, procaine and sulfacetamide.
- Limit tests of inorganic impurities such as chloride in dextrin, sulfates in potassium bicarbonate and calcium in tartaric acid.
- Impurity testing of atropine, cephalexin and lactose using UV-Vis spectrophotometry.
- Impurity testing of nifedipine and chloramphenicol using TLC.

<table>
<tr><td></td><td colspan="4">

Impurity testing of chiral drug substances, ascorbic acid, chloramphenicol, codeine and morphine using polarimetry.
Impurity testing of acetylsalycilic acid using high performance liquid chromatography.
Impurity testing of ethanol by gas chromatography.
Determination of theobromine, acetylsalicylic acid, sodium chloride in eye drops, calcium lactate and ascorbic acid using titrimetric methods.
Determination of chloramphenicol, rifampicin and ketoprofen using UV-Vis spectrophotometry.
Determination of cephalexin monohydrate using HPLC.
Determination of the percentage of the declared content of ibuprofen in the dosage form by HPLC.
Validation of the analytical method for the determination of chloramphenicol by UV-Vis spectrophotometry.

</td></tr>
<tr><td>2.6. Type of instruction</td><td colspan="2">lectures
seminars
workshops
exercises
online in entirety
mixed e-learning
mixed m-learning</td><td colspan="2">field work
independent study
multimedia and the internet
work with the mentor
(other)</td></tr>
<tr><td>2.7. Student responsibilities</td><td colspan="4">Mandatory attendance at lectures, seminars and laboratory exercises.</td></tr>
<tr><td rowspan="7">2.8. 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)</td><td>Class attendance</td><td>2</td><td>Seminar essay</td><td></td></tr>
<tr><td>Experimental work</td><td>2</td><td>Oral exam</td><td>3,5</td></tr>
<tr><td>Essay</td><td></td><td>Project</td><td></td></tr>
<tr><td>Tests</td><td>1</td><td>Practical training</td><td></td></tr>
<tr><td>Written exam</td><td>2</td><td>(Other--describe)</td><td></td></tr>
<tr><td>Research</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>Report</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>2.9. Grading and evaluation of student work over the course of instruction and at a final exam</td><td colspan="4">Entry and final test for laboratory exercises, experimental work grade, written and oral exam.</td></tr>
<tr><td rowspan="4">2.10. Required literature (available at the library and via other media)</td><td>Title</td><td colspan="2">Number of copies at the library</td><td>Availability via other media</td></tr>
<tr><td>B. Nigović, Predavanja iz analitike lijekova, Faculty of Pharmacy and Biochemistry, 2016.
B. Nigović, Seminari iz analitike lijekova, Faculty of Pharmacy and Biochemistry, 2016.
B. Nigović, R. Jurišić-Grubešić, J. Vuković-Rodriguez, A. Mornar Turk, M. Sertić, Praktikum iz analitike lijekova, skripta, Faculty of Pharmacy and Biochemistry, 2014.</td><td colspan="2"></td><td>available on web</td></tr>
<tr><td>D. G. Watson, Pharmaceutical analysis, A Textbook for Pharmacy Students and Pharmaceutical Chemists, 3nd Edition, Elsevier, 2012.</td><td colspan="2">25</td><td></td></tr>
<tr><td>European Pharmacopoeia 8th edition, Council of Europe, Strasbourg, 2014.</td><td colspan="2">1</td><td></td></tr>
<tr><td>2.11. Optional literature</td><td colspan="4">Satinder Ahuja, Stephen Scypinski, eds., Handbook of modern pharmaceutical analysis, Academic Press, San Diego, 2010.</td></tr>
<tr><td>2.12. Methods of monitoring quality that ensure acquisition of exit</td><td colspan="4">Outcomes 1, 5 and 7 are checked during the experimental work and final test from exercises. Outcomes 2, 3, 4, 6 are checked by written and oral exam.</td></tr>
</table>

competences	
2.13. Comments	

PHARMACEUTICAL ASPECTS OF TRADITIONAL CHINESE MEDICINE

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Asst. prof. Biljana Blažeković, PhD
1.2. Associate teachers	Prof. Sanda Vladimir-Knežević, PhD Marija Kindl, PhD Assoc. prof. Roberta Petlevski, PhD
1.3. Graduate programme	Pharmacy - integrated study program
1.4. Status of the course	Elective
1.5. Year of study, Semester	4th and 5th years
1.6. Credit value (ECTS)	2,5
1.7. Type of instruction (number of hours L+E+S+e-learning)	25+5+0+*
1.8. Expected enrolment in the course	60
1.9. 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	The aim of the course is to acquire knowledge about the traditionally used Chinese herbal drugs which are more widespread in the European pharmacy. Students will be introduced to the basic concepts of treatment within the system of Traditional Chinese medicine (TCM) and learn the most commonly-used Chinese herbal and animal drugs, their active principles, traditional and rational use, procedures used in evaluation of their safety and efficacy and quality control as well as the regulatory frameworks for Chinese herbal drugs and phytopharmaceuticals.
2.2. Enrolment requirements and required entry competences for the course	Enrolment requirement: passed examination in Pharmacognosy 2
2.3. Learning outcomes at the level of the study programme to which the course contributes	• Apply expert knowledge and skills to provide advice on pharmacotherapy (phytotherapy) and medical care to patients • Informing and advising patients on the effects and proper application of (phyto)pharmaceuticals • Critically assess and apply scientific discoveries and available data with the aim of enhancing knowledge
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After successfully completing the course, students will be able to: 1. Understand and describe the fundamental concepts of Traditional Chinese Medicine and the main TCM therapeutic principles and methods 2. Identify the differences in phytotherapy in the context of traditional Chinese and conventional medicine 3. Define and describe the most commonly-used Chinese herbal drugs and their active principles 4. Understand the importance of standardization and quality assurance of Chinese herbal drugs and for their effective and safe use 5. Critically evaluate and propose procedures for quality control as well as safety and efficacy assessments of TCM herbal drugs and preparations 6. Understand the valid legal regulations in the field of herbal remedies and food supplements containing Chinese herbal drugs 7. Recognize the importance of research of TCM herbal drugs for the drug discovery and development 8. Apply basic knowledge and skills of Chinese herbal drugs identification in practice

<table>
<tr><td>2.5. Course content broken down in detail by weekly class schedule (syllabus)</td><td colspan="4">LECTURES:
• Historical development and current status of traditional Chinese medicine
• Basic Theories of TCM. TCM diagnosis and therapeutic principles
• Phytotherapy and other TCM treatment methods
• Characteristics, functions and processing of herbal drugs in TCM
• Pharmaceutical dosage form of traditional Chinese herbal medicine
• Chinese herbal drugs containing carbohydrates, lipids and essential oil
• Chinese herbal drugs with diterpenoids and triterpenoids
• Chinese herbal drugs containing phenolic compounds
• Alkaloid-containing Chinese herbal drugs
• Animal drugs in Chinese Materia Medica
• Pharmaceutical quality of Chinese herbal drugs and preparations - Chinese and European Pharmacopoeia; Pharmacopoeial method for identification, purity testing and assay; Use of modern (non-pharmacopoeial) techniques in analysis and quality control.
• Safety issues affecting Chinese herbal medicine – Misidentification, adulteration and contamination problems; Adverse effects and interactions; Toxicity assessment with conventional and “omics” methods.
• Clinical studies of traditional Chinese herbal medicine
• Regulatory framework for Chinese herbal drugs and preparations in the EU and world
• Global importance of TCM herbs research for the drug discovery and development (example of artemisinin, camptothecin, huperzine A)

LABORATORY EXERCISES:
Macroscopic, microscopic and phytochemical identification of selected TCM herbal drugs according to the European Pharmacopoeia Monographs.</td></tr>
<tr><td>2.6. Type of instruction</td><td colspan="2">lectures
seminars
workshops
exercises
online in entirety
mixed e-learning
mixed m-learning</td><td colspan="2">field work
independent study
multimedia and the internet
work with the mentor
(other)</td></tr>
<tr><td>2.7. Student responsibilities</td><td colspan="4">Students are required to attend classes regularly and participate actively, to complete laboratory exercises and pass the final exam successfully.</td></tr>
<tr><td rowspan="8">2.8. 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)</td><td>Class attendance</td><td>0,5</td><td>Seminar essay</td><td></td></tr>
<tr><td>Experimental work</td><td>0,5</td><td>Oral exam</td><td></td></tr>
<tr><td>Essay</td><td></td><td>Project</td><td></td></tr>
<tr><td>Tests</td><td></td><td>Practical training</td><td></td></tr>
<tr><td>Written exam</td><td>1,5</td><td>(Other--describe)</td><td></td></tr>
<tr><td>Research</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>Report</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td colspan="4"></td></tr>
<tr><td>2.9. Grading and evaluation of student work over the course of instruction and at a final exam</td><td colspan="4">Students are evaluated according to a written exam.</td></tr>
<tr><td rowspan="3">2.10. Required literature (available at the library and via other media)</td><td colspan="2">Title</td><td>Number of copies at the library</td><td>Availability via other media</td></tr>
<tr><td colspan="2">Blažeković B et al. Pharmaceutical aspect of traditional Chinese medicine – PowerPoint presentation and other teaching materials</td><td></td><td>e-learning system Merlin</td></tr>
<tr><td colspan="2">EDQM. European Pharmacopoeia. 8. ed. Strasbourg, Council of Europe, 2013.</td><td>1</td><td></td></tr>
</table>

2.11. Optional literature	Hempen CH, Fischer T. A materia medica for Chinese medicine: Plants, minerals, and animal products. Edinburgh, Churchill Livingstone, 2009.
	Wagner H, Bauer R et al. Chromatographic fingerprint analysis of herbal medicines : thin-layer and high performance liquid chromatography of Chinese drugs. Vol. I-III. Wien, New York, Springer Verlag, 2011.
2.12. Methods of monitoring quality that ensure acquisition of exit competences	• Assessment of learning outcomes during laboratory exercises (learning outcome 8) and final written exam (learning outcomes 1-7) • Analysis of the student course evaluation is used to improve the quality of teaching
2.13. Comments	*E-learning is not included in standard teaching hours, but it is used in teaching since it contains useful links to different websites and video materials.

PHARMACEUTICAL BOTANY

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Željan Maleš, Full Professor with tenure
1.2. Associate teachers	Kroata Hazler Pilepić, Associate Professor Maja Crkvenčić, Assistant
1.3. Graduate programme	Pharmacy
1.4. Status of the course	Mandatory
1.5. Year of study, Semester	First, second
1.6. Credit value (ECTS)	7.5
1.7. Type of instruction (number of hours L+E+S+e-learning)	30+30+15
1.8. Expected enrolment in the course	130
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2
2. COURSE DESCRIPTION	
2.1. Course objectives	Students will learn the fundamentals of general and special botany with special emphasis on medicinal plants. The knowledge and skills obtained will serve as basis for courses Pharmacognosy I and Pharmacognosy II.
2.2. Enrolment requirements and required entry competences for the course	There are no requirements for enrolment. However, it is expected that students have passed high school level course of biology.
2.3. Learning outcomes at the level of the study programme to which the course contributes	Knowledge of pharmaceutical botany obtained is necessity in: defining procedures related to research, development, production, analysis and quality control of herbal medicines.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After passing the course the student will be able to: 1. Explain the basic concepts of botany. 2. Define and compare the types and roles of plant tissues. 3. Define the morphological and anatomical characteristics of vegetative and generative plant organs. 4. Describe the functions of plant organs. 5. Describe the processes of pollination, fertilization and dispersal of seeds and fruits. 6. Differentiate and identify the species of selected families with special emphasis on medicinal plant species. 7. Perform microscopic analysis of plant tissues and organs.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES: • Introduction to the course, Division of botany, Structure and secondary changes of the cell wall, Secondary metabolites. • Aleurone granules, The crystals of calcium oxalate, Introduction to histology, Primary and secondary dermal tissues, Ground tissues. • Mechanical tissues, Vascular (transport) tissues, Glandular (secretory) tissues, The function of the root and root zones, Primary structure of root. • Secondary structure of root, Stem - function and types, Primary and secondary structure of stem. • Leaf - function, division and anatomy; Growth, development and reproduction of plants; The life forms of plants. • The function and parts of flower, Flower formula and diagram, Types of

inflorescences,
Pollination and fertilization.

- Characteristics of fruits, Dispersal of seeds and fruits, Introduction to plant systematics,
  Prokaryotes.
- Algae, Fungi, Lichens, Mosses, Ferns.
- Gymnosperms, Characteristics and representatives of the orders Magnoliales, Piperales, Ranunculales,
  Papaverales and Fagales.
- Characteristics and representatives of the orders Urticales, Rosales, Fabales, Myrtales, Rutales, Geraniales, Rhamnales, Euphorbiales and Santalales.
- Characteristics and representatives of the orders Apiales, Theales, Capparales and Malvales.
- Characteristics and representatives of the orders Ericales, Primulales, Caryophyllales, Polygonales and Gentianales.
- Characteristics and representatives of the orders Dipsacales, Oleales, Polemoniales, Scrophulariales and Lamiales.
- Characteristics and representatives of the order Asterales.
- Monocotyledons – orders Zingiberales, Liliales, Orchidales, Poales and Arales

SEMINARS:

- Medicinal plant species – fresh plant material and herbarium material.
- Root transformations, Above-ground stems, Stem position.
- Above-ground and underground stem transformations, Phylloclades,
  Leaf - shapes and venation, Leaf disposition and transformations.
- Eucarpia - dry fruits – dehiscent fruits.
- Eucarpia - dry fruits – indehiscent fruits and loments.
- Eucarpia - fleshy fruits and pseudocarpia (accessory fruits).
- Brown and red algae, Cones of the species of the family Pinaceae, Fruits of the plants of the family Cupressaceae.
- Fruits of the plants of the order Magnoliales, Fruits of the plants of the family Fagaceae.
- Tropical plant species.
- Pharmaceutical Botanical Garden "Fran Kušan“ – getting acquainted with characteristics of the garden and disposition of plant species.
- Pharmaceutical Botanical Garden "Fran Kušan“ – study of Gymnosperms.
- Pharmaceutical Botanical Garden "Fran Kušan“ – study of Dicotyledons: orders Magnoliales, Piperales, Ranunculales, Papaverales, Fagales, Urticales, Rosales, Fabales, Myrtales, Rutales, Geraniales, Rhamnales, Euphorbiales and Santalales.
- Pharmaceutical Botanical Garden "Fran Kušan“ – study of Dicotyledons: orders Apiales, Theales, Capparales, Malvales, Ericales, Primulales, Caryophyllales and Polygonales.
- Pharmaceutical Botanical Garden "Fran Kušan“ – study of Dicotyledons: orders Gentianales, Dipsacales, Oleales, Polemoniales, Scrophulariales, Lamiales and Asterales.
- Pharmaceutical Botanical Garden "Fran Kušan“ – study of Monocotyledons.

LABORATORY EXERCISES:

- Plant histology: ground tissue *(Ricinus, Clematis)*.
- Plant histology: dermal tissue *(Rheo,Vanilla, Elegnus, Verbascum, Sambucus)*.
- Plant histology: vascular (transport) tissue *(Cucurbita, Pinus)*.

	• Plant histology: mechanical tissue *(Rumex, Pirus, Tilia)*. • Plant histology: glandular (secretory) tissue (*Myrtus, Euphorbia, Mentha)*. • Plant anatomy: stem *(Zea, Ranunculus,Tilia, Pinus*), root *(Iris)*. • Plant anatomy: leaf *(Pinus, Iris*, *Helleborus)*. • Plant systematics: algae *(Fucus),* lichens *(Cetraria),*mosses *(Politrichum).* • Plant systematics: ferns *(Equisetum, Polypodium)*. • Plant systematics: gymnosperms *(Taxus, Juniperus),* angiosperms *(Magnolia)*. • Plant systematics: angiosperms dicotyledons Papaverales, Fabales, Rosales *(Chelidonium, Laburnum, Crataegus)*. • Plant systematics: angiosperms Rhamnales, Rutales, Capparales *(Frangula, Ruta, Alliaria)*. • Plant systematics: angiosperms Primulales, Gentianales *(Primula, Vinca)*. • Plant systematics: angiosperms Araliales, Lamiales, Scrophulariales *(Carum, Salvia, Digitalis)*. • Plant systematics: angiosperms monocotyledons Liliales, Poales *(Allium, Secale, Iris)*.

2.6. Type of instruction	**lectures** **seminars** workshops **exercises** online in entirety mixed *e*-learning mixed *m*-learning	field work **independent study** multimedia and the internet work with the mentor (other)

2.7. Student responsibilities	Attendance of lectures, seminars and laboratory exercises is mandatory.			
2.8. 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	1	Seminar essay	0.5
	Experimental work	1	Oral exam	4
	Essay		Project	
	Tests	1	Practical training	
	Written exam		(Other--describe)	
	Research		(Other--describe)	
	Report		(Other--describe)	
2.9. Grading and evaluation of student work over the course of instruction and at a final exam	Practical and written preliminary exam. Recognition of plant species present in the Pharmaceutical Botanical Garden "Fran Kušan". Recognition of dry plant material (fruits, underground organs). Oral exam.			

2.10. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	1. D. Denffer, H. Ziegler, Udžbenik botanike za visoke škole - Morfologija i fiziologija, Školska knjiga, Zagreb 1991., tiskani oblik.	13	
	2. K. Mägdefrau, F. Ehrendorfer, Udžbenik botanike za visoke škole - Sistematika, evolucija i geobotanika, Školska knjiga, Zagreb 1997., tiskani oblik.	4	
2.11. Optional literature	1. R. Domac, Flora Hrvatske: priručnik za određivanje bilja, II. izdanje, Školska knjiga, Zagreb 2002., tiskani oblik. 2. W. Schaffner, B. Häfelfinger, B. Ernst, Ljekovito bilje: kompendij, Leo-commerce,		

	Rijeka 2009., tiskani oblik.
2.12. Methods of monitoring quality that ensure acquisition of exit competences	Learning outcomes 1-5 are assessed by oral exam and learning outcomes 6-7 with practical exam after laboratory exercises.
2.13. Comments	

PHARMACEUTICAL CHEMISTRY

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Assoc. Professor, Milena Jadrijević-Mladar Takač, PhD
1.2. Associate teachers	-
1.3. Graduate programme	Integrated study of medical biochemistry
1.4. Status of the course	Obligatory
1.5. Year of study, Semester	2nd Year, 4th Semester
1.6. Credit value (ECTS)	3.5
1.7. Type of instruction (number of hours L+E+S+e-learning)	30L + e-learning
1.8. Expected enrolment in the course	25
1.9. 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. pharmacological	The primary objective of Pharmaceutical chemistry in the Integrated study of medical biochemistry is to introduce students to the major concepts of pharmaceutical chemistry that support research, development and clinical use of medicine, the design and application of pro-drugs, structural and physico-chemical properties relevant to the pharmacological effects (SAR) and side effects (ADRs) of drugs in clinical use. Where it would be appropriate, the influence of medicines on the diagnostic results will be also discussed. Through the introduction to the main therapeutic groups and their subgroups students will gain knowledge about chemistry, pharmacological effects, side effects and indications of the most important medicines that are in clinical use.
2.2. Enrolment requirements and required entry competences for the course	Attended Organic chemistry as well as the basic knowledge in organic and inorganic chemistry, cell biology, physiology, anatomy and biochemistry are needed.
2.3. Learning outcomes at the level of the study programme to which the course contributes	Acquiring a basic knowledge of pharmaceutical aspects of medicines that are in clinical use will be of benefit to students in defining, analyzing and proposing activities related to research and the implementation of new laboratory procedures in monitoring the outcomes of therapy, also in detection of diseases caused by medicines as well as in the interpretation of laboratory test results. The above mentioned knowledge will also contribute to the positive interactions with patients, colleagues, health care and other professionals in the health system.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After passing the course, students will be able to: o know the most relevant therapeutic groups of medicines and the classification within each group, o draw the chemical structure of certain medicines, o know the mechanisms of pharmacological effect and side effects of medicines from the most important therapeutic groups, o identify medicines that can affect diagnostic tests, and o use acquired knowledge in other similar disciplines of the course.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	Part I - Introduction to medicinal chemistry: Historical background and development. Drugs. Drug classification. Drug use. Rp and OTC drugs. New drug R&D methods. Structure Activity Relationship (SAR). Adverse Drug Reactions (ADRs) Part II - Drugs in therapy for disturbances of water, electrolyte and acid/base regulation. Acids. Bases; Drugs used in gastrointestinal disorders: Antacids. Antiemetics. Antiulcer drugs. Antidiarrheal drugs. Laxatives. Contrast media: Radioactive isotopes in medical diagnosis, contrast imaging agents. Part III - Plasma blood substituents and plasma expanders; Antianemia drugs; Drugs in prevention and therapy of infective diseases: Antiseptics. Disinfectants.

	Preservatives. Acids, esters and phenole dermatological products. Urinary tract antiseptics. Antibacterial drugs: 1st generation of gyrase inhibitors, older drugs; 2nd generation of gyrase inhibitors, newer drugs – fluoroquinolone antibiotics. Sulfonamides and related drugs. History. Pro-drug approach development. Chemistry and mechanism of action. Sulfonamides classification. Combined sulfonamides. Indications and clinical use. Sulfones. Indication, clinical use, ADRs. Part IV - Antibiotics: Introduction. Beta-lactam antibiotics and other cell wall synthesis inhibitors: 1 Penicillins – chemistry and mechanism of action. Biosynthesis. Stability. Classification. Indications and clinical use. Side effects. Propenicillins. Therapeutic combinations. Suicide antibiotics; 2. Cephalosporins. Chemistry and mechanism of action. Indication, clinicl use and ADRs. Pro-drugs; 3. Carbapenems. 4. Monobactams; and Glycopeptide antibiotic (vancomycin) and other cell wall synthesis inhibitors (daptomycin, fosfomycin, bacitracin, cycloserin) Part V - Bacterial protein synthesis inhibitors: Chloramphenicol. Tetracyclines. MLSK antibiotics (Macrolides: erythronolides (erythromycin and congeners), azalides (azithromycin). Lincosamides. Streptogramins. Ketolides; Aminoglycosides: Streptomicyn group. Neomycin group. Kanamycin-Gentamycin group. Structural features. Chemistry. Indication and clinical use. Side effects. Rifamycins. Pyranoside antibiotics. Antibiotics with peptide structure. Glycopeptides. Fosfomycin. Antituberculotics: 1^{st} line and 2^{nd} line. Chemistry and mechanism of actions. Indication, clinical use, ADRs. Part VI - Antimycotics: polyene antibiotics, griseofulvin and synthetic antimycotics. Chemotherapy of protozoal diseases: Antimalarial drugs. Antitripanosomal drugs. Drugs against leichmaniases, trichomoniasis, amebiasis and toxoplasmosis. Anthelmintic drugs. Structural features and classification. Indication, clinical use, ADRs. Part VII - Antiviral drugs: The most common viral infections. Chemotherapy of viral diseases. Classification of antiviral drugs. Chemistry and mechanisms of action. Indication, clinical use, ADRs. HIV Chemotherapy. Interferons. Cytokins. Part VIII - Anticancer Drugs (Antineoplastics): Chemotherapy of malignant tumors. Drug classification. Chemistry and mechanism of action. Indication, clinical use, ADRs. Hormons and hormon antagonists in antineoplastic therapy. Part IX – NSAIDs, acetaminophen and drugs used in rheumatoid arthritis and gout: Pain and chemotherapy of pain. Classification of NSAIDs. COX-1 and COX-2 isoenzyme inhibition. Chemistry and mechanism of action. SAR. Indication, clinical use, ADRs; Antirheumatics. Gout therapy. Opioid analgesics: agonists and antagonists. Addiction. Toxicity. Indication, clinical use, ADRs. Antitussives. Antimigraine drugs; Anesthetics: general and local. Part X – Drugs that act in central nervous system: Muscle relaxants (spasmolytics, CNS acting) and non-centrally acting neuromuscular blokers. Antiepileptics. Chemistry. Classification. Antiparkinsonian drugs (centrally-active anticholinergics, L-dopa, ergot alkaloids). Sedatives-Hypnotic drugs. Neuroleptics (Major tranquilizers, Antipsyhotics). Antidepressants. Tranquilizers (Minor tranquilizers or ataractics). Psychotropics (Stimulants or Psychoanaleptics). Drugs of abuse. Psychodysleptics (Psycholytics, Psychotomimetics or Hallucinogens). Chemistry and mechanism of action. QSAR. Indications, clinical use, ADRs. Part XI – Autonomic nerve system drugs- Drugs affecting the parasympathetic nervous system: Cholinoreceptor-activating (direct) and cholinesterase-inhibiting drugs (indirect); Cholinoreceptor blockers and cholinesterase regenerators. Classification. Chemistry and mechanism of action. Indication, clinical use,

	ADRs.Drugs affecting the symphatetic nervous system: sympathomimetics, adrenoreceptor blockers and antisympathetic agents. Part XII - Cardiovascular drugs: Antihypertensives (direct, centrally-acting, beta blockers, alpha 1 blockers, ACE inhibitors, calcium channel blockers, ganglioblockers). Diuretics (thiazides, sulfonamides, LOOP diuretics, carbonic anhydrase inhibitors, osmotic diuretics). Drugs used in treatment of angina pectoris, heart failure and antiarrhytmic drugs. Classification. Chemistry and mechanism of actions. Indication, clinical use, ADRs. Part XIII – Endocrine drugs (A): Hormones and drugs used in endocrine disease that affecting hormonal system: hypothalamic and pituitary hormones; thyroid and antithyroid drugs; corticosteroids (glucocorticosterids and mineralocorticoids) and antagonists, tissue hormones; Chemistry and physiological activity, mechanism of action, indication, clinical use, ADRs; Part XIV –Endocrine drugs (B): Gonadal hormones and inhibitors (1. estrogens, antiestrogens; 2. progestins, antiprogestins; hormonal contraception, 3. androgens (testosteron) and antiandrogens (receptor antagonists, 5-α-reductase inhibitors, synthesis inhibitors). Pancreatic hormones, antidiabetic agents & glucagon: hypoglycemics (insulin and oral sulfonylurea and biguanide hypoglycemics), antihypoglycemics (glucagon). Chemistry and physiological activity, mechanism of action, indications, clinical use, SAR and ADRs; Part XV - Eicosanoids (leukotrienes, prostacyclin, prostaglandins, thromboxanes); Vitamins (avitaminose, hypovitaminose and hypervitaminose therapy). Chemistry and indications.

2.6. Type of instruction	lectures seminars workshops exercises online in entirety mixed *e*-learning mixed *m*-learning	field work independent study multimedia and the internet work with the mentor (other)

2.7. Student responsibilities

2.8. 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	0.5	Seminar essay	
	Experimental work		Oral exam	2
	Essay		Project	
	Tests		Practical training	
	Written exam		MCQ Test 1	0.5
	Research		MCQ Test 2	0.5
	Report		(Other--describe)	

2.9. Grading and evaluation of student work over the course of instruction and at a final exam	Requirements for signature: Attending classes and MCQ Test 1 MCQ Test 2; Final exam: oral; The rating is assigned based on the concept with (10 + 2) questions before oral exam; understanding the chemistry, pharmacological and side effects of certain therapeutic groups, their classification and examples of certain drugs and their chemical structures (at least one molecule from the appropriate group and subgroup).

2.10. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	Pharmaceutical chemistry, Handouts of presentations 2016/17., M. Jadrijević-Mladar	1 (Department of pharmaceutical chemistry)	available at Merlin system

	Takač		
	Pharmaceutical chemistry - Selected pharmacotherapeutic groups , Part I, FBF 2015, M. Jadrijevic-Mladar Takač	1	Available at Merlin system
	Foye's Principles of Medicinal Chemistry, T. L. Lemke & D. A. Wiliams (Eds), Volters Kluver, Lippincot Wiliams and Wilkins, New York, 2008.	1 (Department of pharmaceutical chemistry)	https://app.box.com/s/82w4inro8g9b1sdsve3geeq64u8va5ky
2.11. Optional literature	Drug Action – Basic Principles and Therapeutic Aspects, E. Muchler & H. Derendorf, Medpharm, Stutgart, 1995; Medicinal Chemistry, G. Patrick, BIOS Scientific Publishers Ltd., 2001; Antitargets, Prediction and Prevention of Drug Side Effects, R. J. Vaz & T. Klabunde (Eds.), Wiley-VCH Series: Methods and Principles in Medicinal Chemistry, Wiley-VCH GmBH & Co. KGaA, Weinheim, 2008; Martindale – Extra Pharmacopoeia, current Ed; Joseph P Remington, Alfonso R Gennaro, Remington's Pharmaceutical Sciences, 18th Ed., Mack Pub. Co., 1990, Easton, Pa. Drug-Induced Disease. Prevention, Detection and Management, 2nd Ed., J. E Tisdale & D. A Miller (Eds.) ASHSP, ASHSP, Bethesda, 2010.		
2.12. Methods of monitoring quality that ensure acquisition of exit competences	Examination by MCQ Test 1 and MCQ Test 2, and students survey		
2.13. Comments			

PHARMACEUTICAL ETHICS AND DEONTOLOGY

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Jadranka Vuković Rodríguez
1.2. Associate teachers	
1.3. Graduate programme	Integrated - Pharmacy
1.4. Status of the course	Required
1.5. Year of study, Semester	5.
1.6. Credit value (ECTS)	1.5
1.7. Type of instruction (number of hours L+E+S+e-learning)	P10+S5(3 seminars+ 2 *m*-learning)
1.8. Expected enrolment in the course	
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2.
2. COURSE DESCRIPTION	
2.1. Course objectives	Pharmaceutical ethics and deontology, as a part of pharmaceutical training, deals with external and internal ethical relations within the pharmacy profession, as well as relationships with patients and other health care professionals. The aim of the course is to introduce students to the principles of professional ethics, pharmacy codes of ethics, professional duties and the role of medicines in society. The course will provide the insight into various problems/issues of pharmaceutical ethics and will help to understand complex ethical issues of professional pharmaceutical practice.
2.2. Enrolment requirements and required entry competences for the course	None
2.3. Learning outcomes at the level of the study programme to which the course contributes	- Applying expert knowledge and skills in advising and implementation of pharmaceutical care, respecting the actual legislation, current health policy and proper guidelines and principles of pharmaceutical ethics and deontology. - Critical evaluation and application of scientific knowledge in order to find the optimal treatment plan for each individual. - Adopt ethical principles: value life and human being, respect the trust of the community and the personality of patients and subjects, refrain from any act that may harm the truth, continuously improve expertise and health care and disseminate health education. - Informing and consultation about the action and the correct application of therapeutics and monitoring the course and outcome of therapy. - Assessing and proposing the application of new technologies and improving existing to improve therapy. - Using different information technologies and relevant databases to extend the professional knowledge and skills.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	1. Understand the pharmacy codes of ethics, standards of good pharmacy practice, and other deontological regulations; 2. Identify and analyze the differences in pharmay ethical codes of various countries; 3. To become aware of the meaning of ethics in daily pharmacy work; 4. Identify possible dillemas/problems in pharmacy work; 5. Adopt the model for ethical dilemmas/problems solving, ethical

	reasoning and decision-making; 6. Identify, analyze and independently offer solutions for ethical dilemmas, with critical thinking; 7. Investigate and critically analyze the relevant literature on ethical dilemmas/problems in pharmacy.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	Overview of pharmaceutical ethics and deontology: Bioethics-Pharmaceutical ethics; History of pharmaceutical ethics and deontology; Deontology in pharmacy; Roots of Croatian deontology; The foundations of ethical behavior; Scandals in pharmacy; Ethical dilemmas in the pharmacy; Scandals in pharmacy; Ethical issues in science; Ethical issues in pharmaceutical industry; Ethical issues in pharmaceutical sales; Recognition of ethical problems; Processing of ethical problems; Ethical-problem solving; Specific areas of pharmaceutical ethics.
2.6. Type of instruction	lectures seminars workshops mixed *m*-learning debates

2.7. Student responsibilities	Class attendance, active participation in discussions, processing ethical dilemmas/problems, debate

2.8. 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	0.15 (10%)	Seminar essay	
	Experimental work		Oral exam	
	Essay		Project	
	Tests		Debate	0.6 (40%)
	Written exam	0.75 (50%)		
	Research			
	Report			

2.9. Grading and evaluation of student work over the course of instruction and at a final exam	Small group activities, debate, written exam

2.10. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	1. V. Grdinić, J. Vuković, Farmaceutska etika, deontologija i praksa, Jadran-Galenski laboratorij, Zagreb, 2000.		
	2. Hrvatska ljekarnička komora, Kodeks ljekarničke etuke i deontologije, 1996.		
	3. R. M. Veatch, A. Haddad, Case studies in pharmacy etics, Oxford University Press Inc., New York, 2008. 4. Royal Pharmaceutical Society of Great Britain, Code of etics, *The Pharmaceutical Journal* **266** (2001) 590-596. 5. International Pharmaceutical Federation, FIP Statement of Professional Standards Code of Ethics for Pharmacists, 2004. Dostupno na: http://www.fip.org/.		

2.11. Optional literature	1. W. K. Frankena, Etika, KruZak, Zagreb, 1998. 2. G. E. Appelbe, J. Wingfield, Pharmacy Law and Ethics, Pharmaceutical Press, London 1997.
2.12. Methods of monitoring quality that ensure acquisition of exit competences	Written exam, debate.
2.13. Comments	

PHARMACEUTICS

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Full Professor Jelena Filipović-Grčić, PhD Associate Professor Anita Hafner, PhD
1.2. Associate teachers	Associate Professor Jasmina Lovrić, PhD
1.3. Graduate programme	Pharmacy
1.4. Status of the course	Obligatory course
1.5. Year of study, Semester	3rd year, 5th semester
1.6. Credit value (ECTS)	3.5
1.7. Type of instruction (number of hours L+E+S+e-learning)	30+0+15
1.8. Expected enrolment in the course	130
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2nd level
2. COURSE DESCRIPTION	
2.1. Course objectives	Students will learn about the basic physicochemical and biological principles of development, production and characterization of pharmaceutical dosage forms. They will understand the interdependence of the physicochemical properties of the active substance, excipients and technology on the biopharmaceutical performance of the dosage forms and therapeutic efficacy of the drug. Students will be introduced with the optimization of the dosage form design/composition with respect to its stability, application route and efficiency. Accomplished knowledge and skills represent required entry competences for Biopharmaceutics and Pharmacokinetics, Drug Formulation, Innovative Drug Delivery Systems and Industrial Pharmacy courses.
2.2. Enrolment requirements and required entry competences for the course	Enrolment requirements: passed examination in Physical Chemistry II course
2.3. Learning outcomes at the level of the study programme to which the course contributes	• Select and apply technological processes in the production of pharmaceuticals. • Critical skills in the development and implementation of solutions for practical problems in the production of pharmaceuticals and the monitoring of safe and appropriate application of pharmaceuticals. • Informing and advising patients on the effects and proper application of pharmaceuticals as well as monitoring the treatment course and outcomes. • Apply expert knowledge and skills to provide advice on pharmacotherapy.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	Aftercompleting the course student will be able to: 1. Explain the basic physicochemical and biological principles of development, production and characterization of pharmaceutical dosage forms. 2. List and explain procedures for physicochemical characterization to be implemented in the development and evaluation of pharmaceutical dosage forms. 3. Assess the quality and stability of the dosage forms. 4. Choose a suitable technological process for the manufacturing of dosage form with regard to its suitable in vivo biopharmaceutical performance. 5. Use rational approach in improving stability of drug formulations. 6. Conduct analysis of experimental data in characterization of drug and/or dosage form.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES: • Introduction – Pharmaceutics, Physical Pharmacy, Biopharmaceutics • Pharmaceutical solids, part I – types of solids, preparation, characterization and stabilization, polymorphism • Pharmaceutical solids, part II – particles and bulk (powder) characterisation

<table>
<tr><td></td><td colspan="4">and properties (size, size distribution, density, porosity, flowability, compressibility, mixing, rheology, fluidization
• Pharmaceutical solids, part III – particles and bulk (powder) characterisation and properties (hygroscopicity/sorption behaviour, drying, lyophilisation, spray drying, stability)
• Pharmaceutical solids, part IV – Dissolution of the solids; Noyes-Whitney equation
• Disperse systems, part I – preparation, characterization and stabilization, electrical double layer, DLVO theory
• Disperse systems, part II – surfactants, association colloids (preparation, characterization and stabilization), flocculated and deflocculated suspensions, examples of colloidal drug delivery systems
• Disperse systems, part III – adsorption, adsorption isotherms
• Disperse systems, part IV – rheology
• Pharmaceutical solutions – chemical stability, adsorption.
• Polymers and macromolecules
• In vitro dissolution testing – importance in formulations screening during development and in insurance of batch-to-batch quality control during production; methods for dissolution studies and mathematical models to describe the dissolution
SEMINARS:
• Principles of Mathematics of importance to the Pharmaceutics
• Micrometry
• Drying processes – the process used for drying pharmaceuticals
• Mass transfer and related phenomena – adsorption and solution phenomena
• Stability/stability testing of pharmaceuticals
• Rheology of pharmaceuticals
• In vitro dissolution testing, mechanisms and kinetics of drug release in vitro</td></tr>
<tr><td>2.6. Type of instruction</td><td colspan="2">lectures
seminars
workshops
exercises
online in entirety
mixed e-learning
mixed m-learning</td><td colspan="2">field work
independent study
multimedia and the internet
work with the mentor
(other)</td></tr>
<tr><td>2.7. Student responsibilities</td><td colspan="4">Regular attendance of lectures and seminars.</td></tr>
<tr><td rowspan="7">2.8. 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)</td><td>Class attendance</td><td>1.5</td><td>Seminar essay</td><td></td></tr>
<tr><td>Experimental work</td><td></td><td>Oral exam</td><td></td></tr>
<tr><td>Essay</td><td></td><td>Project</td><td></td></tr>
<tr><td>Tests</td><td></td><td>Practical training</td><td></td></tr>
<tr><td>Written exam</td><td>2</td><td>(Other--describe)</td><td></td></tr>
<tr><td>Research</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>Report</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>2.9. Grading and evaluation of student work over the course of instruction and at a final exam</td><td colspan="4">Continuous assessment (ISVU system) – 3 partial written exams and/or final written exam.</td></tr>
<tr><td rowspan="3">2.10. Required literature (available at the library and via other media)</td><td colspan="2">Title</td><td>Number of copies at the library</td><td>Availability via other media</td></tr>
<tr><td colspan="2">I. Jalšenjak, V. Jalšenjak, J. Filipović-Grčić, Farmaceutika, Školska knjiga, Zagreb 1998.</td><td>23</td><td></td></tr>
<tr><td colspan="2">I. Jalšenjak, Farmaceutika: Repetitorij osnova;</td><td></td><td>Merlin, e-</td></tr>
</table>

	Praktikum; Seminarski zadaci; FBF, 2010		learning system
	Alexander T. Florence and David Attwood, Physicochemical Principles of Pharmacy, Fourth edition, Pharmaceutical Press, London, UK, 2007.		
2.11. Optional literature	Applied Biopharmaceutics & Pharmacokinetics, Fifth Edition, Leon Shargel, Andrew Yu, Susanna Wu-Pong, McGraw-Hill, 2005.		
2.12. Methods of monitoring quality that ensure acquisition of exit competences	Assessment of learning outcomes through continuous assessment by examinations (3) during semester and final examination. Analysis of assessment results to improve the quality of teaching.		
2.13. Comments			

PHARMACOECONOMICS

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Assistant professor Petra Turčić, PhD
1.2. Associate teachers	
1.3. Graduate programme	Integrated study of pharmacy
1.4. Status of the course	Elective
1.5. Year of study, Semester	4th year of study, VII semester
1.6. Credit value (ECTS)	2.5
1.7. Type of instruction (number of hours L+E+S+e-learning)	L(20) + E (0) + S(10)
1.8. Expected enrolment in the course	60
1.9. 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	The course objective is to help students develop the skills that will help them in assessing the economic profitability of medicine application through acquiring the knowledge of economic evaluation of medicines as well as about proof based medicine. By acquiring the above expertise and skills, the students will get a better insight in the existing issues and obtain the knowledge necessary for correct decision making.
2.2. Enrolment requirements and required entry competences for the course	Prerequisite: commenced 7th semester of the studies
2.3. Learning outcomes at the level of the study programme to which the course contributes	• Effective application of financial, marketing, and organizational principles in work (consideration of pharmaeconomical analyses while choosing medications and treatment methods) • Participation and monitoring of drug distribution (conducting pharmacoeconomic analysis as a prerequisite for the rationalization of drugs administration).
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After completion of the course, students will be able to: 1. Perform basic pharmacoeconomic analysis / assessment. 2. Place the role of pharmacoeconomic evaluations in context in relation to determination of the cost of the medication. 3. Explain pharmacoeconomic analysis. 4. Connect the basic principles of the knowledge and the profession in the pharmacoeconomic modeling. 5. Assess the relevance of pharmacoeconomic evaluations in health systems.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES : • Introduction to Health Economics and Pharmacoeconomics • Basic models of financing in health care and payment methods • Economic evaluation of health • Medicine research and approval process • Jobs and positions in the marketing of medicines • Evidence based medicine and databases • Pharmacoepidemiology • Cost determination in pharmacoeconomics • Pharmacoeconomic analyses • Models in pharmacoeconomics SEMINARS: • Estimate the number of patients that are eligible for New Drug • Calculation of drug average price

<table>
<tr><td></td><td colspan="4">• Development of pharmacoeconomic analysis
• Pharmacoeconomic analysis in practice
• The interpretation of pharmacoeconomic analysis</td></tr>
<tr><td>2.6. Type of instruction</td><td colspan="2"><u>lectures</u>
<u>seminars</u>
<u>workshops</u>
exercises
online in entirety
mixed e-learning
mixed m-learning</td><td colspan="2">field work
independent study
multimedia and the internet
work with the mentor
(other)</td></tr>
<tr><td>2.7. Student responsibilities</td><td colspan="4"></td></tr>
<tr><td rowspan="8">2.8. 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)</td><td>Class attendance</td><td>0.5</td><td>Seminar essay</td><td>0.5</td></tr>
<tr><td>Experimental work</td><td></td><td>Oral exam</td><td></td></tr>
<tr><td>Essay</td><td></td><td>Project</td><td></td></tr>
<tr><td>Tests</td><td></td><td>Practical training</td><td></td></tr>
<tr><td>Written exam</td><td>1</td><td>(Other--describe)</td><td></td></tr>
<tr><td>Research</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>Report</td><td>0.5</td><td>(Other--describe)</td><td></td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>2.9. Grading and evaluation of student work over the course of instruction and at a final exam</td><td colspan="4"></td></tr>
<tr><td rowspan="4">2.10. Required literature (available at the library and via other media)</td><td>Title</td><td colspan="2">Number of copies at the library</td><td>Availability via other media</td></tr>
<tr><td>Lectures available on the web sites of the Faculty of Pharmacology</td><td colspan="2"></td><td></td></tr>
<tr><td>Sanchez LA. Pharmacoeconomics: Principles, Methods and Application. U: Pharmacotherapy: A Pathophysiologic Approach, DiPiro JT, et al. Eds. 8th ed., New York, McGraw-Hill, 2011: 1-15.</td><td colspan="2">1</td><td></td></tr>
<tr><td>Turčić P. Special pharmacology - Pharmacoeconomics. In: Jasna Lipozenčić and co-authors: Update in dermatologic drug therapy; Academy of Medical Sciences of Croatia, Zagreb, 2012. str. 59-71.</td><td colspan="2">1</td><td></td></tr>
<tr><td>2.11. Optional literature</td><td colspan="4">M. Berger, K. Bingefors, E.C. Hedblom, C.L. Pashos, G.W. Torrance: Health Care Costs, Quality and Outcomes. ISPOR, USA</td></tr>
<tr><td>2.12. Methods of monitoring quality that ensure acquisition of exit competences</td><td colspan="4">Outcomes 1-5 are checked through written examination.</td></tr>
<tr><td>2.13. Comments</td><td colspan="4"></td></tr>
</table>

PHARMACOGENETICS

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Prof Karmela Barišić
1.2. Associate teachers	Assistant Prof marija Grdić Rajković Andrea Čeri, mag med biochem
1.3. Graduate programme	Pharmacy
1.4. Status of the course	elective
1.5. Year of study, Semester	5, 7
1.6. Credit value (ECTS)	2.5
1.7. Type of instruction (number of hours L+E+S+e-learning)	10 + 5 + 15
1.8. Expected enrolment in the course	40
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2
2. COURSE DESCRIPTION	
2.1. Course objectives	Course objectives are to familiarise students with principles, concepts, and practical implications of pharmacogenomics that are relevant to clinical applications.
2.2. Enrolment requirements and required entry competences for the course	Enrolment requirements: passed exams in Pharmacology and Molecular Biology with Genetic Engineering
2.3. Learning outcomes at the level of the study programme to which the course contributes	• Demonstrate an understanding of the complexity of most drug responses (i.e. the drug response cascades), and the influence this has on the contribution of genetic variability to drug response. • Evaluate the current and future potential applications of drug target pharmacogenetics to individualization of drug therapy.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	On completion of this course, the student will be able to: 1. describe and define basic pharmacogenomic concepts; 2. evaluate polymorphism types and their impact on pharmacokinetics (PK) and pharmacodynamics (PD); 3. explore the implications of the ethical, legal, social and economic issues related to pharmacogenomic testing; 4. identify resources for obtaining current and updated pharmacogenomics information.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES AND SEMINARS • Fundamentals of pharmacogenomics • The genetic basis of pharmacogenomics • Methodologies in pharmacogenomics • The pharmacogenetics of drug metabolism • Pharmacogenetics and drug transport/efflux • Pharmacodynamics and pharmacogenomics • Social, legal and ethical issue Applications of pharmacogenomics in therapeutics: • Cardiovascular disease

<table>
<tr><td></td><td colspan="4">

Haematology and Oncology
Central nervous system
Infectious diseases
Respiratory diseases
Toxicogenomics

EXERCISES
Solving the clinical problems
</td></tr>
<tr><td>2.6. Type of instruction</td><td colspan="2">lectures
seminars
workshops
exercises
online in entirety
mixed e-learning
mixed m-learning</td><td colspan="2">field work
independent study
multimedia and the internet
work with the mentor
laboratory</td></tr>
<tr><td>2.7. Student responsibilities</td><td colspan="4"></td></tr>
<tr><td rowspan="8">2.8. 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)</td><td>Class attendance</td><td>0.5</td><td>Seminar essay</td><td>0.5</td></tr>
<tr><td>Experimental work</td><td></td><td>Oral exam</td><td>0.5</td></tr>
<tr><td>Essay</td><td>0.5</td><td>Project</td><td></td></tr>
<tr><td>Tests</td><td></td><td>Practical training</td><td>0.5</td></tr>
<tr><td>Written exam</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>Research</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>Report</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td colspan="4"></td></tr>
<tr><td>2.9. Grading and evaluation of student work over the course of instruction and at a final exam</td><td colspan="4">Each student's advancement is continually monitored over the course. The final grade comprises overall endeavour of a student during lectures, seminars, exercises and oral exam. Students are required to write a seminar paper which is presented to other students. The seminar paper requires a project approach to a specific topic, an independent research of scientific and specialist literature, writing of the essay, oral presentation along with the discussion on the topic.</td></tr>
<tr><td rowspan="4">2.10. Required literature (available at the library and via other media)</td><td colspan="2">Title</td><td>Number of copies at the library</td><td>Availability via other media</td></tr>
<tr><td colspan="2">Martin M. Zdanowicz (ur.), Concepts in Pharmacogenomics, American Society of Helath - System Pharmacists, Bethesda, MD, 2010.</td><td>5</td><td></td></tr>
<tr><td colspan="2">Russ B. Altman, David Flockhart i David B. Goldstein (ur.), Principles of Pharmacogenetics and Pharmacogenomics, Cambridge University Press, 2012</td><td>5</td><td></td></tr>
<tr><td colspan="2"></td><td></td><td></td></tr>
<tr><td>2.11. Optional literature</td><td colspan="4">1. Materials from lectures and seminars
2. Felgenhauer K Laboratory Diagnosis of Neurological Diseases. In: Thomas L, ed.,
Clinical Laboratory Diagnostics – Use And Assessment of Clinical Laboratory Results:
Frankfurt: TH Books, 1998: 1308-1326</td></tr>
<tr><td>2.12. Methods of monitoring quality that ensure acquisition of exit competences</td><td colspan="4">

Continuous monitoring of students' performance during lectures, seminars, project and essay preparation, solving cases from clinic practice, laboratory performance, evaluation of the presentation (essay) and oral exam
Survey after the end of the course

</td></tr>
<tr><td>2.13. Comments</td><td colspan="4"></td></tr>
</table>

PHARMACOGNOSY 1

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Professor Sanda Vladimir-Knežević, PhD; Assistant Professor Biljana Blažeković, PhD
1.2. Associate teachers	Higher Assistant Maja Bival Štefan, PhD; Assistant Marija Kindl, PhD
1.3. Graduate programme	Pharmacy integrated study program
1.4. Status of the course	Compulsory
1.5. Year of study, Semester	2nd, 4th
1.6. Credit value (ECTS)	7.5
1.7. Type of instruction (number of hours L+E+S+e-learning)	30 L + 45 E + 15 S
1.8. Expected enrolment in the course	130
1.9. 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	Introduce drugs of natural origin and their bioactive principles, including natural source, biosynthesis pathway and chemical structures. Adopt pharmacognostic terminology. Introduce and understand methods of qualitative and quantitative analysis of pharmacologically active compounds in herbal and animal drugs. Acquire basic knowledge and skills in quality control of herbal drugs and products. Understand the role of natural products in drug research and development as well as in disease prevention and treatment.
2.2. Enrolment requirements and required entry competences for the course	Enrolment requirements: passed examination in Pharmaceutical Botany; Analytical chemistry 1 course completed.
2.3. Learning outcomes at the level of the study programme to which the course contributes	• Selection and application of analytical methods and quality assurance in drug production process • Demonstration of observational, analytical and critical skills in development and implementation of practical problem solution in drug production process and drug control • Application of professional knowledge and skills in pharmacotherapy consultations • Informing and consulting patients about drug effects and correct drug application.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	Upon completion of this course, the student will be able to: 1. Recognize and define natural medicinal compounds according to their chemical structure and biosynthesis pathway 2. Associate pharmacologically active compounds with their natural sources 3. Use pharmacognostic terminology in Croatian and Latin language 4. Describe pharmacognostic methods for analysis of herbal drugs 5. Understand and use European Pharmacopoeia in the area of analysis and quality control of herbal drugs 6. Understand the importance of quality control of herbal drugs and products with their efficient and safe use 7. Conduct basic qualitative and quantitative analysis of herbal drugs and their biactive principles.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES: • Introduction to Pharmacognosy; History of Pharmacognosy • Carbohydrates in herbal drugs • Essential oils (terpenes and phenylpropanoids) • Resins and balms • Iridoidoids and secoiridoids, Pyrethrins • Sesquiterpene lactones; Diterpenes • Triterpenes and sterols; Saponins; Cardiotonic glycosides • Phenols and phenolic acids • Coumarins and furancoumarins

	• Flavonoids • Anthocyanins; Tannins • Anthracene derivatives • Alkaloids. SEMINARS: • Quality aspects of herbal drugs • European Pharmacopoeia; Monographs of herbal drugs • Quality control methods for herbal drugs • Quality control of fatty oils • Pharmacopoeial methods of essential oil analysis • Content determination of bioactive compounds in herbal drugs • Health safety of herbal drug and products. EXERCISES • Loss on drying determination • Total ash content determination • Determination of chemical values of fatty oils • Swelling index determination • Phytochemical identification of herbal drugs • Test for cyanogenic glycosides • Test for anthracene derivatives • Tannin detection • Test for cardiotonic glycosides • Essential oil determination • Determination of total phenolic glycoside • Total hydroxycinnamic derivatives assay • Determination of tropane alkaloid content • Qualitative and quantitative analysis of flavonoids.
2.6. Type of instruction	**lectures** **seminars** workshops **exercises** online in entirety mixed *e*-learning mixed *m*-learning field work independent study multimedia and the internet work with the mentor (other)
2.7. Student responsibilities	Attending lectures, seminars and exercises.

2.8. 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	0.5	Seminar essay	
	Experimental work	0.5	Oral exam	2.5
	Essay		Project	
	Tests		Practical training	
	Written exam	2.5	(Other--describe)	
	Research		(Other--describe)	
	Report		(Other--describe)	

2.9. Grading and evaluation of student work over the course of instruction and at a final exam	The colloquium upon completion of exercises, and written and oral exams.

2.10. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	S. Vladimir-Knežević, B. Blažeković, Praktikum iz Farmakognozije 1, Farmaceutsko-biokemijski fakultet Sveučilišta u Zagrebu, Zagreb 2008.		The e-learning platform Merlin

	S. Vladimir-Knežević, B. Blažeković: Lecture and seminar presentations – Pharmacognosy 1		The e-learning platform Merlin
	G. Samuelsson. Drugs of natural origin. A textbook pf pharmacognosy. Svedish Pharmaceutical Press: Stockholm 2009.	1	
	European Directorate for the Quality of Medicines and Health Care. European Pharmacopoeia, 8th ed.; Council of Europe: Strasbourg 2014.	1	
2.11. Optional literature	WHO Monographs on selected medicinal plants, vol. 1-4. (http://apps.who.int/medicinedocs/en/d/Js2200e/) WHO. Quality Control Methods for Herbal Materials, 2011. (http://apps.who.int/medicinedocs/en/d/Jh1791e/)		
2.12. Methods of monitoring quality that ensure acquisition of exit competences	Learning outcomes 1-6 are validated through written and oral exams, while the outcome 7 is checked by a colloquium upon completion of exercises.		
2.13. Comments			

PHARMACOGNOSY 2

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Professor Sanda Vladimir-Knežević,PhD; Associate Professor Marijana Zovko Končić, PhD
1.2. Associate teachers	Assistant Professor Biljana Blažeković, PhD; Higher Assistant Maja Bival Štefan, PhD; Assistant Marija Kindl, PhD
1.3. Graduate programme	Pharmacy integrated study program
1.4. Status of the course	Compulsory
1.5. Year of study, Semester	3rd, 5th
1.6. Credit value (ECTS)	6
1.7. Type of instruction (number of hours L+E+S+e-learning)	30 L+30 E+15 S
1.8. Expected enrolment in the course	130
1.9. 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	Acquire integral knowledge on bioactive principles and the activity of drugs of herbal animal origin. Comprehend the use of herbal drugs and their active principles in modern pharmaceutical and medical practice. Obtain knowledge and skills on herbal drugs identification according to their unique morphological and anatomical features.
2.2. Enrolment requirements and required entry competences for the course	Enrolment requirements : Pharmacognosy 1 course completed
2.3. Learning outcomes at the level of the study programme to which the course contributes	• Apply expert knowledge and skills to provide advice on pharmacotherapy • Informing and advising patients on the effects and proper application of pharmaceuticals • Demonstrate cognitive, analytical and critical skills in the development and implementation of solutions for practical problems in the production and quality control of pharmaceuticals
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	Upon completion of this course, the student will be able to: 1. Identify drugs of herbal and animal origin based on their morphological and anatomical features according to the European Pharmacopoeia 2. Associate the activity of the drugs with their chemical composition 3. Explain the mechanism of action of bioactive principles from drugs of herbal and animal origin 4. Describe and rationalize the use of drugs according to their use in pharmacy practice.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES: • Introduction to Pharmacognosy 2 • Drugs containing inorganic active principles and fruit acids • Drugs containing carbohydrates, mucilage and gums • Drugs containing fatty oils and waxes • Drugs containing essential oils • Resins and balms • Drugs containing phenolic glycosides • Drugs containing flavonoids and coumarins • Drugs containing tannins • Drugs containing iridoids and lignans • Drugs containing anthracene derivatives • Drugs containing cardiac glycosides • Drugs containing saponinis • Drugs containing thioglycosides and polysulfides • Drugs containing alkaloidis.

	SEMINARS: • Introduction to macroscopic and microscopic analysis of herbal drugs according to European Pharmacopoeia • Identification of drugs containing inorganic active principles, fruit acids and carbohydrates • Identification of mucilage drugs • Identification of drugs containing essential oils; Characteristics of resins and balms • Identification of drugs containing phenolic glycosides, flavonoids and coumarins • Identification of drugs containing lignans, tannins and anthracene derivatives • Identification of drugs containing cardiac glycosides and saponinis • Identification of drugs containing iridoids, thioglycosides, polysulfides and alkaloidis. EXCERSISES: • Macroscopic and microscopic examinations of herbal drugs; Preparation of samples for microscopic analysis • Morphological and anatomical identification of herbal drugs - leaves and flowers • Morphological and anatomical identification of herbal drugs - herbs and barks • Morphological and anatomical identification of herbal drugs - fruits and seeds • Morphological and anatomical identification of herbal drugs - rhizomes and roots • Histochemical analysis of herbal drugs • Analysis of tea mixture.

2.6. Type of instruction	**lectures** **seminars** workshops **exercises** online in entirety **mixed *e*-learning** mixed *m*-learning	field work independent study multimedia and the internet work with the mentor (other)

2.7. Student responsibilities	Regular attendance of lectures, seminars and laboratory exercises. Passed the colloquium (written and practical) after attending exercises.			
2.8. 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	0.5	Seminar essay	
	Experimental work		Oral exam	2.5
	Essay		Project	
	Tests	1	Practical training	
	Written exam	2	(Other--describe)	
	Research		(Other--describe)	
	Report		(Other--describe)	
2.9. Grading and evaluation of student work over the course of instruction and at a final exam	The colloquium upon completion of exercises and written and oral exams.			

2.10. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	S. Vladimir-Knežević, M. Zovko Končić: Lectures and seminars presentations		The e-learning platform Merlin
	Z. Kalođera , M. Zovko. Praktikum iz farmakognozije II, Sveučilište u Zagrebu, Farmaceutsko-biokemijski fakultet, Zagreb, 2008.		The e-learning platform Merlin
	M. Wichtl. Herbal Drugs and Phytopharmaceuticals, CRC Press, Medpharm,	1	

	Stuttgart, 2004.		
	European Directorate for the Quality of Medicines and Health Care. European Pharmacopoeia, 8th ed.; Council of Europe: Strasbourg, 2014.	1	
2.11. Optional literature	R. Hansel, Otto Sticher, Pharmakognosie - Phytopharmazie 9th ed, Springer-Lehrbuch, 2009. D. Kuštrak, Farmakognozija, Fitofarmacija, Golden Marketing, Tehnička knjiga, Zagreb, 2005.		
2.12. Methods of monitoring quality that ensure acquisition of exit competences	Learning outcomes 2-4 are validated through written and oral exams, while the outcome 1 is checked by a colloquium upon completion of exercises.		
2.13. Comments			

PHARMACOLOGY

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Associate prof. Lidija Bach-Rojecky, PhD
1.2. Associate teachers	Assistant prof. Petra Turčić, PhD Višnja Drinovac Vlah, MPharm Ana Dugonjić Okroša, MPharm
1.3. Graduate programme	Medicinal biochemistry study programme
1.4. Status of the course	compulsive
1.5. Year of study, Semester	4., 7.
1.6. Credit value (ECTS)	8.5
1.7. Type of instruction (number of hours L+E+S+e-learning)	75 + 20 + 10
1.8. Expected enrolment in the course	25
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2.
2. COURSE DESCRIPTION	
2.1. Course objectives	The main objective is to describe the pharmacological concept of drug action. Therefore, student will learn basic principles of interaction between drugs with human organism, understand their mechanism of action, therapeutic and unwanted effects, as well as the indications of drugs from the main pharmacotherapeutic groups. Acquired knowledge and skills will provide basis for the subject Clinical pharmacy with pharmacotherapy.
2.2. Enrolment requirements and required entry competences for the course	Prerequisite: passed exam in Pathophysiology with pathology, attended Molecular biology with genetic engineering and Medicinal chemistry 2. Necessary competences: knowledge in pathophysiological and pathological mechanisms of diseases, understanding of basic pharmacokinetic principles affecting drug effect, knowing chemical structure of molecules and basic mechanism of action on biological molecules.
2.3. Learning outcomes at the level of the study programme to which the course contributes	• Defining, analysing and proposing procedures related to research, disease and treatment monitoring. • Interpretation of laboratory analysis results from an analytical and clinical point of view. • Ensuring of positive interaction with patients, colleagues, health experts and the general public. • Significant contributions in diverse situations and contexts, such as inter-professional groups and professional organisations and committees.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After this subject, student will be able to: 1. Describe the nature of interaction between drug and receptor, as well as the interaction of drug with intracellular signaling pathways; 2. Identify the main groups of receptors and possible sites of action of drugs in organism; 3. Explain the mechanism of therapeutic effect of drugs from main pharmacotherapeutic groups; 4. Asses the dosing regimen and duration of action of drug on the basis of its pharmacokinetic parameters; 5. Connect the mechanism of drug's action with its unwanted sideeffects; 6. List indications and contraindications for drug's application; 7. Describe expected effects of selected drugs in experimental models.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES: • Basic principles of drug's action – pharmacodynamics and pharmacokinetics • Drugs affecting gastrointestinal function: antiulcer drugs, laxatives, antidiarrheals; antiemetics, prokinetics, drugs used in treatment of inflammatory bowel disease

<table>
<tr><td></td><td colspan="4">• Endocrine drugs: sex – hormones and antagonists, thyroid hormones and antithyroid drugs, drugs that affect bone mineral homeostasis, pancreatic hormones and antidiabetic drugs
• Drugs used in allergy treatment
• Drugs used in asthma
• Antibiotics
• Antiviral and antifungal drugs
• Cytotoxic and biological drugs
• Anticoagulant, antiplatelet and fibrinolytic drugs
• Hypolipemic drugs
• Introduction in cardiovascular pharmacology. Antihypertensive drugs.
• Diuretics. ADH.
• Drugs affecting renin – angiotensin – aldosterone system.
• Drugs with positive inotropic effect. Drugs used in heart failure.
• Drugs used in ischemic heart diseases and pulmonary hypertension. Vasodilator drugs.
• Drugs used in cardiac arrhythmias.
• Nonsteroidal anti – inflammatory drugs. Anti - rheumatic drugs. Drugs used in gout treatment.
• Opioid analgesics. Anti – migraine drugs. Local anaesthetics.
• Introduction in central nervous system pharmacology.
• Anxiolytics and antidepressants. Sedatives and hypnotics.
• Antipsychotic drugs. Mood stabilizers.
• Drugs used in neurodegenerative diseases: Parkinsonism and dementias.
• Antiepileptic drugs. General anaesthetics.
• Pharmacotherapy of drug abuse.
• General anaesthetics. Neuromuscular blockers. Spasmolytic drugs.
SEMINARS:
• Drug research and development. Pharmacokinetics.
• Anticoagulant, antiplatelet and fibrinolytic drugs.
• Antihypertensive drugs. Diuretics. Vasodilators.
• Antirheumatic drugs.
• Antiepileptic drugs.
EXERCISES:
• Drug application
• Diuretics and ADH
• Isolated ileum – vasodilatator drugs
• Analgesic drugs: opioid and non-opioid
• Psychopharmacology</td></tr>
<tr><td>2.6. Type of instruction</td><td colspan="2"><u>lectures</u>
<u>seminars</u>
workshops
<u>exercises</u>
online in entirety
mixed e-learning
mixed m-learning</td><td colspan="2">field work
independent study
multimedia and the internet
work with the mentor
(other)</td></tr>
<tr><td>2.7. Student responsibilities</td><td colspan="4">Participation on laboratory. Possible non-attendance of 20% of lectures.</td></tr>
<tr><td rowspan="8">2.8. 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)</td><td>Class attendance</td><td>2,5</td><td>Seminar essay</td><td></td></tr>
<tr><td>Experimental work</td><td></td><td>Oral exam</td><td>3</td></tr>
<tr><td>Essay</td><td></td><td>Project</td><td></td></tr>
<tr><td>Tests</td><td></td><td>Practical training</td><td></td></tr>
<tr><td>Written exam</td><td>3</td><td>(Other--describe)</td><td></td></tr>
<tr><td>Research</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>Report</td><td></td><td>(Other--describe)</td><td></td></tr>
</table>

2.9. Grading and evaluation of student work over the course of instruction and at a final exam	Three partial exams during the semester (multiple choice questions); oral exam.		
2.10. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	Katzung BG, Basic and clinical pharmacology. McGraw Hill, 2015.	10	
2.11. Optional literature	H.P Rang, M.M. Dale, J.M. Ritter, P.K. Moore: Pharmacology, 7th edition, Churchill Livingstone, 2016.		
2.12. Methods of monitoring quality that ensure acquisition of exit competences	Outcomes 1-7 are verified by written and oral exam.		
2.13. Comments	-		

PHARMACOLOGY

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Associate prof. Lidija Bach-Rojecky, PhD
1.2. Associate teachers	Assistant prof. Petra Turčić, PhD Višnja Drinovac Vlah, MPharm Ana Dugonjić Okroša, MPharm
1.3. Graduate programme	Pharmacy study programme
1.4. Status of the course	compulsive
1.5. Year of study, Semester	4., 7.
1.6. Credit value (ECTS)	10.5
1.7. Type of instruction (number of hours L+E+S+e-learning)	75 + 20 + 40
1.8. Expected enrolment in the course	130
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2.
2. COURSE DESCRIPTION	
2.1. Course objectives	The main objective is to describe the pharmacological concept of drug action. Therefore, student will learn basic principles of interaction between drugs with human organism, understand their mechanism of action, therapeutic and unwanted effects, as well as the indications of drugs from the main pharmacotherapeutic groups. Acquired knowledge and skills will provide basis for the subject Clinical pharmacy with pharmacotherapy.
2.2. Enrolment requirements and required entry competences for the course	Prerequisite: passed exam in Pathophysiology with pathology, attended Molecular biology with genetic engineering and Medicinal chemistry 2. Necessary competences: knowledge in pathophysiological and pathological mechanisms of diseases, understanding of basic pharmacokinetic principles affecting drug effect, knowing chemical structure of molecules and basic mechanism of action on biological molecules.
2.3. Learning outcomes at the level of the study programme to which the course contributes	• Apply professional knowledge and competencies in advising about pharmacotherapy. • Inform and consult patient about drug effects and correct application of drugs. • Follow the course and outcome of therapy. • Recognize clinically significant interactions of drugs and avoid them.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After this subject, student will be able to: 1. Describe the nature of interaction between drug and receptor, as well as the interaction of drug with intracellular signaling pathways; 2. Identify the main groups of receptors and possible sites of action of drugs in organism; 3. Explain the mechanism of therapeutic effect of drugs from main pharmacotherapeutic groups; 4. Asses the dosing regimen and duration of action of drug on the basis of its pharmacokinetic parameters; 5. Connect the mechanism of drug's action with its unwanted sideeffects; 6. List indications and contraindications for drug's application; 7. Describe expected effects of selected drugs in experimental models.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES: • Basic principles of drug's action – pharmacodynamics and pharmacokinetics

	• Drugs affecting gastrointestinal function: antiulcer drugs, laxatives, antidiarrheals; antiemetics, prokinetics, drugs used in treatment of inflammatory bowel disease • Endocrine drugs: sex – hormones and antagonists, thyroid hormones and antithyroid drugs, drugs that affect bone mineral homeostasis, pancreatic hormones and antidiabetic drugs • Drugs used in allergy treatment • Drugs used in asthma • Antibiotics • Antiviral and antifungal drugs • Cytotoxic and biological drugs • Anticoagulant, antiplatelet and fibrinolytic drugs • Hypolipemic drugs • Introduction in cardiovascular pharmacology. Antihypertensive drugs. • Diuretics. ADH. • Drugs affecting renin – angiotensin – aldosterone system. • Drugs with positive inotropic effect. Drugs used in heart failure. • Drugs used in ischemic heart diseases and pulmonary hypertension. Vasodilator drugs. • Drugs used in cardiac arrhythmias. • Nonsteroidal anti – inflammatory drugs. Anti - rheumatic drugs. Drugs used in gout treatment. • Opioid analgesics. Anti – migraine drugs. Local anaesthetics. • Introduction in central nervous system pharmacology. • Anxiolytics and antidepressants. Sedatives and hypnotics. • Antipsychotic drugs. Mood stabilizers. • Drugs used in neurodegenerative diseases: Parkinsonism and dementias. • Antiepileptic drugs. General anaesthetics. • Pharmacotherapy of drug abuse. • General anaesthetics. Neuromuscular blockers. Spasmolytic drugs. SEMINARS: • Drug research and development. • Pharmacokinetics. • Antiulcer drugs. Laxatives. Antidiarrheals; Antiemetics • Hormonal contraception. Hormonal replacement therapy. Anti - androgen drugs. • Utero – tonic and utero – lytic drugs. Drug use in pregnancy and lactation. • Antidiabetic drugs. Drugs used in osteoporosis. • Anti – allergic and anti – asthmatic drugs. • Antibiotics. • Antiviral and antifungal drugs. • Anticoagulant, antiplatelet and fibrinolytic drugs. • Antihypertensive drugs. Diuretics. Vasodilators. • Drugs affecting renin – angiotensin – aldosterone system. Anti – arrhythmic drugs. • Anti – rheumatic drugs. Non-steroidal anti – inflammatory drugs. Opioid analgesic drugs. • Anxiolytics and antidepressants. • Antipsychotic drugs. • Antiepileptic drugs. Anti - parkinsonism drugs. • Apllied pharmacology in clinical practice – case studies I, II, III

<table>
<tr><td></td><td colspan="4">EXERCISES:
• Drug application
• Diuretics and ADH
• Isolated ileum – vasodilatator drugs
• Analgesic drugs: opioid and non-opioid
• Psychopharmacology</td></tr>
<tr><td>2.6. Type of instruction</td><td colspan="2"><u>lectures</u>
<u>seminars</u>
workshops
<u>exercises</u>
online in entirety
mixed e-learning
mixed m-learning</td><td colspan="2">field work
independent study
multimedia and the internet
work with the mentor
(other)</td></tr>
<tr><td>2.7. Student responsibilities</td><td colspan="4">Participation on seminars and laboratory. Possible non-attendance of 20% of lectures.</td></tr>
<tr><td rowspan="8">2.8. 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)</td><td>Class attendance</td><td>3</td><td>Seminar essay</td><td>1.5</td></tr>
<tr><td>Experimental work</td><td></td><td>Oral exam</td><td>3</td></tr>
<tr><td>Essay</td><td></td><td>Project</td><td></td></tr>
<tr><td>Tests</td><td></td><td>Practical training</td><td></td></tr>
<tr><td>Written exam</td><td>3</td><td>(Other--describe)</td><td></td></tr>
<tr><td>Research</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>Report</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td></td><td colspan="3"></td></tr>
<tr><td>2.9. Grading and evaluation of student work over the course of instruction and at a final exam</td><td colspan="4">Active participation in case-studies discussion; three partial exams during the semester (multiple choice questions); oral exam.</td></tr>
<tr><td rowspan="4">2.10. Required literature (available at the library and via other media)</td><td colspan="2">Title</td><td>Number of copies at the library</td><td>Availability via other media</td></tr>
<tr><td colspan="2">Katzung BG, Basic and clinical pharmacology. McGraw Hill, 2015.</td><td>10</td><td></td></tr>
<tr><td colspan="2"></td><td></td><td></td></tr>
<tr><td colspan="2"></td><td></td><td></td></tr>
<tr><td>2.11. Optional literature</td><td colspan="4">H.P Rang, M.M. Dale, J.M. Ritter, P.K. Moore: Pharmacology, 7th edition, Churchill Livingstone, 2016.</td></tr>
<tr><td>2.12. Methods of monitoring quality that ensure acquisition of exit competences</td><td colspan="4">Outcomes 1-7 are verified by written and oral exam.</td></tr>
<tr><td>2.13. Comments</td><td colspan="4">-</td></tr>
</table>

PHARMACY INFORMATICS

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Associate Professor Renata Jurišić Grubešić
1.2. Associate teachers	
1.1. Graduate programme	Integrated study programme
1.2. Status of the course	Elective
1.3. Year of study, Semester	3rd year, 5th semester
1.4. Credit value (ECTS)	2.0
1.5. Type of instruction (number of hours L+E+S+e-learning)	15+0+15
1.6. Expected enrolment in the course	50
1.7. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2
2. COURSE DESCRIPTION	
2.1. Course objectives	To introduce students in the theory and practice of informatics processes (transmission, storage and processing of data) in pharmacy and healthcare profession in general.
2.2. Enrolment requirements and required entry competences for the course	None.
2.3. Learning outcomes at the level of the study programme to which the course contributes	Use of information technology and databases for the purpose of improving professional knowledge and skills, as well as self-education.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After passing the course the student will be able to: 1. Define the basic concepts of informatics and standardization in healthcare informatics. 2. Explain the informatics and information systems in healthcare. 3. Apply knowledge of operating systems and special programs useful in pharmacy practice. 4. Use Internet in the pharmaceutical and medical science and profession. 5. Collect and apply scientific and professional information in healthcare.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	**LECTURES:** **Introduction to pharmacy informatics and basic informatics concepts.** Informatics. The fundamental information technology (IT) concepts (system, semiotics, science, information theory); Advantages and disadvantages of computerization; The concept of health (medical) and pharmacy informatics. **Standardization in health informatics**. Concept and types of standards and aims of standardization; The need for standards in healthcare; Guidelines in healthcare; Concept of quality and good practice; Good Pharmacy Practice (GPP): Basic guidelines and requirements in the EU; The implementation of GPP and the establishment of national standards. **Computer.** Operating systems and user programs. Computer architecture (John von Neumann); Computer's classification (according to the type of data, the purpose and effect); Historical development of computers; Signs in the computer (bit, byte, word, code); Hardware (central processing unit, memory, input-output circuits, bus, other parts); Computer networks; Operating systems (MS-DOS, Windows, other operating systems); User programs (programs for text, to work with spreadsheets, to create presentations, communications programs, adverse and malicious programs and programs for computer protection). **Internet in the pharmaceutical and medical science and profession.** Scientific information in healthcare. The concept and development of the Internet; Connecting to the Internet; Network services (e-mail, mailing lists, web, service for the transmission of data, news groups, etc.); Options and role of the Internet in the

	pharmaceutical and medical science and profession (e.g. bibliographic databases, electronic journals, thematic portals); Internet in the field of drugs (features, benefits, risks); Internet (online) pharmacies. **Information systems in healthcare.** Medical classifications; Drug information. Data in primary healthcare (which data is collected, the reasons for the collection, the obligation to keep the electronic health record); Examples of information systems in healthcare; Public health activity; Integrated health information system; Medical classifications (International Classification of Diseases, Anatomical Therapeutic Chemical Classification System); Commercial and non-commercial sources of drug information. **Information systems in pharmacy.** Special programs in pharmacy practice; E-prescriptions. Examples of e-prescriptions and introducing students to IT mode of operations in modern pharmacy. **SEMINARS:** Patient information. Public health activities and information in public healthcare. Data protection in healthcare. Biometrics. OTC drugs and regulations on drug advertising. Medicines and the Internet I: organizations, agencies and other institutions that are important sources of information (e.g., WHO, EMA, DIA, etc...). Medicines and the Internet II: counseling patients and distribution of drugs and medicinal products via the Internet (Internet / online pharmacies). Medication errors. Evidence Based Medicine (EBM). Decision Support System (DSS) in improving the quality of pharmacotherapy. Health telematics: telemedicine and telepharmacy. E-learning. E-prescribing: new challenges in pharmacy practice. Markers quality of Internet information on medicines. Pharmaceutical science in the virtual world.

2.6. Type of instruction	**lectures** **seminars** workshops exercises online in entirety **mixed *e*-learning** mixed *m*-learning	field work independent study multimedia and the internet work with the mentor (other)
2.7. Student responsibilities	Attendance at lectures and seminars.	

2.8. 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	0.5	Seminar essay	0.5
	Experimental work		Oral exam	
	Essay		Project	
	Tests		Practical training	0.5
	Written exam	1.0	(Other--describe)	
	Research		(Other--describe)	
	Report		(Other--describe)	

2.9. Grading and evaluation of student work over the course of instruction and at a final exam	Seminars, workshops, written exam.

2.10. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	Kern J, Petrovečki M, ed. Medical Informatics. Zagreb: Medical Edition Zagreb, 2009	5	
	Anderson PO, McGuinness SM, Bourne PE. Pharmacy Informatics. CRC Press, Boca Raton, London, New York, 2010	5	

2.11. Optional literature	Good Pharmacy Practice in Europe, www.pgeu.org Guidelines on good pharmacy practice, www.hljk.hr
2.12. Methods of monitoring quality that ensure acquisition of exit competences	Outcomes 1-3 are checked by written exam, and the outcomes 4-5 throughout seminars and workshops.
2.13. Comments	

PHARMACY PRACTICE 1

1. COURSE DECRIPTION – GENERAL INFORMATION				
1.1. Course teacher	Associate Professor Renata Jurišić Grubešić, PhD Associate Professor Željka Vanić, PhD			
1.2. Associate teachers	Teacher practitioners working in the pharmacy (supervisors-pharmacists)			
1.3. Graduate programme	Integrated study programme, Pharmacy			
1.4. Status of the course	Obligatory course			
1.5. Year of study, Semester	3rd year, 6th semester			
1.6. Credit value (ECTS)	2.0			
1.7. Type of instruction (number of hours L+E+S+e-learning)	0+30+0			
1.8. Expected enrolment in the course	130			
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	.			
2. COURSE DESCRIPTION				
2.1. Course objectives	Getting awareness and understanding organization in community pharmacy setting.			
2.2. Enrolment requirements and required entry competences for the course	Enrolment requirements: Pharmacognosy 1 and 2 and Pharmaceutical Chemistry 1 course completed.			
2.3. Learning outcomes at the level of the study programme to which the course contributes	• Efficiently implement financial, marketing and organizational principals important for autonomous work and teamwork; • Participate in and supervise the distribution of pharmaceuticals.			
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	At the end of the Pharmacy practice 1 course, students will be able to: 1. Use official literature in community pharmacy 2. Describe the appropriate stock management of the drugs and medicinal substances 3. Describe supply chain management (orders and consumption of medicines) 4. Classify medicinal preparations			
2.5. Course content broken down in detail by weekly class schedule (syllabus)	• Getting acquainted with mandatory literature (Vademecum, Formulae magistrales, Drug Registry/National Formulary) and official books used in pharmacy (European and Croatian Pharmacopoeia); • Understanding proper storage of drugs and medicinal substances (special storage conditions; i.e. refrigerators for drug storage, locked drug cabinets for controlled drugs etc.); • Understanding supply chain management; ordering and procurement of drugs and medical devices, verification of rolling stocks etc.; • Weighing mono-component herbal teas (i.e. Chamomillae flos) and classification/sorting of pharmaceutical compounds.			
2.6. Type of instruction	lectures seminars workshops exercises online in entirety mixed *e*-learning mixed *m*-learning		**field work** independent study multimedia and the internet work with the mentor (other)	
2.7. Student responsibilities	Practical work in the community pharmacy supervised by mentor-pharmacists and preparation of reports on the completed pharmacy practice.			
2.8. 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		Seminar essay	
	Experimental work		Oral exam	
	Essay		Project	
	Tests		Practical training	1
	Written exam		(Other--describe)	

	Research		(Other--describe)	
	Report	1	(Other--describe)	
2.9. Grading and evaluation of student work over the course of instruction and at a final exam	During the course, students are required to keep a diary on the basis of which they prepare REPORT ON THE CONDUCTED PHARMACY PRACTICE 1, which is approved and signed by supervisor-pharmacist. On the basis of completed practical part of the course and successful report, the student gets 2 ECTS credits (status passed).			
2.10. Required literature (available at the library and via other media)	**Title**		**Number of copies at the library**	**Availability via other media**
	European Directorate for the Quality of Medicines and Health Care. European Pharmacopoeia, 8th ed.; Council of Europe: Strasbourg, 2014.		1	
	European pharmacopoeia, 2008, vol. 6 (or older editions)*		3	
	Croatian pharmacopoeia, 2007, vol. 1;* new edition available online		3	online
	Drug Registry in Croatia 2015, Medical Edition, Zagreb, 2015*		5	
2.11. Optional literature	Optional literature is available in teaching pharmacies.			
a. Methods of monitoring quality that ensure acquisition of exit competences	Learning outcomes 1-4 should be assessed during field work under mentor supervision and described in written report, and evaluated during the final exam.			
2.12. Comments	* Required literature is available in teaching community pharmacies.			

PHARMACY PRACTICE 2

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Associate Professor Renata Jurišić Grubešić, PhD Associate Professor Željka Vanić, PhD
1.2. Associate teachers	Teacher practitioners working in the pharmacy (supervisors-pharmacists)
1.3. Graduate programme	Integrated study programme, Pharmacy
1.4. Status of the course	Obligatory course
1.5. Year of study, Semester	4th year, 8th semester
1.6. Credit value (ECTS)	3.0
1.7. Type of instruction (number of hours L+E+S+e-learning)	0+60+0
1.8. Expected enrolment in the course	130
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	.
2. COURSE DESCRIPTION	
2.1. Course objectives	Introduction with basic determinants, requirements and application of Good Pharmacy Practice (GPP)
2.2. Enrolment requirements and required entry competences for the course	Prerequisites: practical training in Pharmacy Practice 1 completed; Pharmacology and Magistral Prescription Formulation courses completed, passed examination in Drug Formulation and Pharmacognosy 2.
2.3. Learning outcomes at the level of the study programme to which the course contributes	1. Development and implementation of problem solving skills in the production of extemporaneous and galenic preparations. 2. Quality assurance in the production process of extemporaneous and galenic preparations by applying the principles of Good Laboratory Practice (GLP) and Good Manufacturing Practice (GMP).
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	On completion of the course the student will be able to: 1. Manufacture magistral and extemporaneous preparations. 2. Manufacture galenic preparation. 3. Apply pharmacopoeial and related regulations at the pharmacy. 4. Differentiate nonprescription medicines (BR-nonprescription drugs dispensed in community pharmacies only and BRX- nonprescription drugs dispensed both in community pharmacies and in special used stores for retail sale of medicinal products). 5. Differentiate food supplements (herbal preparations, vitamins and minerals, dietary products, etc.).
2.5. Course content broken down in detail by weekly class schedule (syllabus)	• Describe food supplements (herbal preparations, vitamins and minerals, dietary products, etc.); • Participate in the production of extemporaneous preparations (dosage control, compounding, labelling, keeping records) ; • Application of pharmacopeial and related regulations at the pharmacy; • Describe nonprescription medicines (BR-nonprescription drugs dispensed in community pharmacies only and BRX- nonprescription drugs dispensed both in community pharmacies in special used stores for retail sale of medicinal products): purpose, dosage, side effects, use limitations, potential interactions with other medicines and food supplements; • Compare similar and/or related preparations from different manufacturers: purpose, dosage, side effects, use limitations, potential interactions with other medicines and food supplements, comparison of similar and/or related preparations from different manufacturers.

<table>
<tr><td>2.6. Type of instruction</td><td colspan="2">lectures
seminars
workshops
exercises
online in entirety
mixed e-learning
mixed m-learning</td><td colspan="2"><u>field work</u>
independent study
multimedia and the internet
work with the mentor
(other)</td></tr>
<tr><td>2.7. Student responsibilities</td><td colspan="4">Practical work in the community pharmacy supervised by mentor-pharmacists and preparation of reports on the completed pharmacy practice.</td></tr>
<tr><td rowspan="8">2.8. 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)</td><td>Class attendance</td><td></td><td>Seminar essay</td><td></td></tr>
<tr><td>Experimental work</td><td></td><td>Oral exam</td><td></td></tr>
<tr><td>Essay</td><td></td><td>Project</td><td></td></tr>
<tr><td>Tests</td><td></td><td>Practical training</td><td>2</td></tr>
<tr><td>Written exam</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>Research</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>Report</td><td>1</td><td>(Other--describe)</td><td></td></tr>
<tr><td colspan="4"></td></tr>
<tr><td>2.9. Grading and evaluation of student work over the course of instruction and at a final exam</td><td colspan="4">During the course, students are required to keep a diary on the basis of which they prepare REPORT ON THE CONDUCTED PHARMACY PRACTICE 2 which is approved and signed by mentor pharmacist. On the basis of completed practical part of the course and successful report, the student gets 3 ECTS credits (status passed).</td></tr>
<tr><td rowspan="6">2.10. Required literature (available at the library and via other media)</td><td colspan="2">Title</td><td>Number of copies at the library</td><td>Availability via other media</td></tr>
<tr><td colspan="2">European Directorate for the Quality of Medicines and Health Care. European Pharmacopoeia, 8th ed.; Council of Europe: Strasbourg, 2014.</td><td>1</td><td></td></tr>
<tr><td colspan="2">European pharmacopoeia, 2008, vol. 6 (or older editions)*</td><td>3</td><td></td></tr>
<tr><td colspan="2">Croatian pharmacopoeia, 2007, vol. 1;* new edition available online</td><td>3</td><td>online</td></tr>
<tr><td colspan="2">Drug Registry in Croatia 2015, Medical Edition, Zagreb, 2015*</td><td>5</td><td></td></tr>
<tr><td colspan="2">I. Francetić, Pharmacotherapy Handbook, 6th Ed., Medical Edition, Zagreb 2010*</td><td>4</td><td></td></tr>
<tr><td>2.11. Optional literature</td><td colspan="4">Optional literature is available in teaching pharmacies.</td></tr>
<tr><td>a. Methods of monitoring quality that ensure acquisition of exit competences</td><td colspan="4">Learning outcomes 1-5 should be assessed during field work under mentor supervision and described in written report, and evaluated during the final exam.</td></tr>
<tr><td>2.12. Comments</td><td colspan="4">* Required literature is available in teaching community pharmacies.</td></tr>
</table>

PHYSICAL BIOCHEMISTRY

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Professor Jerka Dumić
1.2. Associate teachers	Associate Professor Sanja Dabelić, Assistant Professor Sandra Šupraha Goreta, Assistant Professor Olga Gornik, Toma Keser, PhD
1.3. Graduate programme	Medical Biochemistry
1.4. Status of the course	Obligatory
1.5. Year of study, Semester	3th year; 6th semester
1.6. Credit value (ECTS)	5
1.7. Type of instruction (number of hours L+E+S+e-learning)	30+10+20+0
1.8. Expected enrolment in the course	25
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2nd level; **e-learning – it is not a part of teaching hours, but it is used in studying since it contains case studies, problems with explanations, links on different useful web pages**
2. COURSE DESCRIPTION	
2.1. Course objectives	To acquire basic knowledge about physical and chemical laws that rule biological processes. Understand life as a steady, energy-consuming, non-equilibrium state and understand the thermodynamic and kinetic principles that govern bioprocesses. To obtain methods for kinetic and thermodynamic study of bioprocesses
2.2. Enrolment requirements and required entry competences for the course	Passed exams of the course Physical Chemistry and attended course Biochemistry.
2.3. Learning outcomes at the level of the study programme to which the course contributes	Applying knowledge of physical biochemistry in the laboratory diagnosis, in defining, analysing and proposing actions related to the research, production, and quality assurance as well as implementation of new laboratory methods for the detection and monitoring of diseases and the effect of therapy.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After passing the exam student will be able to: 1. Connect the structure and function of biological macromolecules; 2. Describe the effect of environmental conditions on the structure of biological macromolecules; 3. Explain the importance of the constant energy flow and monitoring of bioprocess speed for the maintenance of the steady-state conditions in living organisms; 4. Describe the course, speed and factors that affect the enzymatic reaction; 5. Identify the basic physical and chemical laws and principles in biological processes.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES: • The hierarchy of protein structure. The dynamism of protein conformation. (3) • Steady energy flow and bioprocess controlled speed of bioprocesses maintain living matter in the steady state. Biochemical potential and equilibrium. The biological significance of metastability. (3) • Posttranslational modifications. (2) • Physical and chemical properties of water. The ionic strength. Acid-base balance. Stabilisation forces and solvation properties of biomolecules. Homeostasis H+ ions. Ionization of amino acids. (2) • Linking of endergonic and exergonic process. Role of ATP. Group transfer potential. (4) • Oxidation-reduction (redox) processes. Purposeful partition of energy. Electron carriers. Oxidative phosphorylation. (4) • Structural and functional characteristics of biological membranes. Transport across biological membranes. The principles of passive, assisted, and active

<table>
<tr><td></td><td colspan="4">transport. Potential of concentration and electrochemical gradients. (4)
• The enzyme structure: binding and catalytic site. Thermodynamics of enzymatic reactions. Transition state theory. Conservation of functional domains. (2)
• Equation of rate (velocity) in steady state (Michaelis-Menten kinetics). The effect of pH, temperature and ionic strength on the rate of the enzymatic reaction.
• Inhibition of the enzymatic activity: the type and mechanisms of inhibition. (2) Multienzyme complexes. Multisubstrate reactions. (2)
• Evolutionary optimised molar ratios of metabolic reactions. Energy and reductive potential of the cell. Integrated view of bioprocesses. (2)

SEMINARS:
• Problem solving: Buffers, buffer capacity, acid-base properties of amino acids. (3)
• Problem solving: Bioenergetics. (3)
• Problem solving: Redox processes. (3)
• Problem solving: Transport across the membrane. (3)
• Problem solving: Enzyme kinetics. (4)
• Presentation of the seminars that students independently prepare on selected topics. (4)

EXECISE
• Buffers. (2)
• Spectroscopic analysis of DNA. (2)
• Enzyme kinetics: determination of the course of the enzymatic reaction, Km and Vmax. (4)
• Enzyme kinetics: the effect of pH, temperature and inhibitors on the rate of the enzymatic reaction. (4)</td></tr>
<tr><td>2.6. Type of instruction</td><td colspan="2">lectures
seminars
workshops
exercises
online in entirety
mixed e-learning*
mixed m-learning</td><td colspan="2">field work
independent study
multimedia and the internet
work with the mentor
(other)
* e-learning – it is not a part of teaching hours, but it is used in studying since it contains case studies, problems with explanations, links on different useful web pages</td></tr>
<tr><td>2.7. Student responsibilities</td><td colspan="4">The students are required to attend classes that takes place in the form of lectures and practical classes (exercises). The students are required to attend practical classes prepared for teaching in a way that have studied description and protocol of the exercises described as part of e-learning. The students, for the achievement of credits and grades in specified courses, are required to take the written and oral exam and pass them both successfully.</td></tr>
<tr><td rowspan="8">2.8. 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)</td><td>Class attendance</td><td>0.5</td><td>Seminar essay</td><td>1</td></tr>
<tr><td>Experimental work</td><td>0.5</td><td>Oral exam</td><td>2</td></tr>
<tr><td>Essay</td><td></td><td>Project</td><td></td></tr>
<tr><td>Tests</td><td></td><td>Practical training</td><td></td></tr>
<tr><td>Written exam</td><td>1</td><td>(Other--describe)</td><td></td></tr>
<tr><td>Research</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>Report</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>2.9. Grading and evaluation of student work over the course of instruction and at a final exam</td><td colspan="4">The students are judged on presentation of a seminar paper (20%), involvement in exercises, and performance in the written (20%) and oral (60%) exam, which can be accessed only after the completion of lectures, participation in seminars and neatly made practical teaching. On the final exam students are required to demonstrate knowledge of all areas covered by the program of the course, at the level of skilled information management and synthesis of materials.</td></tr>
</table>

2.10. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	J. Dumić Physical Biochemistry *Powerpoint* presentations (within the e-learning)		
	Price NC, Dwek RA, George Ratcliffe R, Wormald MR Principles and Problems in Physical Chemistry for Biochemists (2005) Oxford University Press 3rd ed. ISBN 019872816		
2.11. Optional literature			
2.12. Methods of monitoring quality that ensure acquisition of exit competences	Learning outcomes are checked by written and oral exam.		
2.13. Comments			

PHYSICAL CHEMISTRY 1

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	dr. sc. Viktor Pilepić, associate prof.
1.2. Associate teachers	dr. sc. Cvijeta Jakobušić Brala, assistant prof.; dr. sc. Ana Karković Marković; tech. Željka Glassl
1.3. Graduate programme	Study of Pharmacy and study of medicinal biochemistry.
1.4. Status of the course	Compulsory
1.5. Year of study, Semester	1. year, 2. semester.
1.6. Credit value (ECTS)	7,5
1.7. Type of instruction (number of hours L+E+S+e-learning)	30+30+15
1.8. Expected enrolment in the course	155 (130 F + 25 MB)
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2.
2. COURSE DESCRIPTION	
2.1. Course objectives	Identify and get to know the thermodynamic systems and processes, understand the basic principles of thermodynamics and electrochemistry and know how to apply them to explain and interpret the observations in other areas of chemistry and related fields. The course gives basic knowledge necessary for the course Pharmaceuticals.
2.2. Enrolment requirements and required entry competences for the course	Entry competences: acquired knowledge in the subject of the General Chemistry and Stoichiometry.
2.3. Learning outcomes at the level of the study programme to which the course contributes	• The application of fundamental knowledge of physical chemistry principles in the field of chemical thermodynamics and electrochemistry necessary for defining, analyzing and proposing modern physical chemistry methods, techniques and instrumentation related to research, development and production and analysis of drugs, and in the field of laboratory diagnostic. • The implementation of solution for practical problems in the field of physical chemistry in the production and monitoring of the safe and proper use of medicinal products and in the field of laboratory diagnostic.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After completing this course, students will be able to: 1. List and explain the basic principles of thermodynamics and electrochemistry. 2. Identify the thermodynamic systems and processes. 3. List and explain the basic thermodynamic and electrochemistry methods. 4. Explain the processes taking place in solution and at interfaces. 5. Describe simple electrochemical and thermodynamic measurements. 6. Apply calculation in solving physical chemistry problems.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES: • Basic concepts of thermodynamics, the zeroth and first law of thermodynamics, internal energy, the work and heat in process. • Enthalpy, heat capacity, thermochemistry, properties of the state functions. • Joule-Thomson effect, adiabates and isotherms of an ideal gas, the second law of thermodynamics, entropy. • Entropy, entropy changes in the environment, entropy of the irreversible processes, Clausius inequality, the entropy dependence on temperature. • The third law of thermodynamics, Helmholtz and Gibbs energy, the dependence of Gibbs energy on temperature and pressure.

	• Chemical potential, fugacity, physical transformations of pure substances, the Clapeyron and Clausius-Clapeyron equation. • Gibbs energy, enthalpy and entropy of liquid mixing, the chemical potential of liquid, Raoult's law, properties of solutions, colligative properties of solutions. • Activity, chemical equilibrium, spontaneous chemical reaction, Gibbs reaction energy, egzergonic and endergonic reactions. • The reaction system in equilibrium, thermodynamic equilibrium constant. • The dependence of the equilibrium on pressure and temperature, biological activity, thermodynamics of the aerobic and anaerobic metabolism. • The properties of electrolyte solution, the average activity coefficients of electrolyte solution, Debye-Hückel limiting and expanded law. • Electrochemical cells, cell potential, types of the electrochemical cells, reactions at the electrodes. • Nernst equation, standard potential, electrochemical series, potentiometric measurement, selective electrodes. • Potentiometric titration, conductivity of ions in solution, the mobility of ions. • Electron transfer in heterogeneous systems, processes at the interface of the electrode and electrolyte solution, titrations. SEMINARS: • The zeroth and the first law of thermodynamics, internal energy, work and heat in the process. • Enthalpy, heat capacity, thermochemistry. • The second law of thermodynamics, entropy. • The third law of thermodynamics. • Chemical potential, systems in equilibrium. • Electrochemical cells, cell potential. • Nernst equation, electrolyte solutions. EXERCISE: • Determination of the enthalpy of the neutralization reaction. • Coagulation of colloidal particles. • Determination of the molar mass from melting point. • pH-metric titration. • Conductometric titration of neutralizing. • Amperometric titration. • Potentiometric titration.
2.6. Type of instruction	lectures seminars exercises mixed *e*-learning
2.7. Student responsibilities	Regular attendance and active participation in all forms of teaching, successfully completed the Physical Chemistry Laboratory 1, written and oral exams.

2.8. 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	-	Seminar essay	-
Experimental work	1.5	Oral exam	2.5
Essay	-	Project	-
Tests	-	Practical training	-
Written exam	3.5	(Other--describe)	-
Research	-	(Other--describe)	-

	Report	-	(Other--describe)	-
2.9. Grading and evaluation of student work over the course of instruction and at a final exam	During the course students are evaluated on seminars and in the Physical Chemistry Laboratory 1. Students will be evaluated on written and oral exam.			
2.10. Required literature (available at the library and via other media)	**Title**		**Number of copies at the library**	**Availability via other media**
	P. W. Atkins and J. de Paula, *Atkins' Physical Chemistry*, 10. ed., 2014, Oxford University Press.		10	
	P. W. Atkins and J. de Paula, *Physical Chemistry For The Life Sciences*, 2. ed., 2011, Oxford University Press		4	
	C. A. Trapp, M. P. Cady and C. Giunta, *Students' Solutions Manual To Accompany Atkins' Physical Chemistry*, 10. ed, 2014, Oxford University Press.		1	
2.11. Optional literature	T. Cvitaš: Physical chemistry, manuscript in preparation, chapters accessible at the author web pages and in Central Chemical Library of Science.			
2.12. Methods of monitoring quality that ensure acquisition of exit competences	Outcomes 1-4 are validated by written and oral exams, the outcomes 5-6 are validated durring the Physical Chemistry Laboratory 1 course.			
2.13. Comments				

PHYSICAL CHEMISTRY 2

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	dr. sc. Viktor Pilepić, associate prof.
1.2. Associate teachers	dr. sc. Cvijeta Jakobušić Brala, assistant prof.; dr. sc. Ana Karković Marković; tech. Željka Glassl
1.3. Graduate programme	Study of Pharmacy and study of medicinal biochemistry.
1.4. Status of the course	Compulsory
1.5. Year of study, Semester	2. year, 3. semester.
1.6. Credit value (ECTS)	6
1.7. Type of instruction (number of hours L+E+S+e-learning)	30+15+15
1.8. Expected enrolment in the course	155 (130 F + 25 MB)
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2.
2. COURSE DESCRIPTION	
2.1. Course objectives	Identify and get to know the basic spectroscopic and kinetic methods and techniques, understand the basic principles of spectroscopy and chemical kinetics and to know how to apply them in exploring of the structure and properties of molecules and chemical processes. The course gives basic knowledge necessary for the Pharmaceuticals course.
2.2. Enrolment requirements and required entry competences for the course	Requirement for enrollment: to take and pass Physics course and to attend Physical Chemistry 1 course.
2.3. Learning outcomes at the level of the study programme to which the course contributes	• The application of fundamental knowledge of physical chemistry principles in the field of spectroscopy and chemical kinetics necessary for defining, analyzing and proposing modern physical chemistry methods, techniques and instrumentation related to research, development, production and analysis of drugs, and in the field of laboratory diagnostic. • The implementation of solution for practical problems in the field of physical chemistry in the production and monitoring of the safe and proper use of medicinal products, and in the field of laboratory diagnostic.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After completing this course, students will be able to: 1. List and explain the basic spectroscopic methods and techniques. 2. Explain the interaction between electromagnetic radiation and matter. 3. Describe the principles of measurements and the interpretation of molecular spectra in order to study the structure and properties of molecules. 4. Identify the methods and techniques applied in exploring of kinetics and mechanism of chemical reactions and other processes in homogeneous and heterogeneous systems. 5. Describe simple spectroscopic and kinetic measurements. 6. Apply calculation in solving physical chemistry problems.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES: • Introduction to spectroscopy, absorption and emission of the electromagnetic radiation, spectrum. • Dipole properties of molecules, Rotational and vibrational (IR) spectroscopy. • IR spectroscopy, instruments, IR spectra, Raman spectroscopy. • Electronic (UV-Vis) spectroscopy, spectrophotometers, UV-Vis spectra.

	• The fluorescence and phosphorescence, photochemical reactions, LASER. • Optical activity, CD and ORD spectra, NMR spectroscopy (introduction). • NMR spectrometers, NMR spectrum. • Pulse NMR technique measurements, EPR (ESR) spectroscopy. • Chemical kinetics-introduction, the reaction rate and rate constant. • The integrated rate law for chemical reactions. • Determination of the order of reaction, systems in equilibrium, the enzymatic reactions. • The theories of reaction rate of chemical reactions, Arrhenius relation. • Eyring theory of reaction rate of chemical reactions. • Thermodynamic aspects of the theory of reaction rate of chemical reactions, salt effects. • The kinetic isotope effects, Marcus theory. SEMINARS: • Beer-Lambert law, absorption, dipole moments. • IR, Raman and UV-Vis spectroscopy. • The fluorescence, photochemical reactions, optical activity. • NMR and EPR (ESR) spectroscopy, EPR spectra. • Integrated law of reaction rate of chemical reactions, the rate constant and half time of chemical reactions. • Enzyme kinetics, equilibrium and application of the Eyring relation. • Salt and kinetic isotope effects. EXERCISE: • Adsorption. • Determination of the rate constant of hydrogen peroxide decomposition. • Determination of the rate constant of sucrose hydrolysis. • Spectrophotometric titration.
2.6. Type of instruction	lectures seminars exercises mixed *e*-learning
2.7. Student responsibilities	Regular attendance and active participation in all forms of teaching, successfully completed the Physical Chemistry Laboratory 2, written and oral exams.

2.8. 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	-	Seminar essay	-
Experimental work	1	Oral exam	3
Essay	-	Project	-
Tests	-	Practical training	-
Written exam	2	(Other--describe)	-
Research	-	(Other--describe)	-
Report	-	(Other--describe)	-

2.9. Grading and evaluation of student work over the course of instruction and at a final exam	During the course students are evaluated on seminars and in the Physical Chemistry Laboratory 2. Students will be evaluated on written and oral exam.

2.10. Required literature (available at the library and via other media)

Title	Number of copies at the library	Availability via other media
P. W. Atkins and J. de Paula, *Atkins' Physical Chemistry*, 10. ed., 2014, Oxford University Press.	10	

	P. W. Atkins and J. de Paula, *Physical Chemistry For The Life Sciences*, 2. ed., 2011, Oxford University Press	4	
	C. A. Trapp, M. P. Cady and C. Giunta, *Students' Solutions Manual To Accompany Atkins' Physical Chemistry*, 10. ed., 2014, Oxford University Press.	1	
2.11. Optional literature	T. Cvitaš: Physical chemistry, manuscript in preparation, chapters accessible at the author web pages and in Central Chemical Library of Science.		
2.12. Methods of monitoring quality that ensure acquisition of exit competences	Outcomes 1-4 are validated by written and oral exams, the outcomes 5-6 are validated durring the Physical Chemistry Laboratory 1.		
2.13. Comments			

PHYSICAL CHEMISTRY METHODS IN BIOMEDICAL RESEARCH

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	dr. sc. Viktor Pilepić, associate prof.
1.2. Associate teachers	dr. sc. Cvijeta Jakobušić Brala, assistant prof.; dr. sc. Ana Karković Marković; tech. Željka Glassl
1.3. Graduate programme	Study of Pharmacy and study of medicinal biochemistry.
1.4. Status of the course	Optional
1.5. Year of study, Semester	3. year
1.6. Credit value (ECTS)	2.5
1.7. Type of instruction (number of hours L+E+S+e-learning)	15+15+0
1.8. Expected enrolment in the course	12
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2.
2. COURSE DESCRIPTION	
2.1. Course objectives	Identify and get to know how to apply and integrate different thermodynamic, spectroscopic and kinetic methods and techniques in the study of complex systems and processes by the method which involve the acquired knowledge and a specific approach to research and implementation of the physical chemistry measurements on a model reaction system.
2.2. Enrolment requirements and required entry competences for the course	Enrolled fifth semester, to take and pass Physical Chemistry 2 course.
2.3. Learning outcomes at the level of the study programme to which the course contributes	The application of physical chemistry knowledge required for defining, analyzing and proposing spectroscopic, electrochemistry, thermodynamic and kinetic methods and techniques related to research, development and production and the analysis and quality control of drugs and also in diagnostic.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After passing the course, students will be able to: 1. List the spectroscopic, electrochemistry, thermodynamic and kinetic methods and techniques. 2. Explain how various physical chemistry methods and techniques can be integrated with each other and applied in the study of more complex systems and processes. 3. Setup and implement a spectroscopic, thermodynamic and kinetic measurements. 4. Apply calculation in solving physical chemistry problems.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES: • The use of physical and chemical methods in solving chemical, pharmaceutical and biochemical problems. • Studies of reaction mechanisms and processes by thermodynamic, kinetic and UV, IR, NMR and ESR spectroscopic techniques. EXERCISE: • A model exercise that integrates application of physical chemistry methods and techniques to investigate the interaction of vitamin C with a toxin in solution and in a colloidal system. • Investigation of the reaction of vitamin C and toxins in solution kinetic and thermodynamic methods using UV, IR, NMR and ESR spectroscopic methods.

<table>
<tr><td>2.6. Type of instruction</td><td colspan="2">lectures
exercises
mixed e-learnin</td><td colspan="2"></td></tr>
<tr><td>2.7. Student responsibilities</td><td colspan="4">Regular attendance and active participation in all forms of teaching.</td></tr>
<tr><td rowspan="7">2.8. 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)</td><td>Class attendance</td><td>-</td><td>Seminar essay</td><td>-</td></tr>
<tr><td>Experimental work</td><td>1.5</td><td>Oral exam</td><td>0,5</td></tr>
<tr><td>Essay</td><td>-</td><td>Project</td><td>-</td></tr>
<tr><td>Tests</td><td>-</td><td>Practical training</td><td>-</td></tr>
<tr><td>Written exam</td><td>-</td><td>(Other--describe)</td><td>-</td></tr>
<tr><td>Research</td><td>0,5</td><td>(Other--describe)</td><td>-</td></tr>
<tr><td>Report</td><td>-</td><td>(Other--describe)</td><td>-</td></tr>
<tr><td>2.9. Grading and evaluation of student work over the course of instruction and at a final exam</td><td colspan="4">Students are evaluated during the course and on oral exam.</td></tr>
<tr><td rowspan="4">2.10. Required literature (available at the library and via other media)</td><td colspan="2">Title</td><td>Number of copies at the library</td><td>Availability via other media</td></tr>
<tr><td colspan="2">P. W. Atkins and J. de Paula, Atkins’ Physical Chemistry, 10. izdanje, 2014, Oxford University Press.</td><td>10</td><td></td></tr>
<tr><td colspan="2">P. W. Atkins i J. de Paula, Physical Chemistry For The Life Sciences, 2. izdanje, 2011, Oxford University Press</td><td>4</td><td></td></tr>
<tr><td colspan="2"></td><td></td><td></td></tr>
<tr><td>2.11. Optional literature</td><td colspan="4"></td></tr>
<tr><td>2.12. Methods of monitoring quality that ensure acquisition of exit competences</td><td colspan="4">Outcomes 1 and 2 are validated by oral exams, the outcomes 3 and 4 are validated durring the experimental work.</td></tr>
<tr><td>2.13. Comments</td><td colspan="4"></td></tr>
</table>

PHYSIOLOGICAL AND BIOCHEMICAL ASPECTS OF NUTRITION

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Associate Professor Dubravka Vitali Čepo, PhD
1.2. Associate teachers	Assistant Professor Lovorka Vujić , PhD Kristina Radić, M Pharm Martina Teskera, M Nutr
1.3. Graduate programme	Integrated study of pharmacy
1.4. Status of the course	Compulsory
1.5. Year of study, Semester	3rd year, 6th semester
1.6. Credit value (ECTS)	5
1.7. Type of instruction (number of hours L+E+S+e-learning)	25+30+5+0
1.8. Expected enrolment in the course	130
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	1
2. COURSE DESCRIPTION	
2.1. Course objectives	Introduction to structural characteristics, digestion, absorption, and metabolism of essential nutrients: proteins, lipids, carbohydrates, fiber, vitamins and minerals. Introduction to organism's energy needs, mechanisms that control energy needs (behavioral and biological), and energy balance disorders (obesity, lipodystrophy PEM). Students will become familiar with specific objectives and guidelines for proper/balanced diet: recommended daily intake of nutrients, food and food supplements labeling, and using food composition tables. Introducing students to food components with special effects on health; definition of functional foods and dietary supplements. Introduction to fundamentals of making menus. Guidelines for the treatment of certain nutritional deficits (meal planning and the use of supplements). Students will be able to explain fundamentals of food chemistry and to conduct chemical analyzes of food and food supplements (determination of macro- and micronutrients).
2.2. Enrolment requirements and required entry competences for the course	Enrolment requirements: passed Biological chemistry and Biochemistry exam Entry competences: basic knowledge in chemistry of carbohydrates, amino acids, proteins, sterols, fatty acids, and lipids; knowledge of basic physiology and anatomy with enhanced understanding of digestive system. Comprehension of basic biochemical processes within organism (glycolysis, gluconeogenesis, citric acid cycle, synthesis and breakdown of carbohydrates, fats and proteins, DNA).
2.3. Learning outcomes at the level of the study programme to which the course contributes	• Implementation of pharmaceutical care and counseling on pharmacotherapy. • Developing communication skills to ensure positive interaction with patients and colleagues. • Informing and counseling patients about disease prevention and health preservation. • The use of information technology and databases to upgrade professional knowledge, skills, and self-education.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After passed exam students should be able to: 1. Explain metabolic pathways of various macro- and micronutrients. 2. Explain and understand terms essential nutrient and recommended daily intake of nutrients. 3. Identify and explain symptoms caused by a deficiency of essential nutrients/energy and suggest a diet plan. 4. Identify therapeutic indications for supplementation with vitamins/essential minerals (prevention of deficits or achieving additional health effects) and suggest therapy (dosage, duration, selection of products). 5. List all the parameters that determine the biological value and bioavailability of different nutritional categories and suggest ways to improve biological

	value/bioavailability. 6. List the basic guidelines for a healthy diet and explain mechanisms by which a healthy diet contributes to the homeostasis of the organism: make a balanced diet plan due to the daily energy/nutritional needs. 7. List components of food with special effects on health and explain their mechanisms of action. 8. Define terms "functional food" and "dietary supplement": explain similarities and differences. 9. Perform and explain analytical methods for the determination of macro/micronutrients in food. Determine energy value and nutritional density of foods/food supplement.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES: • **Introduction**. Nutrients - definition. Essentiality; criteria. Nutrients that do not meet strict criteria for essentiality. The recommended daily intake of nutrients (DRI values). Excessive daily intake of nutrients and consequences. Biological efficiency /bioavailability of nutrients. Digestive system - structure and functions. The main digestive processes. Health effects of nutrient and nonnutritive food components. Functional foods and dietary supplements. Nutrients as pharmacological agents. • **Proteins**. Digestion of proteins (gastric and intestinal phases; absorption and intestinal metabolism of amino acids and small peptides. The synthesis and degradation of proteins (hormonal regulation, the impact of nutritional status, the impact of physical activity, the impact of growth). Summary of amino acids metabolism (roles, essential and non-essential, nitrogen excretion). Daily requirements for proteins and amino acids. Proteins in foods: nutritional value and digestibility. Alternative sources of protein in the diet. The average protein and amino acids intake, the recommended share of the total energy intake; assessment of protein status of the organism and consequences of inadequate intake. Food supplements for people on long-term parenteral nutrition. Available amino acids and peptides in oral rehydration therapy. • **Carbohydrates.** Carbohydrate components of food. Digestion of disaccharides and oligosaccharides. Digestion of starch. Non-digestible carbohydrates. Absorption of monosaccharides. Congenital and environmental factors that affect digestion of carbohydrates. Summary of glucose metabolism (liver, muscle, adipose tissue, brain; transport through the membrane, etc). Metabolism of other monosaccharides. Recommended daily intake of carbohydrates; average daily intake. • **Fiber.** Physical and chemical properties; physiological characterization. The main physiological effects: dependence of structure and function. The effect of fiber on energy status of the organism. Recommended daily intake of fiber. Fiber in disease's prevention and treatment. Dietary fiber as nutritional supplements: indications. Dietary fiber and microbiome. • **Lipids**. Digestion and absorption of lipids: luminal degradation, intracellular metabolism of absorbed lipids, portal transport of long-chain fatty acids. Hormonal regulation of lipid absorption. Disorders of lipid absorption. Metabolism of fatty acids and monoglycerides - brief overview. Synthesis, transport and metabolism of cholesterol and lipoproteins - brief overview. Polyunsaturated (essential) fatty acids: metabolism and biological role. Recommendations for daily intake and the average intake of fats and essential fatty acids. Lipids as nutritional supplements. Lipid status and health. • **Energy requirements and energy transport.** Basal metabolism and additional energy needs of the organism - definition, measurement (direct and indirect calorimetry). Calorigenic food effect. Mechanisms controlling

energy balance (behavioral and biological); energy balance disorders (obesity, lipodystrophy, PEM). Control of energy expenditure due to the intake of food: regulation of metabolism of macronutrients at the level of the whole organism; metabolism of macronutrients at the cellular level. The metabolic fate of macronutrients.

- **Niacin, riboflavin and thiamine.** Niacin: nomenclature, structure and biochemistry. Physiological roles. Sources, chemical stability, ADMET. Riboflavin: nomenclature, structure and biochemistry. Physiological roles. Sources, chemical stability, ADMET. Thiamine: nomenclature, structure and biochemistry. Physiological roles. Sources, chemical stability. Niacin, riboflavin and thiamine as supplements: symptoms of deficit, indications for supplementation, therapeutic algorithms. Evidence-based effectiveness. Interdependence of vitamin B2, B3 and B1.
- **Folate, choline, B12 and B6.** Folate: nomenclature, structure and biochemistry. Physiological roles. Sources, chemical stability, ADMET. Folate deficit, folate status assessment. Recommendations for intake. Choline: structure and biochemistry. Physiological roles. Sources, chemical stability, ADMET. Choline deficit, daily intake recommendations, status. Vitamin B12: structure and biochemistry. Physiological roles. Sources, chemical stability, ADMET. Intake needs for vitamin B12. Vitamin B6: structure and biochemistry. Physiological roles. Sources, chemical stability, ADMET. Intake needs for vitamin B6. Folate, choline, B12 and B6 as dietary supplements: symptoms of deficit, indications for supplementation, therapeutic algorithms. Evidence - based effectiveness.
- **Biotin, Pantothenic Acid, Vitamin C.** Biotin: structure and biochemistry, physiological roles, food sources, chemical stability, ADMET. Recommended intake. Pantothenic acid: structure and biochemistry, physiological roles, food sources, chemical stability, ADMET. Recommended intake. The functions of the CAA and the ACP. CoA and carnitine. Pantothenic acid as a therapeutic. Vitamin C: structure and biochemistry, physiological roles, food sources, chemical stability, ADMET. Vitamin C and human health. DRI for vitamin C. Biotin, pantothenic acid, vitamin C as food supplements: symptoms of deficit, evidence - based indications.
- **Vitamin D, Vitamin E, Vitamin A, Vitamin K.** Vitamin D: nutritional and endogenous sources, biological role, vitamin D status, contribution of sunshine to vitamin D status, DRI, controversy regarding the recommendations of the daily intake. Vitamin E: nomenclature, structure and biochemistry. The biological role. Food sources and the average intake of vitamin E. Health effects of the deficit, biopotency. Vitamin A: the structure and biochemistry, physiological roles; carotenoids: structure and biochemistry, physiological roles, retinol-binding proteins, food sources of vitamin A and carotenoids. Toxicity. Vitamin K: nomenclature, mechanism of action, vitamin K antagonists, resistance to warfarin, bioavailability, absorption, transport and metabolism; biological roles. Evaluation of vitamin K status; recommendations for intake. Vitamin D, Vitamin E, Vitamin A, Vitamin K as dietary supplements: symptoms of deficit, evidence - based indications , therapeutic algorithms.
- **Calcium, phosphorus, magnesium.** Chemical properties, physiological roles, ADMET. Food sources, bioavailability and recommendations for daily intake. Determining the status. Deficit. Calcium, phosphorus and magnesium as dietary supplements: symptoms of deficit, evidence - based indications, therapeutic algorithms.
- **Iron, zinc, copper.** Chemical properties, physiological roles, ADMET. Food sources, bioavailability and recommendations for daily intake. Determining the status. Deficit. Calcium, phosphorus and magnesium as dietary supplements: symptoms of deficit, evidence - based indications, therapeutic

<table>
<tr><td></td><td colspan="4">algorithms.
• Iodine, selenium, fluorine. Chemical properties, physiological roles, ADMET. Food sources, bioavailability and recommendations for daily intake. Determining the status and deficit. Thyroid hormones: metabolism and function. Selenoproteins. Essentiality of selenium. Selenium and carcinogenesis. Dental fluorosis and dental caries. Iodine, selenium and fluoride as dietary supplements: symptoms of deficit, evidence - based indications, therapeutic algorithms.

SEMINARS:
• Basic guidelines for a healthy diet (nutritional composition, energy intake).
• Food and dietary supplements labeling.
• Food composition table - nutritional composition and caloric value of foods.
• Creating menus: the use of food composition table; use of software (eg. “Program Prehrane 5.0”).

EXERCISES:
• Determination of protein in a meal replacement (foods for particular nutritional uses): macro-micro Kjeldahl Method; automated Kjeldahl method - Buchi apparatus.
• Determination of lipids in the meal replacement (foods for particular nutritional uses): semicontinuous Soxlet extraction method.
• Determination of carbohydrates in a meal replacement (foods for particular nutritional uses): the method by Bertrand; calculating from difference.
• Determination of ash in the replacement meal (food for particular nutritional uses): gravimetry.
• Determination of moisture in the meal replacement (foods for particular nutritional uses): drying in a vacuum oven.
• Determination of total dietary fiber in a meal replacement (foods for particular nutritional uses): enzymatic gravimetric method.
• Calculation of energy value of the replacement meals (food for particular nutritional uses): conversion factors.
• Calculation of the nutritional density of the replacement meals (food for particular nutritional uses).
• Determination of riboflavin in replacement baby foods (foods for particular nutritional uses).
• Determination of carotene in vitamin syrup (dietary supplements).
• Determination of total phenols in royal jelly/propolis/vitamin syrup (dietary supplements).
• Determination of the antioxidant potential in royal jelly/propolis/vitamin syrup (dietary supplements).</td></tr>
<tr><td>2.6. Type of instruction</td><td colspan="2"><u>lectures</u>
<u>seminars</u>
workshops
<u>exercises</u>
online in entirety
mixed e-learning
mixed m-learning</td><td colspan="2">field work
independent study
multimedia and the internet
work with the mentor
(other)</td></tr>
<tr><td>2.7. Student responsibilities</td><td colspan="4">Lecture attendance.
Seminars attendance and making seminar essay.
Attendance and active participation during exercises. Passing the final test related to exercises.</td></tr>
<tr><td rowspan="3">2.8. Screening of student’s work (specify the proportion of ECTS credits for each activity so that the total number of CTS</td><td>Class attendance</td><td>0.1</td><td>Seminar essay</td><td></td></tr>
<tr><td>Experimental work</td><td>0.4</td><td>Oral exam</td><td>1.5</td></tr>
<tr><td>Essay</td><td></td><td>Project</td><td></td></tr>
</table>

<table>
<tr><td rowspan="4">credits is equal to the credit value of the course)</td><td>Tests</td><td>0.5</td><td>Practical training</td><td></td></tr>
<tr><td>Written exam</td><td>2.5</td><td>(Other--describe)</td><td></td></tr>
<tr><td>Research</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>Report</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>2.9. Grading and evaluation of student work over the course of instruction and at a final exam</td><td colspan="4">Test related to exercises is graded as well as activity and preparedness during class and exercises. Final exam is written and oral.</td></tr>
<tr><td rowspan="4">2.10. Required literature (available at the library and via other media)</td><td colspan="2">Title</td><td>Number of copies at the library</td><td>Availability via other media</td></tr>
<tr><td colspan="2">Lecture synopsis</td><td></td><td>Merlin</td></tr>
<tr><td colspan="2">Course materials for exercises: Physiological and biochemical aspects of nutrition (D. Vitali Čepo)</td><td></td><td>Merlin</td></tr>
<tr><td colspan="2"></td><td></td><td></td></tr>
<tr><td>2.11. Optional literature</td><td colspan="4">1. Nutritional Biochemistry, Academic press, Inc., New York, London, 1999.
2. Biochemical, physiological and molecural aspects of human nutrition, Elsevier, St. Louis, Missoury, 2013.
3. Basic Nutrition and Diat Therapy, C.V. Mosby; 11th CD-Ro edition, 2000.
4. Food Chemistry, Springer,Germany, 2004.
5. Nutrition and Diet Therapy, F. A. Davis Company; 3rd edition 2001.</td></tr>
<tr><td>2.12. Methods of monitoring quality that ensure acquisition of exit competences</td><td colspan="4">Learning outcomes are tested through activity during exercises and with final test (outcome 9), through activity during seminars (outcomes 6 - 8) and with written and oral exam (outcomes 1 - 8).</td></tr>
<tr><td>2.13. Comments</td><td colspan="4"></td></tr>
</table>

PHYTOTHERAPY

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Associate profesor Marijana Zovko Končić
1.2. Associate teachers	
1.3. Graduate programme	Pharmacy integrated study program
1.4. Status of the course	Elective
1.5. Year of study, Semester	4, 8
1.6. Credit value (ECTS)	2,5
1.7. Type of instruction (number of hours L+E+S+e-learning)	15+0+15
1.8. Expected enrolment in the course	30-60
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	3, 20%
2. COURSE DESCRIPTION	
2.1. Course objectives	Students will learn basic principles of interaction of herbal medicines and the human body. They will understand the mechanisms of action, know doses, therapeutic and adverse effects, indications and contraindications of selected phytotherapeutics, as well as learn how to independently search literature. The acquired knowledge and skills are directly applicable to in interaction with patients in the pharmacy.
2.2. Enrolment requirements and required entry competences for the course	Registered eighth semester, passed Pharmacognosy 2, passed Pathophysiology with pathology
2.3. Learning outcomes at the level of the study programme to which the course contributes	• Apply expert knowledge and skills to provide advice on pharmacotherapy while respecting the current legal framework • Informing and advising patients on the effects and proper application of pharmaceuticals • Recognize clinically significant interactions of pharmaceuticals and act with the aim of avoiding them • Demonstrate cognitive, analytical and critical skills in the development and implementation of solutions for practical problems and the monitoring of safe and appropriate application of pharmaceuticals • Use information technology and databases for enhancing expert knowledge and skills and self-learning
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	Upon successfully passing the exam the student will be able to 1. Differentiate between food supplements and herbal drugs with regard to their intended use and quality control 2. Explain the mechanisms of action of herbal preparation (phytopreparations) 3. Connect chemical composition of phytopreparations with their desired and undesired effects

<table>
<tr><td></td><td>4. Describe indications and contraindications of phytopreparations
5. Evaluate dosing and duration of use of phytopreparations
6. Point to clinically significant interaction of phytopreparations
7. Evaluate and compare phytopreparations according to their indications, therapeutic actions, desired-and side-effects
8. Advise patients on the appropriate use of herbal drugs and supplements
9. Independently search for and critically evaluate available literature</td></tr>
<tr><td>2.5. Course content broken down in detail by weekly class schedule (syllabus)</td><td>LECTURES
• Traditional and modern phytotherapy.
• Overview of other alternative/complementary methods of herbal treatments (TCM, Ayurveda, aromatherapy, homeopathy…)
• Therapeutic classification and analysis of phytopreparations according to their use, mechanism of action, clinical studies on their efficacy, indications, contraindications, side-effects, interactions and dosing:
• Phytopreparations for central nervous system disorders
• Phytopreparations for circulatory system disorders
• Phytopreparations for endocrine system disorders
• Phytopreparations for urogenital system disorders
• Phytopreparations for digestive system disorders
• Analgesics and antirheumatics
• Phytopreparations for respiratory system disorders
• Phytopreparations with antimicrobial activity
• Modulators of immune system activity
• Use of phytopreparations in treatment of malign diseases
• Food supplements in sports
• Phytopreparations for use in cosmetics and dermatology

SEMINARS
• Legislation of herbal preparations: herbal drugs and food supplements
• Difference between herbal drugs and food supplements according to their intended use and quality assurance
• Use, package information and advertizing of herbal products in Croatia: examples from practice
• The importance of clinical evidence in phytotherapy.
• Instructions for the preparation of seminar work (review of available literature)
• Presentation of seminars
• Case studies</td></tr>
<tr><td>2.6. Type of instruction</td><td>lectures
seminars
workshops
exercises
online in entirety
mixed e-learning
mixed m-learning</td><td>field work
independent study
multimedia and the internet
work with the mentor
(other)</td></tr>
<tr><td>2.7. Student responsibilities</td><td colspan="2">Attending lectures and active participation in teaching process.
Preparation and presentation of seminar essay</td></tr>
<tr><td>2.8. 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)</td><td colspan="2"><table>
<tr><td>Class attendance</td><td></td><td>Seminar essay</td><td>0.2</td></tr>
<tr><td>Experimental work</td><td></td><td>Oral exam</td><td></td></tr>
<tr><td>Essay</td><td></td><td>Project</td><td></td></tr>
<tr><td>Tests</td><td>0.5</td><td>Practical training</td><td></td></tr>
<tr><td>Written exam</td><td>1.5</td><td>(Other--describe)</td><td></td></tr>
</table></td></tr>
</table>

	Research	0.3	(Other--describe)	
	Report		(Other--describe)	
2.9. Grading and evaluation of student work over the course of instruction and at a final exam	Continuous follow-up of learning process using online tests Evaluation of seminar essays –review of available literature on selected topic			
2.10. Required literature (available at the library and via other media)	**Title**		**Number of copies at the library**	**Availability via other media**
	Marijana Zovko Končić: Lectures and seminars from phytotherapy			
	Catherine Ulbricht, Natural Standard Herbal Pharmacotherapy: An Evidence-Based Approach, 1 edition Mosby; (2009)			
	Kerry Bone, Simon Mills, Principles and Practice of Phytotherapy: Modern Herbal Medicine 2 edition, Churchill Livingstone (2013)			
2.11. Optional literature	Michael Heinrich, Joanne Barnes, Simon Gibbons, Fundamentals of Pharmacognosy and Phytotherapy, 2 edition, Churchill Livingstone; (2012) Robert Alan Bonakdar, The H.E.R.B.A.L. Guide: Dietary Supplement Resources for the Clinician Lippincott Williams & Wilkins; 1 Pap/Psc edition (2010)			
2.12. Methods of monitoring quality that ensure acquisition of exit competences	All learning outcomes are checked by written exam, continuous online follow-up, as well as by means of seminar essays.			
2.13. Comments				

PRINCIPLES OF HUMAN AND POPULATION GENETICS

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Prof Ingeborg Barisic, MD, PhD
1.2. Associate teachers	PhD Ivona Sansović, master of medical biochemistry
1.3. Graduate programme	Integrated study of medical biochemistry
1.4. Status of the course	mandatory
1.5. Year of study, Semester	4th, winter semester
1.6. Credit value (ECTS)	2,5
1.7. Type of instruction (number of hours L+E+S+e-learning)	15+10+5
1.8. Expected enrolment in the course	15-25
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	-
2. COURSE DESCRIPTION	
2.1. Course objectives	The aim of the course is to introduce students to the basics of human genetics - normal and impaired genoma structure, the prevalence and nature of genetic diseases, the ways in which they are arise and how they are transmitted, methods of diagnosis and prevention. The aim of the course is to provide students with knowledge that will enable them to understand the application of modern genetic knowledge into clinical practice and scientific research.
2.2. Enrolment requirements and required entry competences for the course	Attended Molecular Biology with Genetic Engineering
2.3. Learning outcomes at the level of the study programme to which the course contributes	• Implementation of new laboratory diagnostic techniques for detecting and monitoring diseases and therapies • Interpretation of the results of laboratory analysis of the analytical and clinical aspects of quality improvement, respecting the current legislation, current health policy and guidelines and ethical principles of the profession • Critical evaluation and application of scientific knowledge and data available in order to improve the profession, problem solving, application of new technologies and improving existing methods and techniques.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After completing the course, students will be able to: • Describe the normal structure of the human genome, specify disorders that occur in the structure of DNA and chromosomes as well as their effects on the phenotype. • Describe and explain the patterns of inheritance of chromosomal, monogenic and multifactorial disorders, as well as the way in which arise atypical forms of inherited disorders • List the factors that affect the normal and impaired intrauterine development. Define and classify congenital anomalies.

	• Recognize the clinical presentation of the most common genetic disorders. • Name and adequately select diagnostic and preventive tests in genetic diseases. • Nominate and explain the basic postulates of genetic counseling • Define the basics of population genetics (Hardy Weinberg principle, selection, migration and genetic drift, the effect of consanguinity) • To draw a family tree on the basis of family history and to identify the mode of inheritance • Recognise a family history and clinical characteristics that indicate a metabolic disease and identify the possibilities of treatment
2.5. Course content broken down in detail by weekly class schedule (syllabus)	**LECTURES**: • The structure and organization of the human genome. Cellular and molecular basis of inheritance • Mendelian inheritance: autosomal recessive and autosomal dominant type of inheritance, X linked recessive and dominant inheritance. Examples of diseases (cystic fibrosis, Marfan syndrome, neurofibromatosis, hereditary metabolic diseases, spinal muscular atrophy, Duchenne muscular dystrophy) • Screening for genetic disease (carrier testing, newborn screening) • Atypical patterns of inheritance: dynamic mutations (anticipation), mitochondrial inheritance, mosaicism, uniparental disomy, genomic imprinting • Polygenic and multifactorial inheritance; congenital anomalies • Chromosomes and cell division, chromosome disorders- numerical and structural chromosome aberrations. • Applied Genetics: genetic counseling, carrier detection, presymptomatic diagnosis, prenatal diagnosis, ethical aspects of genetic testing. • The interpretation and application of genetic tests in clinical medicine, organization of genetic services. • Poplation genetics (allele frequencies in populations, Hardy-Weinberg principle, genetic polymorphism, segregation analysis) **SEMINARS:** • Mucopolysaccharidosis • Fabry disease • Gaucher disease • Mitochondrial diseases • Disorders of amino acid metabolism • Disorder of copper metabolism • Organic acidemias • Pompe disease • Hypofosfatasia • Urea cycle disorders

	EXCERCISES (PRACTICE) • Molecular diagnosis of genetic disorders - brief overview of all new methods of cytogenetics and molecular genetics with examples of their use in the diagnosis of submicroscopic chromosomal aberrations and frequent monogenetic diseases • Taking blood samples, isolation of DNA, DNA banking, determining the concentration and quality of DNA • Quantitative methods: MLPA and MS-MLPA • Methods of classical cytogenetics and chromosomal microarray • Sanger sequencing and next generation sequencing

2.6. Type of instruction	**lectures** **seminars** workshops **exercises** online in entirety mixed *e*-learning mixed *m*-learning	field work independent study multimedia and the internet work with the mentor (other)

2.7. Student responsibilities				
2.8. 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 0.25		Seminar essay	0.75
	Experimental work		Oral exam	
	Essay		Project	
	Tests		Practical training	
	Written exam 1.5		(Other--describe)	
	Research		(Other--describe)	
	Report		(Other--describe)	

2.9. Grading and evaluation of student work over the course of instruction and at a final exam			
2.10. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	Peter D. Turnpenny i Sian Ellard / Emery's Elements of Medical Genetics, Medicinska Naklada Zagreb, 2011.	5	
	Lectures handouts		On line
2.11. Optional literature			
2.12. Methods of monitoring quality that ensure acquisition of exit competences	Continuous evaluation of learning outcomes during lectures, seminars and exercises		
2.13. Comments			

PROFESSIONAL PRACTICE 1

1. COURSE DECRIPTION – GENERAL INFORMATION				
1.1. Course teacher	Ass. prof. Marija Grdić Rajković, PhD			
1.2. Associate teachers				
1.3. Graduate programme	Medical Biochemistry study programme			
1.4. Status of the course	Compulsory			
1.5. Year of study, Semester	3th			
1.6. Credit value (ECTS)	2			
1.7. Type of instruction (number of hours L+E+S+e-learning)	0+30+0			
1.8. Expected enrolment in the course	25			
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	-			
2. COURSE DESCRIPTION				
2.1. Course objectives	Introduce students to the management of work and organization of medical biochemistry laboratory.			
2.2. Enrolment requirements and required entry competences for the course	The condition for enrolment: attended General Clinical Biochemistry			
2.3. Learning outcomes at the level of the study programme to which the course contributes	Applying expert knowledge and skills in the development of laboratory tests in the field of general clinical biochemistry in medical laboratory of the Health and Clinical Hospital Centre.			
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After were completed Professional Practice 1 student will be able to: 1. Use the professional literature; 2. Describe the mode of work in medical biochemistry laboratory of primary health care; 3. Describe mode in medical biochemistry laboratory of the Clinical Hospital Centre; 4. Describe the principle of determining the individual analytes in a clinical laboratory.			
2.5. Course content broken down in detail by weekly class schedule (syllabus)	EXERCISES: • Introduction to work in medical biochemistry laboratory in primary health care. • Introduction to the organisation of work in medical biochemistry laboratory at the Clinical Hospital Centre. • Introduction to the methods for the determination of the various metabolites and substrates, electrolytes, trace elements, proteins, lipids, and qualitative analysis of urine. • Comparison of the results with the reference intervals.			
2.6. Type of instruction	lectures seminars workshops exercises online in entirety mixed *e*-learning mixed *m*-learning		**field work** independent study multimedia and the internet work with the mentor (other)	
2.7. Student responsibilities				
2.8. Screening of student's work (specify the proportion of ECTS credits for each activity so that the total number of CTS	Class attendance		Seminar essay	
	Experimental work		Oral exam	
	Essay		Project	

credits is equal to the credit value of the course)	Tests		Practical training	**1**
	Written exam		(Other--describe)	
	Research		(Other--describe)	
	Report	1	(Other--describe)	
2.9. Grading and evaluation of student work over the course of instruction and at a final exam	During the course of professional practice, the student is required to keep a journal on the basis of which, after the internship, prepares report on the conducted professional practice which is then approved by the mentor-Master in Medical Biochemistry, and checks the manager of professional practice. On the basis of completed practical part of the course and successful completion reports, the student is recognised course and is awarded ECTS credits (status passed).			

2.10. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	Štrausova medicinska biokemija, Medicinska naklada, 2009.		

2.11. Optional literature	Additional professional literature is available for students in the teaching bases.
2.12. Methods of monitoring quality that ensure acquisition of exit competences	Outcomes 1-4 earned during field work under the guidance of a mentor-Master of Medical Biochemistry describes the written report as a report on the conducted professional practice 1, and checked her head professional practice.
2.13. Comments	

PROFESSIONAL PRACTICE 2

1. COURSE DECRIPTION – GENERAL INFORMATION				
1.1. Course teacher	Ass. prof. Marija Grdić Rajković, PhD			
1.2. Associate teachers				
1.3. Graduate programme	Medical Biochemistry study programme			
1.4. Status of the course	Compulsory			
1.5. Year of study, Semester	4th			
1.6. Credit value (ECTS)	3			
1.7. Type of instruction (number of hours L+E+S+e-learning)	0+60+0			
1.8. Expected enrolment in the course	25			
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	-			
2. COURSE DESCRIPTION				
2.1. Course objectives	Introduce students to the management of work and the organization of cytology, microbiology and molecular diagnostics laboratories.			
2.2. Enrolment requirements and required entry competences for the course	The requirement for admission: a recognized Professional Practice 1 and the attended cytology with histology, Microbiology and Parasitology and Molecular Diagnostics.			
2.3. Learning outcomes at the level of the study programme to which the course contributes	Applying expert knowledge and skills in the development of laboratory tests in the field of cytology, microbiology and molecular diagnostics.			
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After were done Professional Practice 2 students will be able to: 1. Use the professional literature; 2. Describe the second mode in a cytology laboratory; 3. Describe the mode in the microbiological laboratory; 4. Describe the fourth mode in the laboratory for molecular diagnostics.			
2.5. Course content broken down in detail by weekly class schedule (syllabus)	EXERCISES: • Introduction to the organization of work and methods in the cytology laboratory. • Introduction to the organization of work and methods in microbiology laboratory. • Introduction to the organization of work and methods in the laboratory for molecular diagnostics.			
2.6. Type of instruction	lectures seminars workshops exercises online in entirety mixed *e*-learning mixed *m*-learning		**field work** independent study multimedia and the internet work with the mentor (other)	
2.7. Student responsibilities	Practical work in a cytological, microbiological and molecular diagnostics laboratory under the supervision of a mentor - Master of Medical Biochemistry and preparing reports about the expert practice			
2.8. 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	Class attendance		Seminar essay	
	Experimental work		Oral exam	
	Essay		Project	
	Tests		Practical training	**1,5**

the course)	Written exam		(Other--describe)	
	Research		(Other--describe)	
	Report	1,5	(Other--describe)	

2.9. Grading and evaluation of student work over the course of instruction and at a final exam	During the course of professional practice, the student is required to keep a journal on the basis of which, after the internship, prepares report on the conducted professional practice which is then approved by the mentor-Master in Medical Biochemistry, and checks the manager of professional practice. On the basis of completed practical part of the course and successful completion reports, than the student is recognized course and are awarded ECTS credits (status passed).		
2.10. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	Štrausova medicinska biokemija, Medicinska naklada, 2009.		
2.11. Optional literature	Additional professional literature is available for students in the teaching bases.		
2.12. Methods of monitoring quality that ensure acquisition of exit competences	Outcomes 1-4 earned during field work under the guidance of a mentor-Master of Medical Biochemistry describes the written report as a report on the conducted professional practice 2, and checked her head professional practice.		
2.13. Comments			

PROFESSIONAL TRAINING FOR PHARMACISTS

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Associate Professor Renata Jurišić Grubešić, PhD Associate Professor Željka Vanić, PhD Professor Sanda Vladimir-Knežević, PhD
1.2. Associate teachers	Associate Professor Lidija Bach-Rojecky, PhD Assistant Professor Iva Mucalo, PhD Assistant Professor Ivan Pepić, PhD Maja Ortner Hadžiabdić, PhD Andrea Brajković, MPharm Teacher practitioners working in the pharmacy (supervisors-pharmacists)
1.3. Graduate programme	Integrated study programme, Pharmacy
1.4. Status of the course	Obligatory course
1.5. Year of study, Semester	5th year, 10th semester
1.6. Credit value (ECTS)	30.0
1.7. Type of instruction (number of hours L+E+S+e-learning)	0+720+0
1.8. Expected enrolment in the course	120
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	.
2. COURSE DESCRIPTION	
2.1. Course objectives	Training for independent work within pharmaceutical profession.
2.2. Enrolment requirements and required entry competences for the course	Prerequisites: practical training in Pharmacy Practice 2 completed, passed examination in all obligatory courses, and completed all elective courses.
o Learning outcomes at the level of the study programme to which the course contributes	• Application of knowledge and skills in Pharmacotherapy counseling and pharmaceutical care providing in line with applicable laws and regulations, current health policies and guidelines, and the principles of pharmacy ethics and deontology. • Development and implementation of problem solving skills in manufacturing and monitoring of safe and appropriate drug application by applying receptive, analytical and critical skills. • Ensuring positive interaction with patients, associates, other healthcare professionals and the public through verbal and written communication. • Professional and responsible behavior with significant contribution in various situations and surroundings, such as interprofessional groups, pharmaceutical surroundings and professional organizations and boards. • Pharmaceutical care provision implying patient counseling on mechanisms and correct application of medicines, and monitoring therapy course and outcomes; identifying and preventing clinically significant drug-drug interactions; actively participating in disease prevention and health safeguarding, and public health initiatives. • Efficient application of financial, advertising and organizational principles important for individual and team-work; participating and supervising distribution of drugs; planning and implementation of pharmaceutical care. • Use of information technologies and databases for the purpose of improving knowledge and skills and self- education. • Demonstrating independence in organization, governing and management, preparing professionally relevant strategies and business plans. • Application of legal and ethical professional principles in individual and team work
2.3. Expected learning outcomes at the level of the course (4-10 learning outcomes)	On completion of the course the student should be able to: 1. Apply user pharmacy programs and procedures of keeping mandatory turnover and business records at community and hospital pharmacy.

<table>
<tr><td></td><td colspan="4">2. Dispense prescription medicines and medicines from special drug groups (psychotherapeutic substances and narcotics), as well as medicinal products.
3. Prepare, dispense, distribute and monitor turnover of medicines at hospital pharmacies (prescription medicines, galenic, magistral and extemporaneous formulations).
4. Monitor and report side effects
5. Give advice on cosmetic products and food supplements
6. Implement procedures of providing pharmaceutical care.</td></tr>
<tr><td>o Course content broken down in detail by weekly class schedule (syllabus)</td><td colspan="4">Community pharmacies:
• Introduction with administrative work, user pharmacy programs and procedures of keeping mandatory turnover and business records at community and hospital pharmacy.
• Introduction to therapeutic drug groups, their indications, side-effects and contraindications, and potential clinically significant interactions
• Application of professional/expert literature and clinical decision support tools (e.g. Stockley, Lexicomp etc.).
• Getting familiar with correct monitoring and reporting of side effects and medicinal product quality defects (Adverse Reaction Notification Form and Medicinal Product Quality Defect Notification Form).
• Describing generic medicines (pharmaceutical equivalents), alternatives and their pharmaceutical forms.
• Getting familiar with strong, very strong and intoxicating compounds, evidence of their dispensing and pursuant law regulations (storing, dispensing regimen).
• Describing and dispensing veterinary drugs.
• Describing the group of cosmetic products.
• Understanding all operating procedures related to dispensing of prescription only and non-prescription medicines (e.g. data on the prescription, drug dispensing on private prescription, e-prescription, filing records at pharmacy).
• Describing methods of pharmaceutical care delivery (communication with the patient, patient adherence, counseling on therapeutics and self-medication).
Hospital pharmacies:
• Describing the role and scope of work of a hospital pharmacist, and organization and structure of hospital pharmacy.
• Introduction to therapeutic drug groups and medical substances most commonly or exclusively applied in hospitals, their pharmaceutical forms, bandaging and laboratory materials, and storage at hospital pharmacies.
• Introduction to production of extemporaneous and galenic preparations for the purpose of hospital inpatient treatment, including aseptic preparation steps and sterilization of medical devices, and preparing infusion solutions.
• Introduction to dispensing drugs to the ward, filing records of evidence and laboratory log-book.
• Introduction to mandatory literature for hospital pharmacy.</td></tr>
<tr><td>2.4. Type of instruction</td><td colspan="2">lectures
seminars
workshops
exercises
online in entirety
mixed e-learning
mixed m-learning</td><td colspan="2"><u>field work</u>
<u>independent study</u>
multimedia and the internet
work with the mentor
(other)</td></tr>
<tr><td>2.7. Student responsibilities</td><td colspan="4">Practical work in the community pharmacy supervised by mentor-pharmacists, positively marked report and completed pre-registration exam.</td></tr>
<tr><td rowspan="3">2.8. Screening of student’s work (specify the proportion of ECTS credits for each activity so that the total number of CTS</td><td>Class attendance</td><td></td><td>Seminar essay</td><td></td></tr>
<tr><td>Experimental work</td><td></td><td>Oral exam</td><td>6</td></tr>
<tr><td>Essay</td><td></td><td>Project</td><td></td></tr>
</table>

credits is equal to the credit value of the course)	Tests		Practical training	15
	Written exam	6	(Other--describe)	
	Research		(Other--describe)	
	Report	3	(Other--describe)	

2.9. Grading and evaluation of student work over the course of instruction and at a final exam	During Professional Training for Pharmacists (PTP), the student is required to resolve the preset tasks related to pharmacy practice and record them in forms that certify mentor-pharmacist. On completion the PTP, reports collected in the student portfolio are submitted to the Centre for Applied Pharmacy, Faculty of Pharmacy and Biochemistry. On the basis of completed practical part of the PTP and the successful completion of the portfolio, the student can take the final pre-registration exam. The final exam consists of a written test (comprises pharmacy practice, health care legislation, magistral and galenic preparations, and quality control of galenic preparations) and the practical part, which includes checking of student knowledge in drug prescription, magistral preparation, counselling patients in self-care (OTC drug dispensing), advising patients in the use of inhalers/blood pressure measurement/ blood glucose measurement, as well as the student knowledge in prescribed therapy assessment of hospitalized patients, and a review of the portfolio. After passing the final pre-registration exam, the student receives a certificate of completion of the integrated study programme of pharmacy at the Faculty of Pharmacy and Biochemistry, University of Zagreb.		
2.10. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	European Directorate for the Quality of Medicines and Health Care. European Pharmacopoeia, 8th ed.; Council of Europe: Strasbourg, 2014.	1	
	European pharmacopoeia, 2008, vol. 6 (or older editions)*	3	
	Croatian pharmacopoeia, 2007, vol. 1;* new edition available online	3	online
	Drug Registry in Croatia 2015, Medical Edition, Zagreb, 2015*	5	
	I. Francetić, Pharmacotherapy Handbook, 6th Ed., Medical Edition, Zagreb 2010*	4	
2.11. Optional literature	Optional literature is available in teaching pharmacies.		
a. Methods of monitoring quality that ensure acquisition of exit competences	Learning outcomes 1-6 should be assessed during the field work under the supervision of mentor-pharmacists and described in the written report of the student upon the completed Professional Training for Pharmacists, and are examined as a part of the final exam.		
2.12. Comments	* Required literature is available in teaching community pharmacies.		

QUALITY ASSURANCE AND REGISTRATION OF DRUGS

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Associate Professor Renata Jurišić Grubešić
1.2. Associate teachers	Assistant Professor Mirza Bojić
1.3. Graduate programme	Integrated study programme
1.4. Status of the course	Elective
1.5. Year of study, Semester	4th year, 8th semester
1.1. Credit value (ECTS)	2.0
1.2. Type of instruction (number of hours L+E+S+e-learning)	15+0+5
1.3. Expected enrolment in the course	50
1.4. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2
2. COURSE DESCRIPTION	
2.1. Course objectives	To explain the processes of quality developing and improving; to introduce students in the regulations in the field of pharmaceuticals and medicinal products, drug registration procedures (Croatia, EU), and the harmonization of the corresponding documentation at the international level.
2.2. Enrolment requirements and required entry competences for the course	Enrolment requirements: Pharmaceutical Analysis course completed; Conditions for taking an examination in this subject: passed exam in Pharmaceutical Analysis.
2.3. Learning outcomes at the level of the study programme to which the course contributes	Application of professional knowledge and skills in defining, analyzing, and proposing procedures related to quality assurance in production and registration of drugs.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After passing the course the student will be able to: 1. Describe the quality system and quality management (focus on the analytical laboratory and pharmaceutical industry). 2. Identify the legislation in the field of medicines and medicinal products. 3. Describe the procedures of registration of medicines (Croatia, EU) and specify the content of the drug documentation. 4. Compare the development and registration process of generic drugs with the original ones. 5. Detect deterioration in the quality of the drug and to monitor adverse effects (pharmacovigilance). 6. Propose solving deficiencies during drug registration (Deficiency letters).
2.5. Course content broken down in detail by weekly class schedule (syllabus)	**LECTURES:** • **The quality system and quality management.** The concept of quality system; Standards and standardization; The concept of quality management (policy and quality objectives, program planning for quality assurance and quality control, auditing); Quality assurance and control in the analytical laboratory. • **Quality assurance in drug production: good manufacturing practice (GMP).** GMP guidelines, the purpose of the application of GMP, the consequences of non-compliance with GMP; Introduction and application of GMP in the pharmaceutical industry; The main areas of GMP (quality management, personnel, premises and equipment, documentation, production, quality control, contract processing and analysis, reclamation and product withdrawal, self-inspections; 20 supplements). ICH guidelines Q1-Q10. • **Regulations related to drugs and medicinal products**; **Regulatory bodies; Harmonization**. The concept and objective of drug regulations; Laws and implementing regulations in the area of drugs, medical devices and homeopathic products; Pharmacopoeia; Regulatory authorities (national, regional, international): HALMED, FDA, EMA, EDQM & HealthCare, WHO, ICH. Harmonization of regulatory requirements (Europe-Japan-USA): ICH guideline M4 - Common Technical Document (CTD).

	• **Registration of drugs.** The procedure of marketing authorization for drugs; Drug documentation: Common technical document (CTD: Modules 1-5); Summary of Product Characteristics (SmPC), Patient Information Leaflet (PIL), and drug labeling; Procedures for drug registration (Croatia; EU): National Procedure (NP), Centralised Procedure (CP), Mutual Recognition Procedure (MRP), Decentralised Procedure (DCP), nCADREAC - the New Collaboration Agreement between Drug Regulatory Authorities in Central and Eastern European Countries; Modification and withdrawing approval for marketing authorizations for medicinal products. • **Development of generic drugs.** Definition of innovative, reference, and generic drug; Strategy development: generic vs. innovative drug; Stages in the development of generic drug: idea generation, evaluation and planning of development, preformulation studies, pharmaceutical development - the development of formulation and production process: development and validation of analytical methods for drug, quality development for testing drug, testing the release profile of the active substance from the pharmaceutical formulation, stress tests, production of stability series / clinical series; the evaluation phase: testing the stability and bioequivalence; biowaiver studies; Scientific challenges and opportunities in the development of generic drug. • **Regulatory requirements for generic drugs.** Patent restrictions and "data exclusivity"; The importance of generic drugs; The operating processes before and during the development and registration of generic drug (portfolio management, project teams, management of development projects, regulatory strategies); Creating a registration dossier (CTD format, Modules 1, 2, 3, and 5); The process of registration of generic drug; Summary of Product Characteristics (SmPC) and Patient Information Leaflet (PIL); Testing intelligibility of PIL (User Testing); Labeling drug. • **Checking the quality of drugs, monitoring of deterioration in the quality of drug. Pharmacovigilance. Supervision: pharmaceutical inspection.** Checking the quality of drugs: regular, special, from traffic, extraordinary; Procedures of quality control (sampling, receiving of samples and standard substances, receiving of documentation, analytical testing, expert evaluation, findings); Monitoring the quality defect of the drug; Reports of malfunction or doubt in the quality of the drug regard to the degree of urgency (Class I, II and III), Monitoring of adverse drug reactions (pharmacovigilance) and Periodic Safety Update Report (PSUR); Supervision over testing, manufacture, quality control, pharmacovigilance, as well as advertising and informing on the drug - pharmaceutical inspection. **SEMINARS:** • **The approach to resolving *Deficiency letters* during the drug registration** (work in groups). Students learn about notification of defects during drug registration (NP, CP, MRP, DCP) and how to approach solving them. Special emphasis is on Module 3 of Common Technical Document (Quality of active pharmaceutical ingredient, API, and drug). As a basis for solving problems is used the network resources of The International Conference on Harmonisation of Technical Requirements for Registration of Pharmaceuticals for Human Use (ICH), as well as "The rules governing medicinal products in the European Union (EudraLex). Solving problems from the examples of *Deficiency letters* actively includes students.	
2.6. Type of instruction	**<u>lectures</u>** **<u>seminars</u>** **<u>workshops</u>** exercises online in entirety mixed *e*-learning mixed *m*-learning	field work independent study multimedia and the internet work with the mentor (other)
2.7. Student responsibilities	Attending the lectures and seminars.	

<table>
<tr><td rowspan="7">2.8. 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)</td><td>Class attendance</td><td>0.5</td><td>Seminar essay</td><td></td></tr>
<tr><td>Experimental work</td><td></td><td>Oral exam</td><td></td></tr>
<tr><td>Essay</td><td></td><td>Project</td><td></td></tr>
<tr><td>Tests</td><td></td><td>Practical training</td><td>0.5</td></tr>
<tr><td>Written exam</td><td>1.0</td><td>(Other--describe)</td><td></td></tr>
<tr><td>Research</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>Report</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>2.9. Grading and evaluation of student work over the course of instruction and at a final exam</td><td colspan="4">Qualitative evaluation of the proposed solutions of the individual tasks in workshops, written exam.</td></tr>
<tr><td rowspan="4">2.10. Required literature (available at the library and via other media)</td><td colspan="2">Title</td><td>Number of copies at the library</td><td>Availability via other media</td></tr>
<tr><td colspan="2">Kaštelan-Macan, M.: Chemical analysis in the quality system, Školska knjiga, Zagreb, 2003, pp. 57-104.</td><td>5</td><td></td></tr>
<tr><td colspan="2">Organisation of the Common Technical Document for the Registration of Pharmaceuticals for Human Use; M4, ICH, 2004</td><td></td><td>online</td></tr>
<tr><td colspan="2">Low on medicines (Official Gazette 76/13)</td><td></td><td>online</td></tr>
<tr><td>2.11. Optional literature</td><td colspan="4">Quality assurance of pharmaceuticals, Volume 2, 2nd updated edition, Good manufacturing practices and inspection, World Health Organization, Geneva, 2007
European Pharmacopoeia, 2008, 6th Ed.
Croatian Pharmacopoeia, 2007</td></tr>
<tr><td>2.12. Methods of monitoring quality that ensure acquisition of exit competences</td><td colspan="4">Outcomes 1-5 are checked by written examination, and the outcome 6 throughout seminars.</td></tr>
<tr><td>2.13. Comments</td><td colspan="4"></td></tr>
</table>

RADIONUCLIDES IN DIAGNOSTICS

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Professor Drazen Huic, MD, Phd
1.2. Associate teachers	Professor Mirjana Poropat, MD, PhD Darko Grosev, Phd Stanko Tezak, MD, Phd Andrea Mutvar, MD Marijan Zuvic
1.3. Graduate programme	integrated
1.4. Status of the course	elective
1.5. Year of study, Semester	5.
1.6. Credit value (ECTS)	1,5
1.7. Type of instruction (number of hours L+E+S+e-learning)	9+0+6
1.8. Expected enrolment in the course	10-20
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2.
2. COURSE DESCRIPTION	
2.1. Course objectives	Learning about diagnostic and therapeutic procedures in nuclear medicine, indications for their clinical application. Learning how to work with open radiation sources. Acquiring principles of radiation protection.
2.2. Enrolment requirements and required entry competences for the course	
2.3. Learning outcomes at the level of the study programme to which the course contributes	Application of acquired knowledge in nuclear medicine diagnostic and therapeutic procedures. Interpretation of scintigrams data.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After finishing the course students should be able to: 1. Interpret scintigram scan on a computer 2. Describe the principles od radionuclide and radiopharmaceutical production 3. Explain the use of radionuclides in different organic systems (cerebrovascular, thyroid, genitourinary, gastroenterological, skeletal, hematological and cardiopulmological) 4. Anticipate factors which can cause and help avoid nuclear accidents; medical procedures after a nuclear accident
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES -Physics and instrumentation in nuclear medicine, scintigram data analysis -Radinuclides and radipharmaceutical production -Skeletal system diagnosis -Diagnosis of genitourinary system -Thyroid investigation -Investigation of cardiopulmonary system -Investigations in hematology and gastroenterology -Nuclear medicine in neurology -Lymphoscintigraphy SEMINARS -Physics and instrumentation in nucelar medicine, scintigram data analysis -Radinuclides and radipharmaceutical production -Thyroid investigation -Investigation of cardiopulmonary system

	-Investigations in hematology and gastroenterology -PET/CT			
2.6. Type of instruction	lectures seminars			
2.7. Student responsibilities				
2.8. 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	0,5	Seminar essay	
	Experimental work		Oral exam	1
	Essay		Project	
	Tests		Practical training	
	Written exam		(Other--describe)	
	Research		(Other--describe)	
	Report		(Other--describe)	
2.9. Grading and evaluation of student work over the course of instruction and at a final exam	Student acitivty during classes will be evaluated. Final grade is based on oral exam.			

2.10. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	Klinička nuklearna medicina (ur. Damir Dodig i Zvonko Kusić), Zagreb, 2012.		

2.11. Optional literature	
2.12. Methods of monitoring quality that ensure acquisition of exit competences	
2.13. Comments	

SELECTED METHODS IN INSTRUMENTAL ANALYSIS

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	PhD Jasna Jablan
1.2. Associate teachers	
1.3. Graduate programme	Medical biochemistry integrated study programme
1.4. Status of the course	Compulsory
1.5. Year of study, Semester	3rd, 6th
1.6. Credit value (ECTS)	2,5
1.7. Type of instruction (number of hours L+E+S+e-learning)	10 + 20 + 0
1.8. Expected enrolment in the course	25
1.9. 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 learn about the physical-chemical principles of quantitative instrumental analysis; they will understand the development and validation of analytical methods for real samples; know modern analytical techniques for analyse the complex patterns with regard to the content of inorganic or organic analytes.
2.2. Enrolment requirements and required entry competences for the course	• Analytical chemistry II – exam passed. • Understanding the principles and basis to perform the procedures for quantitative chemical analysis.
2.3. Learning outcomes at the level of the study programme to which the course contributes	• The application of analytical skills in developing and implementing solutions to practical problems in real samples (informing and advising the user / customer analysis on the choice of the analytical method and process separation). • The selection and application of instrumental analytical methods in the process of manufacturing and quality control of medicines, dietary supplement and biological samples.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	Student will be able to: 1. Describe physical principles some of instrumental method of analysis; 2. Apple validated analytical procedure; 3. Identify and implement purposeful process in the analysis of the real complex samples; 4. Explain the analysis of pharmaceuticals using some spectroscopic; chromatographic and thermoanalytical techniques; 5. Compare the possibility of different analytical techniques and choose the appropriate technique to address specific problems in analysis of real samples.

2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES:
	• UV-Vis spectrophotometry-theoretical principles and analytical meaning ;
	  • Atomic absorption spectroscopy (AAS) – flame technique, theoretical principles and analytical meaning;
	  • Thermoanalitical method- introduction, thermogravimetry, differential scanning calorimetry
	  • Chromatographic methods (TLC, HPLC)

<table>
<tr><td></td><td colspan="4">

- X-ray fluorescence analysis (EDXRF, TXRF), validation of analytical procedures

LABORATORY EXCERCISES:

- Spectrophotometric determination of Fe (II) 1,10-phenanthroline in aqueous solution and in a sample of syrup.
- Determination of zinc in human serum or urine by flame atomic-absorption spectroscopy.
- Determination of lorazepam in the sample, the determination of impurities in the sample and evaluation of the crystallinity of the sample by differential scanning calorimetry.
- Determination of malondialdehyde in biological samples of high performance liquid chromatography (HPLC).
- Validation of methods

</td></tr>
<tr><td>2.6. Type of instruction</td><td colspan="2">lectures
seminars
workshops
exercises
online in entirety
mixed e-learning
mixed m-learning</td><td colspan="2">field work
independent study
multimedia and the internet
work with the mentor
(other)</td></tr>
<tr><td>2.7. Student responsibilities</td><td colspan="4"></td></tr>
<tr><td rowspan="8">2.8. 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)</td><td>Class attendance</td><td>0,5</td><td>Seminar essay</td><td>1</td></tr>
<tr><td>Experimental work</td><td>0,5</td><td>Oral exam</td><td></td></tr>
<tr><td>Essay</td><td></td><td>Project</td><td></td></tr>
<tr><td>Tests</td><td></td><td>Practical training</td><td></td></tr>
<tr><td>Written exam</td><td>1</td><td>(Other--describe)</td><td></td></tr>
<tr><td>Research</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>Report</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>2.9. Grading and evaluation of student work over the course of instruction and at a final exam</td><td colspan="4"></td></tr>
<tr><td rowspan="4">2.10. Required literature (available at the library and via other media)</td><td>Title</td><td>Number of copies at the library</td><td colspan="2">Availability via other media</td></tr>
<tr><td>S. Luterotti, D. Bicanic: Odabrane teme iz bioanalitike, 4. izdanje, Zagreb 2013.</td><td></td><td colspan="2">web</td></tr>
<tr><td>D. C. Harris: Quantitative Chemical Analysis, 8. izd, W. H. Freeman and Co., New York 2010.</td><td></td><td colspan="2">Web</td></tr>
<tr><td></td><td></td><td colspan="2"></td></tr>
<tr><td>2.11. Optional literature</td><td colspan="4">R. Kellner, J.-M. Mermet, M. Otto i H. M. Widmer (ur.): Analytical Chemistry, Wiley-VCH, Weinheim 1998.
F. W. Fifield i D. Kealey: Principles and Practice of Analytical Chemistry, 5. izd.,</td></tr>
</table>

	Blackwell Science, Oxford 2000. D. A. Skoog, D. M. West i F. J. Holler: *Osnove analitičke kemije*, 6. izd. engl., 1. izd. hrv., Školska knjiga, Zagreb 1999.
2.12. Methods of monitoring quality that ensure acquisition of exit competences	Final written test after experimentals to be completed.
2.13. Comments	

SELECTED METHODS IN INSTRUMENTAL ANALYSIS

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	PhD Jasna Jablan
1.2. Associate teachers	
1.3. Graduate programme	Pharmacy integrated study programme
1.4. Status of the course	Compulsory
1.5. Year of study, Semester	3rd, 6th
1.6. Credit value (ECTS)	2,5
1.7. Type of instruction (number of hours L+E+S+e-learning)	10 + 20 + 0
1.8. Expected enrolment in the course	25
1.9. 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 learn about the physical-chemical principles of quantitative instrumental analysis; they will understand the development and validation of analytical methods for real samples; know modern analytical techniques for analyse the complex patterns with regard to the content of inorganic or organic analytes.
2.2. Enrolment requirements and required entry competences for the course	• Analytical chemistry II – exam passed. • Understanding the principles and basis to perform the procedures for quantitative chemical analysis.
2.3. Learning outcomes at the level of the study programme to which the course contributes	• The application of analytical skills in developing and implementing solutions to practical problems in real samples (informing and advising the user / customer analysis on the choice of the analytical method and process separation). • The selection and application of instrumental analytical methods in the process of manufacturing and quality control of medicines, dietary supplement and biological samples.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	Student will be able to: 1. Describe physical principles some of instrumental method of analysis; 2. Apple validated analytical procedure; 3. Identify and implement purposeful process in the analysis of the real complex samples; 4. Explain the analysis of pharmaceuticals using some spectroscopic; chromatographic and thermoanalytical techniques; 5. Compare the possibility of different analytical techniques and choose the appropriate technique to address specific problems in analysis of real samples.

2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES:
	• UV-Vis spectrophotometry-theoretical principles and analytical meaning ;
	  • Atomic absorption spectroscopy (AAS) – flame technique, theoretical principles and analytical meaning;
	  • Thermoanalitical method- introduction, thermogravimetry, differential scanning calorimetry
	  • Chromatographic methods (TLC, HPLC)

<table>
<tr><td></td><td colspan="4">

- X-ray fluorescence analysis (EDXRF, TXRF), validation of analytical procedures

LABORATORY EXCERCISES:

- Spectrophotometric determination of Fe (II) 1,10-phenanthroline in aqueous solution and in a sample of syrup.
- Determination of zinc in human serum or urine by flame atomic-absorption spectroscopy.
- Determination of lorazepam in the sample, the determination of impurities in the sample and evaluation of the crystallinity of the sample by differential scanning calorimetry.
- Determination of malondialdehyde in biological samples of high performance liquid chromatography (HPLC).
- Validation of methods

</td></tr>
<tr><td>2.6. Type of instruction</td><td colspan="2">lectures
seminars
workshops
exercises
online in entirety
mixed e-learning
mixed m-learning</td><td colspan="2">field work
independent study
multimedia and the internet
work with the mentor
(other)</td></tr>
<tr><td>2.7. Student responsibilities</td><td colspan="4"></td></tr>
<tr><td rowspan="8">2.8. 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)</td><td>Class attendance</td><td>0,5</td><td>Seminar essay</td><td>1</td></tr>
<tr><td>Experimental work</td><td>0,5</td><td>Oral exam</td><td></td></tr>
<tr><td>Essay</td><td></td><td>Project</td><td></td></tr>
<tr><td>Tests</td><td></td><td>Practical training</td><td></td></tr>
<tr><td>Written exam</td><td>1</td><td>(Other--describe)</td><td></td></tr>
<tr><td>Research</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>Report</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>2.9. Grading and evaluation of student work over the course of instruction and at a final exam</td><td colspan="4"></td></tr>
<tr><td rowspan="4">2.10. Required literature (available at the library and via other media)</td><td>Title</td><td>Number of copies at the library</td><td colspan="2">Availability via other media</td></tr>
<tr><td>S. Luterotti, D. Bicanic: Odabrane teme iz bioanalitike, 4. izdanje, Zagreb 2013.</td><td></td><td colspan="2">web</td></tr>
<tr><td>D. C. Harris: Quantitative Chemical Analysis, 8. izd, W. H. Freeman and Co., New York 2010.</td><td></td><td colspan="2">Web</td></tr>
<tr><td></td><td></td><td colspan="2"></td></tr>
<tr><td>2.11. Optional literature</td><td colspan="4">R. Kellner, J.-M. Mermet, M. Otto i H. M. Widmer (ur.): Analytical Chemistry, Wiley-VCH, Weinheim 1998.
F. W. Fifield i D. Kealey: Principles and Practice of Analytical Chemistry, 5. izd.,</td></tr>
</table>

	Blackwell Science, Oxford 2000. D. A. Skoog, D. M. West i F. J. Holler: *Osnove analitičke kemije*, 6. izd. engl., 1. izd. hrv., Školska knjiga, Zagreb 1999.
2.12. Methods of monitoring quality that ensure acquisition of exit competences	Final written test after experimentals to be completed.
2.13. Comments	

SOCIOLOGY AND HEALTHCARE

1. COURSE DESCRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Prof. Živka Juričić, Ph.D.
1.2. Associate teachers	-
1.3. Graduate programme	Integrated study of pharmacy and medical biochemistry
1.4. Course status	Mandatory
1.5. Year of study, Semester	1. year, 2. semester
1.6. Credit value (ECTS)	2,5
1.7. Type of instruction (number of hours L+E+S+e-learning)	15+0+15+0
1.8. Expected enrolment in the course	125
1.9. Level of use of e-learning (1., 2., 3. level), percentage of instruction in the course online	2. level of e-learning; 10% of online course
2. COURSE DESCRIPTION	
2.1. Course objectives	The course objective is to explicate the basic postulate of social sciences: condition of health and illness, respectively, transition from one to another condition, represents a complex connection of physiological conditions with culture, social institutions as well as wider political-economic context. A student should approach the issues of health and illness as changeable, complex, multiple-meaning and multidimensional social categories. A student should become aware that health and illness are not only medical categories but are also, in a crucial way, social ones. The course objective is to enable students a broader perspective starting from the insight that health is not only an individual but also an over-individual (social) value and that medical treatment, respectively an overall care for a sick person represent par excellence a social task as well.
2.2. Enrolment requirements and required entry competencies needed for the course	None
2.3. Learning outcomes at the level of the study programme to which the course contributes	To make sure that a health protection expert in the field of medical treatment should also master social competencies, aiming at protection and maintenance of health, as well as treatment of illness. Understanding of a wider social perspective can result in an integral approach to a patient.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After having attended and passed the course, a student will be able to: 1. Clearly recognise the importance of social dimensions of health and illness. 2. Systematically and critically analyse the basic principles and the key constitutive elements of the dominant, official paradigm of biomedicine. 3. Describe the ways in which social sciences can be integrated in the area of biomedical sciences. 4. Evaluate in which way the prevailing spirit of the times, together with the related health-protection reforming interventions have influence on health and treatment prospects. 5. Analyse and assess a therapeutical value of various paradigms/modalities of treatment which coexist on the contemporary medical market of services and products.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	Lectures: 1. Social concept and social content of health. 2. Social concept and social context of illness. 3. Philosophical origins, basic principles and limitations of biomedical paradigm. 4. On some reasons of an increasing proliferation of the alternative and complementary medicine on the contemporary medical market. 5. Social role of a patient

	6. The necessity of (de)reconstruction of the Parsons' concept of patient's social role in postmodern society. 7. On causes and consequences of medicalisation of life and society: analytical-critical discourse. Seminars: 1. Biofantasies in modern pharmacy and society. 2. Integration of the complementary medicine in the treatment process. What does a sick person want? 3. Illness and medicines as metaphors: the analysis of the works of Susan Sontag. 4. Patient's lay understanding of the concepts of health and quality of life. 5. *Disease, illness and sickness*: an attempt of clarification of some elusive concepts. 6. Placebo effect: how words and rituals can have an impact on a sick person. 7. Pharmaceuticalisation permeating every aspect of everyday human life.

2.6. Type of instruction	***lectures*** ***seminars*** workshops exercises online in entirety ***mixed e-learning*** mixed *m*-learning	field work independent study multimedia and the internet work with the mentor (other)

2.7. Student responsibilities	Regular attendance to all types of instruction; active participation at the lectures; writing and presentation of seminar papers based on the recent scientific literature published in the world.			
2.8. Screening of students' 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	0,5	Seminar essay	
	Experimental work		Seminar work	1,0
	Essay		Oral exam	1,0
	Tests		Project	
	Written exam		**(other - describe)**	
	Research		(other - describe)	
	Report		(other - describe)	
2.9. Grading and evaluation of student work over the course and at a final exam	Grading of student's activity and preparedness during lectures and seminars. The final exam is oral.			

2.10. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	Teacher's lectures published in the e-learning system Merlin (PowerPoint presentation)		Online
	Teaher's script ''Sociology and Healthcare'' published in the e-learning system Merlin	2	Online
	Bond J., Bond S. Sociology and Health Care. An Introduction for Nurses and other Health Care Professionnals. Second Edition. Churchill Livingstone: An imprint of Elsevier Science Limited, 2003.	2	

2.11. Optional literature (at the moment of submitting the proposal of the study programme)	1. Taylor S., Field D. (eds): Sociology of Health and Health Care. Third Edition. Blackwell Publishing, 2003. 2. Williams S.J., Gabe J., Calnan M. (eds): Health, Medicine and Society. Key Theories, Future Agendas.Routledge: London and New York, 2000. 3. Green J., Thorogood N. Analysing Health Policy. A Sociological Approach. Longman:London and New York, 1998. 4. Stainton R. W.. Explaining Health and Illness. An Exploring of Diversity.

	Harvester/Wheatsheaf, 1991.
4.12. Methods of monitoring quality that ensure acquisition of exit competencies	Exit competencies 1-5 are checked on the basis of writing the seminar paper and its oral presentation and the final oral exam.
4.13. Comments	

SOCIOLOGY IN PHARMACY

1. COURSE DESCRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Prof. Živka Juričić Ph.D.
1.2. Associate teachers	-
1.3. Graduate programme	Integrated study of pharmacy
1.4. Status of the course	Optional
1.5. Year of study, semester	5. year, 9. semester
1.6. Credit value (ECTS)	1,5
1.7. Type of instruction (number of hours L+E+S+e-learning)	15+0+0+ e-learning
1.8. Expected enrolment in the course	50
1.9. Level of the use of e-learning (1., 2., 3. level), percentage of instruction in the course *online* (max. 20%)	2. level; 15%
2. COURSE DESCRIPTION	
2.1. Course objectives	The course objective is to explicate to students a broader social-polictical context which in an essential way determines not only the content and method but also a basic purpose of a pharmacist's professional work. Students will learn all the important social and behavioural aspects of their professional activities. Such kind of knowledge will enable students to be prepared to take over a new, widened role that society ultimately puts upon them recently: taking care of the wellbeing of every patient in terms of healthcare, as well as the care for health of the community.
2.2. Enrolment requirements and required entry competencies for the course	None
2.3. Learning outcomes at the level of the study programme to which the course contributes	Student has to understand that pharmacy is not only dealing with a chemical composition of a drug but also with a patient and society as well. Namely, the state of all important social facts (technological discoveries, ruling political-economic paradigm) determine legal and institutional frame of a pharmacist's professional acting.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After having attended the course, students will be able to: 1. Understand that the professional status of a pharmacist doesn't depend exclusively on a big corpus of knowledge about intricate ways in which drugs work but also on a ruling constellation of power of various agents or ''players'' which can nowadays be met in the field of medical treatment: patients, government regulatory bodies, doctors and pharmaceutical industry. 2. When deciding on the therapy – take into consideration patient's personal, lay perspective about illness as well as her/his perception of a drug and expectations from the therapy. 3. Besides the medical diagnosis – make also a social, behavioural and political diagnosis, i.e. understand also non-medical factors which in an essential way have impact on the occurrence of disease but on the progression and final outcome of the treatment as well. 4. Get to know some of the most important neuralgic points in all phases of the social life of the drugs: from their discovery, testing, production, control, distribution, giving out, use, to the phase of their post-marketing follow up. 5. Interiorise the attitude that the act of giving out medicines represents the ultimate transformation point of an inert chemical substance to a medicine with an additional social and symbolic value. 6. Raise also the consciousness of a wider social responsibility for a positive outcome of medical treatment.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	Lectures: 1. On the professional status of a pharmacist in modern society: Or: On the

<table>
<tr><td></td><td colspan="4">process of re(de)professionalisation of a pharmacist.
2. Are pharmacists primarily health-protection professionals or just mere sellers of drugs? An attempt of social-reflexive approach to pharmacists' ethics.
3. Deconstruction of the greek notion pharmakon: the basis for critical thinking of ''social lives of medicines'' in contemporary society.
4. Pharmaceutical industry: On some ethical and commercial aspects of the research, development and production of drugs.
5. Are new drugs (new molecular entities) crucial to the ever-increasing longevity? Biotechnological versus social paradigm.
6. On numerous negative consequences that discovery of ''elixir of youth'' would inevitably have for society in total (one invented but credible and instructive story).
7. Meaning and a specific therapeutical effect of empathy in pharmacist's professional acting.
Značenje i specifičan terapeutski učinak empatije u ljekarnikovom profesionalnom djelovanju</td></tr>
<tr><td>2.6. Type of instruction</td><td colspan="2"><u>lectures</u>
seminars
workshops
excersises
online in entirety
<u>mixed e-learning</u>
mixed m-learning</td><td colspan="2">field work
independent study
multimedia and the internet
work with the mentor
(other)</td></tr>
<tr><td>2.7. Student responsibilities</td><td colspan="4">Regular attendance to the lectures and active participation in discussion lead by the teacher by applying so-called maieutic type of dialogue.</td></tr>
<tr><td rowspan="7">2.8. 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)</td><td>Class attendance</td><td>0,5</td><td>Seminar essay</td><td></td></tr>
<tr><td>Experimental work</td><td></td><td>Seminar work</td><td></td></tr>
<tr><td>Essay</td><td></td><td>Oral exam</td><td>1,0</td></tr>
<tr><td>Tests</td><td></td><td>Project</td><td></td></tr>
<tr><td>Written exam</td><td></td><td>(other - describe)</td><td></td></tr>
<tr><td>Research</td><td></td><td>(other - describe)</td><td></td></tr>
<tr><td>Report</td><td></td><td>(other - describe)</td><td></td></tr>
<tr><td>2.9. Grading and evaluation of student work over the course of instruction and at a final exam</td><td colspan="4">Student's activity is evaluated during the lectures. The final exam is oral.</td></tr>
<tr><td rowspan="4">2.10. Required literature (available at the library and via other media)</td><td>Title</td><td colspan="2">Number of copies at the library</td><td>Availability via other media</td></tr>
<tr><td>Teacher's lectures published in the e-learning system Merlin (PowerPoint presentation)</td><td colspan="2"></td><td>Online availability</td></tr>
<tr><td>Teacher's script ''Sociology in Pharmacy'' published in the e-learning system Merlin</td><td colspan="2">2</td><td>Online availability</td></tr>
<tr><td>Taylor, Kevin and Harding, Geoffrey (eds): Pharmacy Practice.Taylor and Francis: London and New York. 2001.</td><td colspan="2">2</td><td></td></tr>
<tr><td>2.11. Optional literature (at the moment of submitting the proposal of the study programme)</td><td colspan="4">Dent, Mike and Whitehead, Stephen (eds): Managing Professional Identities. Knowledge, Performativity and the „New" Professional. Routledge Studies in Bussiness Organizations and Networks, 2002.</td></tr>
<tr><td>2.12. Methods of monitoring quality that ensure acquisition of exit competencies</td><td colspan="4">Exit competencies 1-6 are checked in the oral exam.</td></tr>
<tr><td>2.13. Comments</td><td colspan="4"></td></tr>
</table>

SPECIAL AREAS OF CLINICAL BIOCHEMISTRY

1. COURSE DECRIPTION – GENERAL INFORMATION		
1.1. Course teacher	assoc prof Dunja Rogić, PhD, assoc prof Ksenija Fumić, PhD	
1.2. Associate teachers	assoc prof Nada Vrkić	
1.3. Graduate programme	integrated study of medical biochemistry	
1.4. Status of the course	mandatory	
1.5. Year of study, Semester	4th year, 8th semester	
1.6. Credit value (ECTS)	5	
1.7. Type of instruction (number of hours L+E+S+e-learning)	15+30+15	
1.8. Expected enrolment in the course	25	
1.9. 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	Provide students with information on special areas, samples, procedures and pathological conditions that are included in the scope of of work of the medical biochemist and that students will address in their future practice	
2.2. Enrolment requirements and required entry competences for the course	Enrolment requirement: audited course: Clinical biochemistry of organs and organ systems 2	
2.3. Learning outcomes at the level of the study programme to which the course contributes	- Definition, analysis and proposition of procedures related to research, production, quality monitoring and implementation of new laboratory diagnostic procedures for disease detection and therapy monitoring - Assessment of clinical significance of biochemical indicators, detection of sources of errors and variability of results of laboratory analyses, interpretation of results of laboratory tests - Development and implementation of solutions for practical issues in laboratory diagnostics.	
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After passing the course exam, students will be able to: 1) state the biochemical and molecular bases of inherited metabolic diseases and psychosomatic disorders 2) propose laboratory procedures and samples for screening and confirmation of the diagnosis of metabolic diseases 3) describe the method of therapeutic drug monitoring in the body 4) state and describe the most significant laboratory tests in neonatology 5) explain the role of pharmacogenetics in treatment of neuropsychiatric patients 6) predict oral anticoagulant dose based on determined laboratory parameters 7) describe the principles of pharmacogenetic testing 8) explain the principle of GC-MS and tandem mass spectrometry and their application in clinical laboratory	
2.5. Course content broken down in detail by weekly class schedule (syllabus)	Lectures and seminars: Hereditary metabolic diseases; Laboratory and neonatology; Psychosomatic disorders - molecular-biochemical indicators; Therapeutic drug monitoring (TDM) and toxicology; The role of liquid chromatography - tandem mass spectrometry in laboratory medicine; The role of pharmacogenetics in treating neuropsychiatric patients; The role of pharmacogenetics in oral anticoagulant therapy. Exercises: Prediction of anticoagulant therapy dose; Pharmacogenetics; Analytical toxicology; GC-MS and tandem mass spectrometry	
2.6. Type of instruction	lectures seminars workshops exercises online in entirety mixed *e*-learning mixed *m*-learning	field work independent study multimedia and the internet laboratory work with the mentor (other)

2.7. Student responsibilities	Attendance to lectures and active participation in seminars, completed exercises. Oral and written exam.			
2.8. 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	0.5	Seminar essay	0.5
	Experimental work	1	Oral exam	1
	Essay		Project	
	Tests	0.5	Practical training	
	Written exam	1.5	(Other--describe)	
	Research		(Other--describe)	
	Report		(Other--describe)	
2.9. Grading and evaluation of student work over the course of instruction and at a final exam	Students have a test after they complete exercises. When the classes are completed, student's knowledge is tested in oral and written exam.			

2.10. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	Čvorišćec D, Čepelak I, ur. Štrausova medicinska biokemija. Zagreb: Medicinska naklada, 2009.		
	Topić E, Primorac D, Janković S. Medicinsko-biokemijska dijagnostika u kliničkoj praksi. Zagreb: Medicinska naklada, 2004.		

2.11. Optional literature	Čepelak I i sur. Medicinsko-biokemijske smjernice. Zagreb: Medicinska naklada, 2004.
2.12. Methods of monitoring quality that ensure acquisition of exit competences	Outcomes 1-5 are attained by attendance of lectures and seminars, and are tested in oral and written exam. Outcome 6-8 are realized through exercises followed by a test.
2.13. Comments	

TOXICOLOGY

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Full Professor Irena Žuntar, specialist of toxicology
1.2. Associate teachers	Associates on exercises from Teaching Institute of Public Health "Dr. Andrija Štampar" (dr. sc. A. Krivohlavek, Professor. J. Bošnir/ dr. sc. D. Lasić) and Croatian National Institute of Public Health (mr. sc. I. Vidić Štrac)
1.3. Graduate programme	Integrated study of Pharmacy and Medical Biochemistry
1.4. Status of the course	obligatory
1.5. Year of study, Semester	4th year/8th semester
1.6. Credit value (ECTS)	5
1.7. Type of instruction (number of hours L+E+S+e-learning)	30+6+24
1.8. Expected enrolment in the course	150
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2.
2. COURSE DESCRIPTION	
2.1. Course objectives	Students will be introduced into basic toxicological topics, terms and basic principles of interactions of poisons (toxins and toxicants) and human organism (absorption, distribution, metabolism and elimination of poisons from organism), as well as effects of chemicals on ecosystem. Students will understand biochemical mechanisms of poison toxicity, know different types of adverse effects, describe toxokinetic properties of basic chemical groups and understand basic principles of first aid and therapeutic approach. Students will know to link terms hazard, risk assessment and safety of chemicals/poisoning in field of human health and environment. Also, students will be introduced with classification and labelling of chemicals (MSDS, material safety data sheet) and safety handling according to legislation of Republic of Croatia and EU.
2.2. Enrolment requirements and required entry competences for the course	Enrolment pre requirements: audited course Pharmacology Pre-knowledge of Physiology, Pathophysiology, Pharmacology and Biochemistry of Drugs
2.3. Learning outcomes at the level of the study programme to which the course contributes	• Develop solutions of practical problems in production and monitoring of safe and appropriate application of drugs (recognize basic principles of safe work, handling and management with chemicals). • Inform and advise patients and general population about the effects and appropriate application of drugs, possible side-effects of chemicals, dietary supplements and herbal preparations, as well as their combinations.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	Passing the exam students will be able to: 1. Describe and explain basic toxicological topics, terms; 2. Describe absorption, distribution and elimination (including metabolisms) of poisons as well as factors that influence the extant of these processes; 3. List of basic toxicological processes (absorption, distribution, metabolisms and elimination) and biochemical mechanisms of toxicity of basic group of poisons (chemicals); 4. Estimate procedures of first aid and therapy (antidotes) depending on toxicological characteristics of poisons (chemicals); 5. Link hazard, risk assessment and safety of poisons (chemicals)/poisoning in context of human health and environment; 6. Recognize labels of chemical classification and procedures of safe handling.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES: • Introduction to toxicology with short history of toxicology (examples of poisoning) • Basic toxicology terms – 1st part

	• Basic toxicology terms – 2nd part • Transport across membranes. Lipophilicity/Hydrophilicity • Absorption of poisons • Distribution of poisons • Elimination of poisons • Inorganic poisons • Gases • Industrial organic chemicals • Pesticides (Biocides) • Biochemical mechanisms of toxicity of therapeutic drugs • Therapeutic drug monitoring (TDM) • The basis of nanotoxicology • The basis of dermatotoxicology • The basis of military toxicology (chemical warfare agents) • Drugs of abuse • Ecotoxicology SEMINARS: • Classification of chemicals and the handling of chemicals in health institutions (in pharmacies) • Sampling and samples for toxicological analysis (Extraction of poisons from various toxicological samples, Detection of toxicity, Screening test and confirmative techniques for final detection of poisons) • Documentary “Fashion victims” educational film • Plants poisons • Mushroom poisons • Mycotoxins • Bacterial toxins • Excipient toxicity and safety in drug dosage forms • Handling of chemicals in health institutions (in pharmacies) • Poisons of animals • Documentary “The toxin return”” educational film • Seminar student's essays with discussion and repetition of materials EXERCISES & DEMONSTRATION EXERCISES At Teaching Institute of Public Health ”Dr. Andrija Štampar” and Croatian National Institute of Public Health: Demonstration of sample preparation for toxicological analysis with emphasis on the results of the analysis and comment/evaluation of the safety of different samples (e.g. food, beverages, objects for general use and food supplements) 4 hours of demonstration and 2 hours of exercises in the laboratory (student work). 4 exercises included are: 1. Test of acute toxicity on an organism *Daphnia magna* 2. Determination of the volume fraction of sedimentable substance in waste water samples and Determination of dried and annealed of residue (Determination of organic and inorganic substances, for example - antibiotics in water). 3. Preparation of samples for determining the transition of certain elements of materials and articles intended to come into contact with food. Analysis of the results of the AAS. 4. Preparation of samples for determining the transition of certain elements of materials and articles intended to come into contact with food. Analysis of the results of the ICP-MS.	
2.6. Type of instruction	**lectures** seminars workshops **exercises** online in entirety mixed *e*-learning mixed *m*-learning	field work independent study multimedia and the internet work with the mentor (other) **demonstration exercises**

2.7. Student responsibilities	Class attendance, positive mark of seminar essay, passed exams, written and oral			
2.8. 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	0.5	Seminar essay	1.5
	Experimental work		Oral exam	2
	Essay		Project	
	Tests		Practical training	
	Written exam	1	(Other--describe)	
	Research		(Other--describe)	
	Report		(Other--describe)	
2.9. Grading and evaluation of student work over the course of instruction and at a final exam				

2.10. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	Plavšić F, Žuntar I. Analitička toksikologija, Školska knjiga, Zagreb, 2006.		
	Plavšić F. et al. Osnove kliničke farmakokinetike, Školska knjiga, Zagreb, 1993.		
	Žuntar I., Plavšić F., Wolf Čoporda A., Štraus B. Određivanje koncentracije lijekova tijekom terapije, str. 605-621., U: Štrausova medicinska biokemija; ur. Čvorišćec D., Čepelak I., Medicinska naklada, Zagreb, 2009.		
	Duraković Z. et al., Klinička toksikologija, Grafos, Zagreb, 2011.		
	Osnove forenzične toksikologije, ed. Davorka Sutlović, Web knjižara Redak, Split, 2011. Sveučilišni udžbenik Sveučilišta u Splitu. • Sutlović D., Žuntar I. Apsorpcija, raspodjela, metabolizam i izlučivanje: ARMI. p. 19-58. • Žuntar I., Plavšić F. Otrovi biljaka i životinja. p. 171-210.		
	Timbrell J.A. Principles of Biochemical Toxicology, Fourth Edition, Informa Healthcare, New York, 2009.		
	Dart R.C. et al., Medical Toxicology, Third Edition, Lippincott, Williams & Wilkins, Philadelphia, 2004.		
	Turk R. Novi hrvatski propisi o kemikalijama – znakove opasnosti zamjenjuju piktogrami. Sigurnost 2013; 55:27-36.		http://hrcak.srce.hr/index.php?show=toc&id_broj=8076
	Žuntar I., Sliško vić I., Plavšić F. Analiza gospodarenja kemikalijama u ljekarnama u Hrvatskoj. Farm Glas 2007; 63:723-750.		http://www.plivamed.net/knjiznica/farmaceutski-glasnik/izdanje/128/Farmaceutski-glasnik-122007.html
2.11. Optional literature	Useful the Internet addressses about chemicals: - http://ec.europa.eu/environment/chemicals/index_en.htm		

	- http://echa.europa.eu/hr/ - http://www.unep.org/ - http://www.epa.gov/ - http://www.atsdr.cdc.gov/ - http://ec.europa.eu/growth/sectors/cosmetics_en - https://echa.europa.eu/regulations/biocidal-products-regulation - http://www.hzt.hr/		
	Žuntar I., Wolf Čoporda A., Plavšić F. Farmakokinetički kemijski procesi. p. 18-24. In: Farmakoterapija u gerijatriji, Geriatric pharmacotherapy, ed. Zijad Duraković, C. T. – Poslovne informacije d.o.o., Medixova medicinska biblioteka, Zagreb, 2011. Sveučilišni udžbenik: Sveučilišta u Zagrebu, Sveučilišta u Osijeku, Sveučilišta u Mostaru, Sveučilišta u Splitu i Sveučilišta u Rijeci.		
2.12. Methods of monitoring quality that ensure acquisition of exit competences	Outcomes are verified by written and oral exams.		
2.13. Comments			

ANALYTICAL BIOCHEMISTRY

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Prof Jerka Dumić, PhD Associate Prof Olga Gornik, PhD
1.2. Associate teachers	Prof Gordan Lauc, PhD Associate Prof Sanja Dabelić, PhD Associate Prof Gordana Maravić Vlahoviček, PhD Assistant Prof Sandra Šupraha Goreta, PhD Toma Keser, PhD
1.3. Graduate programme	Integrated study of Medical Biochemistry and Laboratory Medicine
1.4. Status of the course	Compulsory
1.5. Year of study, Semester	3rd year, 6th semester
1.6. Credit value (ECTS)	5
1.7. Type of instruction (number of hours L+E+S+e-learning)	30 L + 30 E
1.8. Expected enrolment in the course	25
1.9. Level of use of *e*-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2nd (possibility of e-learning according to the student's personal affinity to use teaching materials and problem based examples for knowledge improvement)
2. COURSE DESCRIPTION	
2.1. Course objectives	Students will learn about the theoretical background, advantages and disadvantages of analytical methods and procedures and their application i biomedicine.
2.2. Enrolment requirements and required entry competences for the course	Passed exams of the courses Analytical Chemistry II and Biochemistry.
2.3. Learning outcomes at the level of the study programme to which the course contributes	• Development and implementation of the solutions of practical problems of laboratory diagnostics using the observational, analytical and critical skills. • Optimization, validation and accomplishment of laboratory analyses in different areas of health care. • Evaluation of novel and improvement of existing analytical methods • Conducting procedures of calibration and traceability. • Evaluation methods and equipment as well as all forms of quality control systems applying the principles of good laboratory practice, and relevant European and ISO directives.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After successfully completing the course, students will be able to: 1. Explain the performance principle of the specific analytical method; 2. Define the possibilities and limitations of the specific analytical method; 3. Select a suitable analytical method for the analysis of the particular biological sample with respect to the information that is necessary to collect on it; 4. Design of the analytical procedure using biochemical method (sample preparation, selection of standard sample, the demand for purity of the reagents, etc.); 5. Conduct an analysis of the biological sample using modern biochemical method; 6. Interpret the results of the analysis of biological sample.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	**LECTURES AND SEMINARS:** • Sources and preparation of biological material. Cell and tissue cultures. Sedimentation methods • Electrophoretic methods (electrophoresis, capillary electrophoresis, 2D electrophoresis, isoelectric focusing, isotachophoresis). • Immunoassays (Immunochemical methods). • Methods of analysis of particles (flow cytometry). • Spectroscopic methods (spectrophotometry, luminescent methods (fluorescence, chemiluminescence, timeresolved fluorescence, fluorescence polarization), atomic absorption spectroscopy, flame emission spectroscopy, infrared spectroscopy. • Chromatographic methods and advanced separation techniques. • Mass spectrometry.

	• Principles and application of radioisotope methods. Advanced enzymatic techniques. Microcalorimetry. • Crystallographic method. Surface plasmon resonance (SPR Nuclear magnetic resonance (NMR) spectroscopy (NMR). Electron Paramagnetic Resonance (EPR) spectroscopy, circular dichroism. • Determination of the primary structure of macromolecules. • Modern method of nucleic acids analyses. • Microchip technologies. Nanotechnologies. Biosensors. Molecular modelling. Bioinformatic analysis. • Rational approach to planning and design of experiments. Analysis of the application of certain methods in the primary scientific literature. Analysis and presentation of results. **EXERCISES:** • Cell cultures. Determination of the protein concentration. SDS-polyacrylamide gel electrophoresis. Western blot I. • Western blot II. Flow cytometry. • High performance liquid chromatography (HPLC) and mass spectrometry (MS). • Analysis of gene expression I (RNA isolation, determination concentration and purity of RNA, reverse transcription). • Analysis of gene expression II (quantitative real-time polymerase chain reaction, qRT-PCR). • Single-stranded DNA conformational polymorphism (SSCP) analysis (DNA isolation, polymerase chain reaction - PCR, polyacrylamide gel electrophoresis and detection).
2.6. Type of instruction	**lectures** **seminars** **workshops** **exercises** online in entirety **Pismeni ispit, usmeni ispit** mixed *m*-learning field work **independent study** **multimedia and the internet** work with the mentor (other)
2.7. Student responsibilities	The students are required to attend classes that take place in the form of lectures and practical classes (exercises). The students are required to attend practical classes prepared for teaching in a way that have studied description and protocol of the exercises described in the script Biochemical Laboratory II. - Analytical and preparative biochemistry. The students, for the achievement of credits and grades in specified courses, are required to take the written and oral exam and pass them both successfully.

2.8. 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	1	Seminar essay	
	Experimental work	1	Oral exam	2.5
	Essay		Project	
	Tests		Practical training	
	Written exam	0.5	(Other--describe)	
	Research		(Other--describe)	
	Report		(Other--describe)	

2.9. Grading and evaluation of student work over the course of instruction and at a final exam	The students are evaluated according to the performance in the written (30%) and oral (70%) exam, which can be accessed only after the completion of lectures and neatly made practical teaching. On the final exam students are required to demonstrate knowledge of all areas covered by the program of the course, at the level of skilled information management and synthesis of materials.

2.10. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	J. Dumić i sur. Analitička biokemija Powerpoint presentations (within the e-learning)		YES
	V. A. Gault i N. H. McClenaghan Understanding		NO

	Bioanalytical Chemistry: Principles and Applications (2009) Wiley-Blackwell 1st ed. ISBN: 978-0-470-02906-0		
	J. Dumić i sur. Biokemijski praktikum II. - Analitička i preparativna biokemija. Scripta biocemica (2008) Farmaceutsko-biokemijski fakultet, Zagreb, ISBN 953-6256-46-0		YES
2.11. Optional literature			
2.12. Methods of monitoring quality that ensure acquisition of exit competences	Outcomes 1-7 are checked by written and oral exam.		
2.13. Comments			

ANALYTICAL CHEMISTRY 1

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Assistant Professor Suzana Inić, PhD
1.2. Associate teachers	Jasna Jablan, PhD Davor Šakić, PhD
1.3. Graduate programme	Pharmacy integrated study programme
1.4. Status of the course	Compulsory
1.5. Year of study, Semester	1st, 2nd
1.6. Credit value (ECTS)	7,5
1.7. Type of instruction (number of hours L+E+S+e-learning)	30+30+15
1.8. Expected enrolment in the course	130
1.9. 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 acquire the knowledge on application of basic chemical terms and phenomena in analytical chemistry, will learn basic principles of chemical–analytical process, will be able to analyze salts and organic analytes by the use of classical analytical separation and detection methods, will understand the conditions of performing chemical-analytical procedures under real conditions, will be able to define the conditions and how to apply classical and modern instrumental procedures of analytical separations. The knowledge and skills acquired throughout the course of Analytical chemistry 1 make the basis for the courses that follow, namely Analytical chemistry 2, Pharmacognosy 1, Analytics of drugs. etc.
2.2. Enrolment requirements and required entry competences for the course	Knowledge in General and inorganic chemistry satisfied. Competences needed: knowledge of basic chemical phenomena, terms and principles, and chemical calculations.
2.3. Learning outcomes at the level of the study programme to which the course contributes	1. Application of basic knowledge in analytical chemistry in defining, analyzing and suggesting the procedures to be used in analysis of drugs and quality control of drugs 2. Application of analytical skills in development and implementation of real problem-solving during drugs production (informing and advising the analysis user about the choice of analytical/separation procedures) 3. Choice and application of analytical methods in the process of drugs production (application of analytical separations and classical chemical analysis of inorganic and organic samples/analyte)
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After the student has passed the exam he/she will be able to: 1. Apply the general chemical knowledge, terms and phenomena acquired during the prevous studies into analytical-chemical practice. 2. Apply basic chemical-analytical principles in qualitative and quantitative chemical analysis of diverse samples. 3. Apply acquired knowledge in analysis of inorganic salts, alone or in mixtures, inorganic-organic salts and organic analytes, by the classical chemical analysis procedures, with no separation or after separation. 4. Explain the principles of analytical separations, to compare them and make the proper choice. 5. Analyze chemical samples after separation based on distribution between two solvents, or ion-exchange, on a micro- or macroscale, or by chromatography on thin layer, or by ion-exchange chromatography in the column. 6. Define the conditions of separation of ionic species by classical precipitations, based on calculations 7. Define the conditions and feasibility of chemical-analytical procedures under real,

	complex conditions, based on calculations (complex chemical equilibria) 8. Explain the choice of separation procedure and its analytical applicability 9. Explain and elaborate the principles of modern chromatographic separations
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES: • Introduction and general terms in chemical analysis, analytical process, sample/sampling, analytical signal, information • Protolytic equilibria in chemical analysis: dissociation of a weak electrolyte, common ion effect (example with acetylsalicylic acid), indicators, amphoterism, hydrolysis • Complexes equilibria in chemical analysis: Analytically important complexes with monodentate and bidentate inorganic ligands • Analytically important complexes with organic bidentate and polydentate ligands, Analytical applicability of complex species • Redox reactions in chemical analysis • Reactions of luminescence in chemical analysis: photoluminescence and chemiluminescence • Heterogeneous equilibria in chemical analysis: heterogeneous equilibria in solid-liquid: selective precipitation and dissolution • Heterogeneous equilibria in chemical analysis: ion-exchange; heterogeneous equilibria in gas-liquid and gas-solid • Heterogeneous equilibria in chemical analysis: liquid-liquid (solvent extraction) • Complex chemical equilibria: masking and demasking • Complex chemical equilibria: dissolving of poorly soluble salts • Chromatography: introduction • Chromatography: planar chromatography (thin layer chromatography, paper chromatography) • Chromatography: column chromatography: gas chromatography, liquid chromatography (LC, HPLC, UPLC) SEMINARS: • Equilibria in analytical systems: protolytic equilibria: amphoterism, hydrolysis: mathematical deduction, calculations, examples; buffers: mathematical deduction, calculations, examples • Equilibria in analytical systems: equilibria of complexation: introduction • Performing of the analytical reactions and detection of ions; sample, matrix, analytical examples; dissolution and decomposition of solid samples, solubility: calculations, examples • Selective precipitation/dissolution: chlorides and sulphides, calculation of the conditions, examples • Selective precipitation/dissolution: hydroxides and carbonates, calculation of the conditions, examples • Performances of analytical reactions, evaluation • Analysis on the capillary support; ion-exchange in chemical analysis; classification of analytical procedures EXPERIMENTALS: • Equilibria in chemical analysis: reactions of complexation, precipitation/dissolution/evaporation, light emission, redox reactions, acid-base equilibria, masking, demasking; Solid inorganic salts as samples: salts soluble in water, salts soluble in acids, dissolution, detection of ions, neutralization, sodium carbonate-added mixture • Weak organic electrolytes and inorganic-organic salts as samples: detection of functional groups and radicals of organic acids; inorganic salts as samples: detection of ions • Selective precipitation/dissolution: separation and detection of cations in the

<table>
<tr><td></td><td colspan="4">mixture (I+IV, IIa+b, or III+V+VI anal. groups); detection of co-ions
• Selective precipitation/dissolution: separation and detection of cations in the mixture (I+IV, IIa+b, or III+V+VI anal. groups); detection of co-ions; Chromatography , TLC: separation and detection of organic and inorganic compounds
• Improving performances of analytical reactions (selectivity, sensitivity) by the use of separations: application of organic solvents (separation and detection of metal ions), application of ion exchangers (separation and detection of metal ions)</td></tr>
<tr><td>2.6. Type of instruction</td><td colspan="2">lectures
seminars
workshops
exercises
online in entirety
mixed e-learning
mixed m-learning</td><td colspan="2">field work
independent study
multimedia and the internet
work with the mentor
(other)</td></tr>
<tr><td>2.7. Student responsibilities</td><td colspan="4">Lectures, seminars, experimental work in laboratory, consultations, investigation of the literature, solving problems. Attendance of experimentals and seminars is obligatory</td></tr>
<tr><td rowspan="8">2.8. 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)</td><td>Class attendance</td><td>0,5</td><td>Seminar essay</td><td>0,5</td></tr>
<tr><td>Experimental work</td><td>1</td><td>Oral exam</td><td>2,5</td></tr>
<tr><td>Essay</td><td></td><td>Project</td><td></td></tr>
<tr><td>Tests</td><td>1</td><td>Practical training</td><td></td></tr>
<tr><td>Written exam</td><td>2</td><td>(Other--describe)</td><td></td></tr>
<tr><td>Research</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>Report</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>2.9. Grading and evaluation of student work over the course of instruction and at a final exam</td><td colspan="4">Two tests (written) during semester; final written and oral exam. Entrance test (oral) and final test (written) at the end of experimentals.</td></tr>
<tr><td rowspan="4">2.10. Required literature (available at the library and via other media)</td><td colspan="2">Title</td><td>Number of copies at the library</td><td>Availability via other media</td></tr>
<tr><td colspan="2">1. S. Luterotti: Introduction into chemical analysis, 6. ed., Faculty of Pharmacy and Biochemistry, University of Zagreb, Zagreb 2013 2.11. Required literature (available at the library and via other media)</td><td></td><td>web</td></tr>
<tr><td colspan="2">2. D. Kodrnja, D. Pavišić-Strache and S. Luterotti: Practicals in Analytical Chemistry I, 2. ed., Faculty of Pharmacy and Biochemistry, University of Zagreb, Zagreb 2006.</td><td></td><td></td></tr>
<tr><td colspan="2"></td><td></td><td></td></tr>
<tr><td>2.11. Optional literature</td><td colspan="4">1. F. W. Fifield and D. Kealey: Principles and Practice of Analytical Chemistry, 5. ed., Blackwell Science, Oxford 2000.
2. D. Kealey and P. J. Haines: Analytical Chemistry, in: Instant Notes (Ed. B. D. Hames), BIOS Scientific Publishers Ltd., Oxford 2002.
3. R. Kellner, J.-M. Mermet, M. Otto and H. M. Widmer (Eds.): Analytical Chemistry, Wiley-VCH, Weinheim 1998.
4. D. A. Skoog, D. M. West and F. J. Holler: Fundamentals in Analytical Chemistry (Croatian translation: Osnove analitičke kemije), 6. ed. Školska knjiga, Zagreb 1999.
5. M. Valcárcel: Principles of Analytical Chemistry, A textbook, Springer-Verlag, Berlin-Heidelberg 2000.</td></tr>
<tr><td>2.12. Methods of monitoring quality that</td><td colspan="4">Learning outcomes 1, 4, 6-9 are checked through the written and oral exams; learning</td></tr>
</table>

ensure acquisition of exit competences	outcomes 2, 3 and 5 also during the experimental work in the laboratory and by the final test.
2.13. Comments	

ANALYTICAL CHEMISTRY 1

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Assistant Professor Suzana Inić, PhD
1.2. Associate teachers	Jasna Jablan, PhD Davor Šakić, PhD
1.3. Graduate programme	Medical Biochemistry integrated study programme
1.4. Status of the course	Compulsory
1.5. Year of study, Semester	1st, 2nd
1.6. Credit value (ECTS)	7,5
1.7. Type of instruction (number of hours L+E+S+e-learning)	30+30+15
1.8. Expected enrolment in the course	25
1.9. 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 acquire the knowledge on application of basic chemical terms and phenomena in analytical chemistry, will learn basic principles of chemical–analytical process, will be able to analyze salts and organic analytes by the use of classical analytical separation and detection methods, will understand the conditions of performing chemical-analytical procedures under real conditions, will be able to define the conditions and how to apply classical and modern instrumental procedures of analytical separations. The knowledge and skills acquired throughout the course of Analytical chemistry 1 make the basis for the courses that follow, namely Analytical chemistry 2, Pharmacognosy 1, Analytics of drugs. etc.
2.2. Enrolment requirements and required entry competences for the course	Knowledge in General and inorganic chemistry satisfied. Competences needed: knowledge of basic chemical phenomena, terms and principles, and chemical calculations.
2.3. Learning outcomes at the level of the study programme to which the course contributes	1. Application of basic knowledge in analytical chemistry in defining, analyzing and suggesting the procedures to be used in research, manufacture and quality assurance , and implementation of novel laboratory procedures in diagnostics, the illness follow-up, and efficacy of therapy 2. Application of analytical skills in the development and implementation of problem-solving in laboratory diagnostics (informing and advising the analysis user about the choice of analytical/separation procedures)
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After the student has passed the exam he/she will be able to: 1. Apply the general chemical knowledge, terms and phenomena acquired during the prevous studies into analytical-chemical practice. 2. Apply basic chemical-analytical principles in qualitative and quantitative chemical analysis of diverse samples. 3. Apply acquired knowledge in analysis of inorganic salts, alone or in mixtures, inorganic-organic salts and organic analytes, by the classical chemical analysis procedures, with no separation or after separation. 4. Explain the principles of analytical separations, to compare them and make the proper choice. 5. Analyze chemical samples after separation based on distribution between two solvents, or ion-exchange, on a micro- or macroscale, or by chromatography on thin layer, or by ion-exchange chromatography in the column. 6. Define the conditions of separation of ionic species by classical precipitations, based on calculations. 7. Define the conditions and feasibility of chemical-analytical procedures under real, complex conditions, based on calculations (complex chemical equilibria) 8. Explain the choice of separation procedure and its analytical applicability

	9. Explain and elaborate the principles of modern chromatographic separations
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES: • Introduction and general terms in chemical analysis, analytical process, sample/sampling, analytical signal, information • Protolytic equilibria in chemical analysis: dissociation of a weak electrolyte, common ion effect (example with acetylsalicylic acid), indicators, amphoterism, hydrolysis • Complexes equilibria in chemical analysis: Analytically important complexes with monodentate and bidentate inorganic ligands • Analytically important complexes with organic bidentate and polydentate ligands, Analytical applicability of complex species • Redox reactions in chemical analysis • Reactions of luminescence in chemical analysis: photoluminescence and chemiluminescence • Heterogeneous equilibria in chemical analysis: heterogeneous equilibria in solid-liquid: selective precipitation and dissolution • Heterogeneous equilibria in chemical analysis: ion-exchange; heterogeneous equilibria in gas-liquid and gas-solid • Heterogeneous equilibria in chemical analysis: liquid-liquid (solvent extraction) • Complex chemical equilibria: masking and demasking • Complex chemical equilibria: dissolving of poorly soluble salts • Chromatography: introduction • Chromatography: planar chromatography (thin layer chromatography, paper chromatography) • Chromatography: column chromatography: gas chromatography, liquid chromatography (LC, HPLC, UPLC) SEMINARS: • Equilibria in analytical systems: protolytic equilibria: amphoterism, hydrolysis: mathematical deduction, calculations, examples; buffers: mathematical deduction, calculations, examples • Equilibria in analytical systems: equilibria of complexation: introduction • Performing of the analytical reactions and detection of ions; sample, matrix, analytical examples; dissolution and decomposition of solid samples, solubility: calculations, examples • Selective precipitation/dissolution: chlorides and sulphides, calculation of the conditions, examples • Selective precipitation/dissolution: hydroxides and carbonates, calculation of the conditions, examples • Performances of analytical reactions, evaluation • Analysis on the capillary support; ion-exchange in chemical analysis; classification of analytical procedures EXPERIMENTALS: • Equilibria in chemical analysis: reactions of complexation, precipitation/dissolution/evaporation, light emission, redox reactions, acid-base equilibria, masking, demasking; Solid inorganic salts as samples: salts soluble in water, salts soluble in acids, dissolution, detection of ions, neutralization, sodium carbonate-added mixture • Weak organic electrolytes and inorganic-organic salts as samples: detection of functional groups and radicals of organic acids; inorganic salts as samples: detection of ions • Selective precipitation/dissolution: separation and detection of cations in the mixture (I+IV, IIa+b, or III+V+VI anal. groups); detection of co-ions • Selective precipitation/dissolution: separation and detection of cations in the

	mixture (I+IV, IIa+b, or III+V+VI anal. groups); detection of co-ions; Chromatography , TLC: separation and detection of organic and inorganic compounds • Improving performances of analytical reactions (selectivity, sensitivity) by the use of separations: application of organic solvents (separation and detection of metal ions), application of ion exchangers (separation and detection of metal ions)

2.6. Type of instruction	**lectures** **seminars** workshops **exercises** online in entirety mixed *e*-learning mixed *m*-learning	field work independent study multimedia and the internet work with the mentor (other)

2.7. Student responsibilities	Lectures, seminars, experimental work in laboratory, consultations, investigation of the literature, solving problems. Attendance of experimentals and seminars is obligatory			
2.8. 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	0,5	Seminar essay	0,5
	Experimental work	1	Oral exam	2,5
	Essay		Project	
	Tests	1	Practical training	
	Written exam	2	(Other--describe)	
	Research		(Other--describe)	
	Report		(Other--describe)	
2.9. Grading and evaluation of student work over the course of instruction and at a final exam	Two tests (written) during semester; final written and oral exam. Entrance test (oral) and final test (written) at the end of experimentals.			

2.10. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	1. S. Luterotti: Introduction into chemical analysis, 6. ed., Faculty of Pharmacy and Biochemistry, University of Zagreb, Zagreb 2013 2.11. Required literature (available at the library and via other media)		web
	2. D. Kodrnja, D. Pavišić-Strache and S. Luterotti: Practicals in Analytical Chemistry I, 2. ed., Faculty of Pharmacy and Biochemistry, University of Zagreb, Zagreb 2006.		

2.11. Optional literature	1. F. W. Fifield and D. Kealey: Principles and Practice of Analytical Chemistry, 5. ed., Blackwell Science, Oxford 2000. 2. D. Kealey and P. J. Haines: Analytical Chemistry, in: Instant Notes (Ed. B. D. Hames), BIOS Scientific Publishers Ltd., Oxford 2002. 3. R. Kellner, J.-M. Mermet, M. Otto and H. M. Widmer (Eds.): Analytical Chemistry, Wiley-VCH, Weinheim 1998. 4. D. A. Skoog, D. M. West and F. J. Holler: Fundamentals in Analytical Chemistry (Croatian translation: Osnove analitičke kemije), 6. ed. Školska knjiga, Zagreb 1999. 5. M. Valcárcel: Principles of Analytical Chemistry, A textbook, Springer-Verlag, Berlin-Heidelberg 2000.
2.12. Methods of monitoring quality that ensure acquisition of exit competences	Learning outcomes 1, 4, 6-9 are checked through the written and oral exams; learning outcomes 2, 3 and 5 also during the experimental work in the laboratory and by the final test.
2.13. Comments	

ANALYTICAL CHEMISTRY 2

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Assistant Professor Suzana Inić, PhD
1.2. Associate teachers	Jasna Jablan, PhD Davor Šakić, PhD
1.3. Graduate programme	Pharmacy integrated study programme
1.4. Status of the course	Compulsory
1.5. Year of study, Semester	2nd, 3rd
1.6. Credit value (ECTS)	6
1.7. Type of instruction (number of hours L+E+S+e-learning)	30 + 30 + 0
1.8. Expected enrolment in the course	130
1.9. 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	The student will learn about theoretical principles, meaning and application of classical methods of quantitative chemical analysis. The acquired knowledge and skills make the basis for professional courses which deal with analytical methods in analysis of drugs and in clinical chemistry.
2.2. Enrolment requirements and required entry competences for the course	Attending the course of Analytical chemistry 1. Competences needed: knowledge of principles of chemical equilibria, chemical calculations, and basic statistical tests
2.3. Learning outcomes at the level of the study programme to which the course contributes	• Application of basic knowledge acquired in analytical chemistry when establishing, analyzing and proposing procedures for analysis of drugs and quality control of drugs • Application of analytical skills in development and implementation when solving real problems during drugs production • Choice and application of analytical methods in the process of drugs production and quality control
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After the student has passed the exam he/she will be able to: 1. To make a proper choice and elaborate the principle of the quantitative analysis method 2. To perform reliable sampling and preparation (pretreatment) of the sample prior to analysis 3. To perform gravimetric and volumetric analyses 4. To calculate the result of analysis and to document its reliability
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES: • Application of quantitative chemical analysis; phases of quantitative analysis • Formation of insoluble compounds; types of precipitates; influence on solubility: temperature, organic solvent, complex formation, common ion • Influence on solubility: electrolytes; ionic strength, activity coefficient, Debye-Hückel's relations, calculations • Gravimetric methods: precipitation; relative supersaturation; phases of gravimetric analysis, calculations • Gravimetric methods: colloid precipitates, co-precipitation on colloids, crystalline precipitates; errors due to co-precipitation, homogeneous precipitation; precipitating reagents • Gravimetric methods: thermal treatment of the precipitates, evaporation methods, applicability and discussion of gravimetric methods

	• Volumetric methods: basic principles; standards/standard solutions; calculations • Volumetric methods: precipitation titrations: mathematical deduction of titrimetric curve, indicators; applicability, examples • Volumetric methods: neutralimetric titrations: mathematical deduction of titrimetric curve for pairs of strong electrolytes; indicators; applicability, calculations • Volumetric methods: titration of weak electrolytes, mathematical deduction of titrimetric curve • Volumetric methods: titrations of polyfunctional acids and bases; non-aqueous titrations • Volumetric methods: complexometric titrations; selectivity; mathematical deduction of titrimetric curve; metal indicators; types of titrations with EDTA, applicability; calculations • Volumetric methods: redox titrations: electrode potential; mathematical deduction of titrimetric curve; indicators; applicability; calculations • Validation of analytical methods EXPERIMENTALS: • Gravimetric analysis • Gravimetric analysis: Analytical balance – weighing on the classical, Mettler and electronic analytical balance • Precipitation titration • Complexometric titration • Neutralimetric titration • Redox titrations: manganometric analysis, iodometric analysis
2.6. Type of instruction	**lectures** seminars workshops **exercises** online in entirety mixed *e*-learning mixed *m*-learning field work independent study multimedia and the internet work with the mentor (other)
2.7. Student responsibilities	Attendance of lectures and experimentals. Final written test after experimentals to be completed.

2.8. 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	0,5	Seminar essay	
	Experimental work	0,5	Oral exam	2
	Essay		Project	
	Tests	1	Practical training	
	Written exam	2	(Other--describe)	
	Research		(Other--describe)	
	Report		(Other--describe)	

2.9. Grading and evaluation of student work over the course of instruction and at a final exam	Two twst during the semester; final written and oral exam. Written test after laboratory work. T

2.10. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	1. D. A. Skoog, D. M. West and F. J. Holler, Fundamentals of Analytical Chemistry (translated into Croatian: Osnove analitičke kemije), 6. izd, Školska knjiga, Zagreb 1999.	27	web
	2. I. Kos, Analytical chemistry II - Experimentals, Faculty of Pharmacy and Biochemistry, University of Zagreb, Zagreb 2010.		

2.11. Optional literature	1. D. C. Harris: Quantitative Chemical Analysis, 8. izd., W. h. Freeman and CO., New York, 2010. 2. D. Kealey i P. J. Haines, Instant notes; Analytical Chemistry, Bios Sci. Publisher, Oxford, 2002. 3. D. A. Skoog, D. M. West, F. J. Holler: Foundamentals of Analytical Chemistry, Školska knjiga, Zagreb, 1999. 4. Nj. Radić i L. Modun Kukoč, Uvod u analitičku kemiju I, Sveučilište u Splitu, Split 2013.		
2.12. Methods of monitoring quality that ensure acquisition of exit competences	Outcomes 1 and 4 are checked through written and oral exam; outcomes 2-4 during experimental work and by the final test.		
2.13. Comments			

ANALYTICAL CHEMISTRY 2

1. COURSE DECRIPTION – GENERAL INFORMATION	
1.1. Course teacher	Assistant Professor Suzana Inić, PhD
1.2. Associate teachers	Jasna Jablan, PhD Davor Šakić, PhD
1.3. Graduate programme	Medical Biochemistry integrated study programme
1.4. Status of the course	Compulsory
1.5. Year of study, Semester	2nd, 3rd
1.6. Credit value (ECTS)	6
1.7. Type of instruction (number of hours L+E+S+e-learning)	30 + 30 + 0
1.8. Expected enrolment in the course	25
1.9. 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	The student will learn about theoretical principles, meaning and application of classical methods of quantitative chemical analysis The acquired knowledge and skills make the basis for professional courses which deal with analytical methods in analysis of drugs and in clinical chemistry
2.2. Enrolment requirements and required entry competences for the course	Attending the course of Analytical chemistry 1. Competences needed: knowledge of principles of chemical equilibria, chemical calculations, and basic statistical tests
2.3. Learning outcomes at the level of the study programme to which the course contributes	• Application of basic knowledge in analytical chemistry in defining, analyzing and suggesting the procedures to be used in research, manufacture and quality assurance, and implementation of novel laboratory procedures in diagnostics, the illness follow-up, and efficacy of therapy • Application of analytical skills in the development and implementation of problem-solving in laboratory diagnostics
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	After the student has passed the exam he/she will be able to: 1. To make a proper choice and elaborate the principle of the quantitative analysis method 2. To perform reliable sampling and preparation (pretreatment) of the sample prior to analysis 3. To perform gravimetric and volumetric analyses 4. To calculate the result of analysis and to document its reliability
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES: • Application of quantitative chemical analysis; phases of quantitative analysis • Formation of insoluble compounds; types of precipitates; influence on solubility: temperature, organic solvent, complex formation, common ion • Influence on solubility: electrolytes; ionic strength, activity coefficient, Debye-Hückel's relations, calculations • Gravimetric methods: precipitation, relative supersaturation, phases of gravimetric analysis, calculations • Gravimetric methods: colloid precipitates, co-precipitation on colloids , crystalline precipitate, errors due to co-precipitation, homogeneous precipitation, precipitating reagents • Gravimetric methods: thermal treatment of the precipitates, evaporation

<table>
<tr><td></td><td colspan="4">methods, applicability and discussion of gravimetric methods
• Volumetric methods: basic principles; standards/standard solutions; calculations
• Volumetric methods: precipitation titrations: mathematical deduction o titrimetric curve, indicators; applicability, examples
• Volumetric methods: neutralimetric titrations: mathematical deduction of titrimetric curve for pairs of strong electrolytes; indicators; applicability, calculations
• Volumetric methods: titration of weak electrolytes, mathematical deduction of titrimetric curve
• Volumetric methods: titrations of polyfunctional acids and bases; non-aqueous titrations
• Volumetric methods: complexometric titrations; selectivity; mathematical deduction of titrimetric curve; metal indicators; types of titrations with EDTA, applicability; calculations
• Volumetric methods: redox titrations: electrode potential; mathematical deduction of titrimetric curve; indicators; applicability; calculations
• Validation of analytical methods

EXPERIMENTALS:
• Gravimetric analysis
• Gravimetric analysis: Analytical balance – weighing on the classical, Mettler and electronic analytical balance
• Precipitation titration
• Complexometric titration
• Neutralimetric titration
• Redox titrations: manganometric analysis, iodometric analysis</td></tr>
<tr><td>2.6. Type of instruction</td><td colspan="2">lectures
seminars
workshops
exercises
online in entirety
mixed e-learning
mixed m-learning</td><td colspan="2">field work
independent study
multimedia and the internet
work with the mentor
(other)</td></tr>
<tr><td>2.7. Student responsibilities</td><td colspan="4">Attendance of lectures and experimentals. Final written test after experimentals to be completed.</td></tr>
<tr><td rowspan="7">2.8. 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)</td><td>Class attendance</td><td>0,5</td><td>Seminar essay</td><td></td></tr>
<tr><td>Experimental work</td><td>0,5</td><td>Oral exam</td><td>2</td></tr>
<tr><td>Essay</td><td></td><td>Project</td><td></td></tr>
<tr><td>Tests</td><td>1</td><td>Practical training</td><td></td></tr>
<tr><td>Written exam</td><td>2</td><td>(Other--describe)</td><td></td></tr>
<tr><td>Research</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>Report</td><td></td><td>(Other--describe)</td><td></td></tr>
<tr><td>2.9. Grading and evaluation of student work over the course of instruction and at a final exam</td><td colspan="4">Two twst during the semester; final written and oral exam. Written test after laboratory work. T</td></tr>
<tr><td>2.10. Required literature (available at the library and via other media)</td><td colspan="2">Title</td><td>Number of copies at the library</td><td>Availability via other media</td></tr>
<tr><td></td><td colspan="2">1. D. A. Skoog, D. M. West and F. J. Holler, Fundamentals of Analytical Chemistry (translated into Croatian: Osnove analitičke kemije), 6. izd, Školska knjiga, Zagreb 1999.</td><td>27</td><td>web</td></tr>
<tr><td></td><td colspan="2">2. I. Kos, Analytical chemistry II - Experimentals, Faculty of Pharmacy and Biochemistry,</td><td></td><td></td></tr>
</table>

	University of Zagreb, Zagreb 2010.		
2.11. Optional literature	1. D. C. Harris: Quantitative Chemical Analysis, 8. izd., W. h. Freeman and CO., New York, 2010. 2. D. Kealey i P. J. Haines, Instant notes; Analytical Chemistry, Bios Sci. Publisher, Oxford, 2002. 3. D. A. Skoog, D. M. West, F. J. Holler: Foundamentals of Analytical Chemistry, Školska knjiga, Zagreb, 1999. 4. Nj. Radić i L. Modun Kukoč, Uvod u analitičku kemiju I, Sveučilište u Splitu, Split, 2013.		
2.12. Methods of monitoring quality that ensure acquisition of exit competences	Outcomes 1 and 4 are checked through written and oral exam; outcomes 2-4 during experimental work and by the final test.		
2.13. Comments			