

Study program of integrated academic
studies in

PHARMACY

BOOK OF SUBJECTS

Compulsory subjects

Introduction to Pharmacy

Study programme:	pharmacy		
Course title:	Introduction to Pharmacy		
Course status:	compulsory		
ECST Value:	3		
Requirement:	none		
Course goals and objectives:	Understanding the importance and role of pharmacy in the healthcare and social system, the role of medicines in society, the place and role of the faculty of pharmacy in educating pharmacists, the importance and diversity of future occupations. Acquiring basic knowledge of pharmacy development, the complexity and multidisciplinary nature of pharmaceutical sciences and practices, and the social responsibility of pharmacists in the protection of health, prevention and treatment of diseases.		
Course outcomes:	The student is familiar with the historical and cultural bases of the development of the pharmaceutical profession and pharmaceutical sciences; Understands the professional and social role of the pharmaceutical business; The student is familiar with the perspectives and challenges of the pharmaceutical profession. Understands the role and need of continual personal and professional development, and masters the principles of scientific reflection; understands the needs from a patient's perspective and is familiar with the communication skills in pharmacy and society.		
Course content:	<p><i>Theory</i></p> <p>The development of pharmacy as a scientific discipline. The most important discoveries significant for the development of pharmacy, a review of drug development over time. Pharmacopoeia. Professional development of pharmacy - the contemporary role of pharmacists in the healthcare system and society. Pharmacists' professional associations. License to operate. Pharmacist competencies and competency frameworks - changing the education paradigm over time. Pharmaceutical activity in economy, health and regulation - pharmaceutical industry, wholesale and retail of medicines, regulatory bodies. Public and hospital pharmacy. Clinical Pharmacy. Quality in Pharmacy. Good practice guides in the pharmaceutical industry. Pharmaceutical healthcare - concept, structure, levels and frameworks. Basic concepts about the role of pharmacists in the safe and effective use of medicines, counseling, information and patient education, health protection and disease prevention and treatment. Behavioral aspects of pharmaceutical healthcare. Basic principles of communication in pharmaceutical practice - with the patient, professional and general public. Pharmacists and public health. Professional orientation in pharmacy. Career in pharmacy. Pharmacist's portfolio.</p> <p><i>Practice</i></p> <p>Case study analysis, panel discussions, homework on a given topic: historical pharmacy development; the contemporary role of pharmacists in society; the health, economic and social aspects of pharmaceutical activity; the concept of health and disease; patient's attitude to illness; development and evaluation of pharmacist competencies; professional standards in pharmaceutical practice; communication with patients, professional and general public; pharmacist portfolio development. Test.</p>		
Literature:	<ol style="list-style-type: none"> Anderson S. ed., Making Medicines - A brief History of pharmacy and pharmaceuticals, 1st ed. Pharmaceutical Press, London, 2005. Remington: The Science and Practice of Pharmacy, 21th ed., Lippincott Williams and Wilkins, London, 2006. Bissell P. at al., Sociology and Pharmacy Practice, Pharmaceutical Press, London, 2005. A. J. Winfield, R. M. E. Richards, Pharmaceutical Practice, Churchill Livingstone, Edinburg, 2004. Schmitz R., Geschichte der Pharmazie band II, Govi-Verlag Pharmazeutischer Verlag, GmbH, Eschborn, 2005. 		
Active teaching hours: 30			
Lectures: 15	Practice: 15		
Applicable teaching methods:	Interactive lectures, practice, discussions		
Grading Scheme (max. 100 points)			
Pre-exam requirements	Points	Final exam	Points

Lectures	5	written exam	50
Practical classes	15		
Colloquim	20		
Seminar	10		

General Chemistry

Study programmes: pharmacy			
Name of subject: General Chemistry			
Subjects status: compulsory			
ECTS: 7			
Requirement: none			
Subjects objective: Students acquire basic knowledge of general chemistry necessary for mastering in the basic and applied chemical sciences: analytical, physical and pharmaceutical chemistry, drug analysis. Basic knowledge of general chemistry include understanding chemical concepts, theories and principles, knowledge of laws, rules and principles of chemical calculations, understanding of chemical reactions and the influence of intermolecular interactions on the states of matter.			
Subjects outcome: After passing the exam, the student is able to: develop analytical thinking to solve chemical problems, perform all kinds of calculations in chemical (galenic) lab, predict and analyze the course of chemical reactions, the application of basic chemical principles and laws of the understanding of chemical processes in chemical systems, plans and organize work in a chemical lab, apply the acquired knowledge to the study of pharmacy in higher years.			
Subjects content:			
<i>Lectures</i>			
Basic chemical laws. Matter and energy. Nomenclature of inorganic compounds. Stoichiometric calculations. Periodic table of the elements. The structure of the atom. Chemical bonding. Intermolecular connection. Solutions. The quantitative composition of the solution. Chemical reactions. Colligative properties of solutions. Acids, bases and amphoteric electrolytes. Theories of acids and bases. The activity of ions. Chemical reactions velocity. Chemical equilibrium. Equilibria in solutions of acids and bases. pKa values. pH in solutions of acids and bases. Equilibria in aqueous salt solutions. Buffers. Equilibria in heterogeneous systems. Solubility product. Redox reactions.			
<i>Practical Classes</i>			
Chemical Laboratory, functions and equipment; chemical laboratory safety and basic laboratory techniques. Solutions. Preparation of solutions. Calculations and measurement of pH in aqueous electrolyte solutions. Buffers. Analysis of elements' reactivity and inorganic compounds relevant to the field of pharmacy.			
Literature:			
1. Whitten K. W., Davis R. E., Peck M. L., General Chemistry, 9th ed., Saunders College Publishing, Philadelphia, 2010.			
2. Kotz J., Treichel P., Chemistry and Chemical Reactivity, 8th ed., Saunders College Publishing, Philadelphia, 2012.			
Number of active teaching: 90			
Lectures: 45	Exercises: 45		
Methods of teaching: lectures, practical classes, discussions, solving problems.			
Grading (maximum 100 points)			
Pre-Exam commitments	Points	Final Exam	Points
Lectures	5	written exam	50
Practical classes	25		
Colloquim	10+10		

Organic Chemistry I

Study programmes: pharmacy			
Name of subject: Organic Chemisrty I			
Subjects status: compulsory			
ECTS: 6			
Requirement: none			
Subjects objective: Gaining knowledge about building links, types of hybridization and electronic effects in organic compounds, introduction to the basic classes of organic compounds (systematic naming, structure, and reactivity), exploring the types and mechanisms of ionic and radical reactions characteristic of organic compounds.			
Subjects outcome: Gaining knowledge about the structure and reactivity of organic compounds, understanding the mechanisms of organic reactions, making elementary logical framework for the interlinked structure and function of organic molecules.			
Subjects content:			
<i>Lectures</i>			
Structure, types of connections, the electronic effects in organic molecules. Hybridization. The acidity and basicity of organic compounds. Stereochemistry, working with models. Nomenclature, physical properties, chemical properties, reaction mechanisms characteristic and application of the basic classes of organic compounds: alkanes, cycloalkanes, alkenes, alkadieni, alkynes, aromatic compounds, alkyl halides, aryl halides, alcohols, phenols, ethers, tioalkoholi, thioethers, carbonyl compounds, carboxylic acids, substituted carboxylic acid derivatives of carboxylic acids, amines, nitro compounds.			
<i>Practical Classes</i>			
Nomenclature, physical properties and chemical properties of the main classes of organic compounds: alkanes, cycloalkanes, alkenes, alkadieni, alkynes, aromatic compounds, alkyl halides, aryl halides, phenols, alcohols, ethers, tioalkoholi, thioethers, carbonyl compounds, carboxylic acids, substituted carboxylic acid derivatives of carboxylic acids, amines, nitro compounds.			
Literature:			
1. Vollhardt K. P., Schore N. E., Organic chemictry, 4 th ed., Haidigraf, Belgrade, 2004.			
2. Vollhardt K. P, Schore, N. E., Organic Chemistry: Structure and Function, 8 th ed., W. H. Freeman, 2018.			
3. Clayden J., Greeves N., Warren S., Ogranic Chemistry, 2 nd ed., Oxford University Press, 2012.			
4. Klein D., Ogranic Chemistry, 2 nd ed., Wiley, 2013.			
5. Dewick M. Paul: Essentials of Organic Chemistry: For Students of Pharmacy, Medicinal Chemistry and Biological Chemistry, 1 st ed., Willey, New York, 2006.			
6. Morison R., Boyd R., Organic chemistry, 6 th ed., Prentice Hall, Harlow, 1992.			
Number of active teaching: 120			
Lectures: 60	Exercises: 60		
Methods of teaching:			
lectures, exercises, work with models, discussions.			
Grading (maximum 100 points)			
Pre-Exam commitments	Points	Final Exam	Points
Lectures	5	written exam	70
Practical classes	25		

English in Pharmacy

Study programmes:	pharmacy, pharmacy – medical biochemistry
Name of subject:	English in Pharmacy
Subjects status:	compulsory
ECTS:	4

Requirement:	none		
Subjects objective: The aim of this subject is to help students adopt English terminology and basic grammar rules in the context of pharmaceutical profession as well as master everyday conversation used by pharmacists at their workplace.			
Subjects outcome: After passing the exam the student will be able to: actively use basic technical English terminology in the field of pharmacy, medicine, medical biochemistry, chemistry, botany and decorative cosmetics, understand specialized literature in specific areas of the profession and use the Internet.			
Subjects content: <i>Lectures</i> Analysis of technical terms presented using illustrations, texts with exercises and exercises with examples taken from real conversations. Technical terminology includes basic medical terminology (body parts, body organs, ailments, skin injuries and changes, medical equipment etc.), chemical elements, units of measurement, laboratory apparatuses, parts of a plant, medicinal plants, terminology from decorative cosmetics as well as terms used by pharmacists and medical biochemists at their workplace. Analysis of basic grammar categories (nouns, verbs, adjectives, adverbs, articles, conditional sentences and passive voice). <i>Practical Classes</i> Practising verbal communication. Lexical exercises regarding the use of professional terminology. Defining and reformulation. Practising grammar categories.			
Literature: 1. Đorđević M.: Pharmaceutical English Course Book, Novi Sad, Faculty of Pharmacy Novi Sad, 2017. 2. Kerničan- Varga L.: English Language Pharmacy Practise, Belgrade, Grafopan, 2015. 3. McCarter S.: Oxford English for careers: Medicine 1, Oxford University Press, 2013. 4. Mičić S.: Medical Dictionary, Belgrade, Zavod za izdavanje udžbenika, 2011. 5. Pohl A.: Testing Your Professional English: Medical, Essex, Pearson Education Limited, 2007. 6. Vince M.: Advaned Language Practice, Oxford, Macmillian Publishers Limited, 2003. 7. Crowther J et al.: Oxford Advanced Learner's Dictionary, Oxford University Press, 1995.			
Number of active teaching: 60			
Lectures: 30	Exercises: 30		
Methods of teaching: interactive lectures, pair and group speaking exercises, audio-exercises, video-projections, writing summaries of technical texts, analysis of technical and commercial cosmetic articles written in English, working with technical English texts on the Internet.			
Grading (maximum 100 points)			
Pre-Exam commitments	Points	Final Exam	Points
Lectures	5	Written exam	60
Practical classes	25	Oral exam	10

Anatomy and Histology

Study programs:	pharmacy, pharmacy - medical biochemistry
Name of subject:	Anatomy and Histology
Subjects status:	compulsory
ECTS:	5
Requirement:	none
Subjects objective: Understanding normal anatomical and histological structures and concepts.	

Mastering the use of microscope and learning fundamental features of normal cell structure of tissues and organs, which makes morphological foundation necessary to understand all the vital processes in the body, with particular emphasis on the knowledge of the cell types that are target of action of pharmacological substances (muscle cells, nerve cells, marginal cells), metabolic products of cells that are used as active pharmacological substances (hormones, neurotransmitters) and cells through which drugs are absorbed, secreted or degraded (enterocytes, nephrocyte, hepatocytes).

Subjects outcome:

The ability to define, understand, describe, integrate and reproduce terms related to the normal anatomical and histological structure.

Introduction to basic micromorphological and functional characteristics of normal structure of cells, tissues and organs.

Subjects content:

Lectures

Basic anatomical terms. Body parts. Upper extremity. Bones, joints, muscles, blood vessels and nerves. Lower extremity. Bones, joints, muscles, blood vessels and nerves. Thorax. Walls, division and the thoracic contents. Lung tissues. Heart. Mediastinal content. Abdomen. Walls, division and abdominal content. Peritoneum. Peritoneal cavity (liver, stomach, spleen, pancreas, small and large intestines). Retroperitoneal space (kidney, adrenal glands, aorta, inferior vena cava, celiac plexus). Pelvis. Walls and contents. Bladder, anus bowel, male and female reproductive organs. Pelvic diaphragm. Head and neck. Bones of the head and face. Muscles of the head and neck. Large blood vessels and nerves of head and neck. Central nervous system.

Basic microscopic methods. General characteristics of the structural organization of the cell. General characteristics and division of different tissues. Epithelial, connective, muscle and nervous tissue. Hematopoietic organs and blood. Lymphatic system. Cardiovascular system. Respiratory system. Digestive system. Urinary system. Male and female reproductive systems. Nervous system. Endocrine system. Skin and sensory organs.

Practical classes

Practical demonstration on anatomical models. Using the atlas. Video presentations.

Histology presentations: forms of cells and nuclei, covering epithelium. Connective tissue (loose connective tissue, white adipose tissue, bone tissue). Muscle tissue (smooth, skeletal and cardiac). Nervous system (central nervous system, spinal cord, peripheral nerves). Blood (blood smear: erythrocytes, leukocytes, platelets). Cardiovascular system (arteries and veins). Immune system (palatine tonsil, lymph node). Endocrine system (pituitary gland, thyroid gland, adrenal gland). Respiratory system (trachea, lungs). Digestive system (tongue, stomach, duodenum, liver, pancreas). Urinary system (kidneys). Male and female reproductive systems (testis, ovary, uterus).

Literature:

1. Netter F. H., Machado, C. A. G.: Atlas of Human Anatomy & CD, ILS, Mala velika knjiga, Novi Sad, 2005.

Number of active teaching: 75

Lectures: 45

Exercises: 30

Methods of teaching:

Lectures and practical teaching wusingith anatomical and histological preparations, atlas, and video projections.

Grading (maximum 100 points)

Pre-Exam commitments	Points	Final Exam	Points
Lectures	5	Written exam	60
Practical classes	10		
Colloquium	25		

Calculations in Pharmacy

Study programes: pharmacy, pharmacy – medical biochemistry

Name of subject:	Calculations in Pharmacy		
Subjects status:	compulsory		
ECTS:	4		
Requirement:	none		
Subjects objective:	Linking basic knowledge and skills in arithmetic operations and calculations in basic chemical sciences to solving examples and problems within the courses of applied chemical sciences: analytical, pharmaceutical chemistry, as well as pharmaceutical sciences: drug analysis, pharmaceutical technology, pharmacokinetics.		
Subjects outcome:	After passing the exam, the student knows and understands arithmetic operations, is able to use and converts units and perform calculations in chemical tasks, perform calculations in chemical (galenic) laboratory, as well as to apply the acquired knowledge in courses of analytical chemistry, pharmaceutical chemistry, drug analysis, pharmaceutical technology, pharmacokinetics.		
Subjects content:	<p><i>Lectures</i></p> <p>SI system of units. Conversion of measuring units. Basic measures and formulas in chemistry and pharmacy. Mathematical operations. Performing formulas and units. Stoichiometric calculations. Logarithm and antilogarithm. Calculation of pKa and pH values, nth roots, exponentiation. Examples of calculations in pharmacy.</p> <p><i>Practical Classes</i></p> <p>Working on concrete examples and problem solving. Solving problems of importance for chemistry and pharmacy using the acquired theoretical knowledge.</p>		
Literature:	<p>1. Whitten K. W., Davis R. E., Peck M. L., General Chemistry, 9th ed., Saunders College Publishing, Philadelphia, 2010.</p> <p>2. Kotz J., Treichel P., Chemistry and Chemical Reactivity, 8th ed., Saunders College Publishing, Philadelphia, 2012.</p>		
Number of active teaching:	45		
Lectures:	30	Exercises:	15
Methods of teaching:	interactive lectures, practical classes, analysis and problem solving.		
Grading (maximum 100 points)			
Pre-Exam commitments	Points	Final Exam	Points
Lectures	5	Written exam	70
Practical classes	25		

Botany

Study programmes:	pharmacy		
Name of subject:	Botany		
Subjects status:	compulsory		
ECTS:	4		
Requirement:	none		
Subjects objective:	Make students familiar with basic knowledge of morphology, anatomy, physiology and ecology of plants important for pharmacy learning about the classification systems as information systems, knowledge of a select group of medicinal plants, application of acquired knowledge in problem botanical herbs and other useful plants.		
Subjects outcome:	After completing the course student should be able to: describe and explain the morphological and anatomical characteristics of plant organs and tissues, identify them macroscopically and microscopically, describe and explain the basic physiological processes of plants, be aware of environmental principles, determines the group		

correctly identified, named, described and classify species predict plant properties based on their systematic identification, access information using literature and electronic databases.			
Subjects content:			
<i>Lectures</i>			
The position and role of plants in the system of organisms and their significance to pharmacy. Physical organization of plants. Basic characteristics of plant cells. Basic features of the anatomy of plants. Plant tissue: dermal and parenchymal tissues. Mechanical and conductive tissues, consignment bundles. Basic concepts of plant physiology, plant water regime. Photosynthesis, respiration and mineral nutrition. Secretory structures of plants. Products of metabolism. Anatomy of root, stem and leaf. Nomenclature, taxonomy and classification systems of plants. Summary biosystematic group of plants. Fungi, algae, lichens, mosses, horsetail, fern. The morphology of vegetative and reproductive organs of seed coat. Gymnosperms, Angiosperms. Dikotile, monocots. Botany and Biotechnology. Fundamentals of ecology of plants. Natural populations of medicinal plants: knowledge, potential use and protection. Plant species in the territory of Serbia			
<i>Practical classes</i>			
Microscopic analysis of the characteristics of plant cells. Microscopic analysis of plant tissues. Microscopic identification of vegetative plant organs. Morphological analysis of vegetative organs. Morphological analysis and miroskopska reproductive structures. Methods of determination of higher plants. Using the literature and databases. Biosystematic groups of plants important for pharmacy. Selected representatives of deciduous Angiosperms and relevant to pharmacy. Plant species in the territory of Serbia. Excursion.			
Literature:			
1. Takhtajan A. Flowering Plants, second Edition. Springer, 2009.			
2. Rudall P. Anatomy of Flowering Plants. Cambridge University Press, Cambridge, 2007.			
Number of active teaching: 60			
Lectures: 30	Exercises: 30		
Methods of teaching:			
interactive lectures, practical classes			
Grading (maximum 100 points)			
Pre-Exam commitments	Points	Final Exam	Points
Lectures	5	Written exam	50
Practical classes	30		
Colloquium	15		

Inorganic Chemistry

Study programmes:	pharmacy, pharmacy – medical biochemistry
Name of subject:	Inorganic Chemistry
Subjects status:	compulsory
ECTS:	4
Requirement:	General Chemistry
Subjects objective:	Gaining knowledge of the properties and applications of elements and their inorganic compounds important for pharmacy that are needed to master all other fundamental and applied chemical disciplines.
Subjects outcome:	The student is able to apply the acquired knowledge to assess the chemical properties of the elements and their inorganic compounds, to predict and analyze the course of reactions involving inorganic substances, to organize work in chemical laboratories, to apply acquired knowledge to understanding other scientific disciplines such as pharmaceutical chemistry, bromatology, toxicology etc.
Subjects content:	

<i>Lectures</i>			
Prevalence of chemical elements in nature. General properties of metals, non-metals and metalloids. Position and characteristics of elements in the periodic table. Hydrogen and binary hydrogen compounds, properties and applications. s- and p-elements, physical, physicochemical and chemical properties, application, importance in pharmacy and medicine, the most important compounds. Air and noble gases. Transition elements, physical, physicochemical and chemical properties, application, importance in pharmacy and medicine, the most important compounds. General properties of inner transition elements. Complex compounds, nomenclature, linkage in complex compounds, biological complexes.			
<i>Practical Classes</i>			
Testing the reactivity of selected s-, p- and d-elements and their compounds of importance for pharmacy.			
Literature:			
1. Housecroft E. C., Sharpe G. A.: Inorganic Chemistry, 3 rd Edition, Pearson, Prentice Hall, 2008.			
Number of active teaching: 30			
Lectures: 15	Exercises: 15		
Methods of teaching:			
Lectures, interactive teaching, practical teaching, laboratory exercises, consultations.			
Grading (maximum 100 points)			
Pre-Exam commitments	Points	Final Exam	Points
Lectures	5	Written exam	70
Practical classes	25		

Biology with Human Genetics

Study programs:	pharmacy, pharmacy - medical biochemistry
Name of subject:	Biology with Human Genetics
Subjects status:	compulsory
ECTS:	3
Requirement:	none
Subjects objective:	To familiarize students with basic knowledge of cell, with special emphasis on the importance of genetic factors in its functioning.
Subjects outcome:	Course outcomes: After completing this course, the student should be able to: master the technique of microscopy, describe and explain the structure and function of the cell as the basic unit of structure of the body, understand the organization of the processes in cytoplasm and in nucleus of cells, describe and explain the transfer of information from DNA through RNA to protein, understand and explain the mechanisms of mutations of genetic material (genotype) and link these changes with the appropriate phenotype, apply the acquired knowledge in Biology and Human Genetics at other biomedical subjects during the study
Subjects content:	<p><i>Lectures</i></p> <p>The concept of the subject, the importance for students of pharmacy. The methodology of research in cell biology and genetics. Basic characteristics of eukaryotic cells. The evolution of cell. The chemical composition of cells and metabolism. Organization of eukaryotic cells. Hereditary basis and its function. Changes in the structure of genes and chromosomes. Cell cycle and cell death. Gametogenesis, fertilization, and developmental biology. Mutations of genes and chromosomes. DNA and gene expression. DNA repair mechanisms. Immunobiology. Oncogenetics. The molecular basis of human diseases. Pharmacogenomics. The methodology of research in cell biology and genetics</p> <p><i>Practical classes</i></p> <p>Microscope and microscopy techniques. The size and shape of cells and nuclei, embryonic origin of cells. Plasma membrane. Cytoplasmic organelles. Interphase nucleus, chromatin. Cell division: mitosis and meiosis. Transcription and translation. Chromosomal aberrations and gene mutations.</p>

Literature:			
1. Bruce Alberts. Molecular Biology of the Cell, 5 th ed., Garland Science, New York, 2008.			
2. Nussbaum R. L., R. McInnes R. Willard H. F.: Genetics in Medicine, 7 th ed., Saunders, Philadelphia, 2007.			
Number of active teaching: 60			
Lectures: 30	Exercises: 30		
Methods of teaching: lectures, practical exercises.			
Grading (maximum 100 points)			
Pre-Exam commitments	Points	Final Exam	Points
Lectures	5	written exam	60
Practical classes	15		
Colloquium	20		

Physical Chemistry and Biophysics

Study programmes: pharmacy, pharmacy – medical biochemistry
Name of subject: Physical Chemistry and Biophysics
Subjects status: compulsory
ECTS: 4
Requirement: none
Subjects objective: To provide fundamental knowledge of selected topics of physical chemistry, which will allow comprehension of physical and chemical processes and phenomena relevant for drug action. To provide the foundation knowledge for understanding of specialized modules that are offered in later years of study and to develop the ability to apply the acquired concepts in various pharmaceutical applications.
Subjects outcome: The student will be enabled to apply the acquired theoretical knowledge about physio-chemical relationships to solve given practical problems, to set and solve tasks related to physical chemistry by using certain mathematical equations and models, and to relate obtained knowledge with phenomena in the healthcare.
Subjects content: <i>Lectures</i> Selected topics on chemical thermodynamics including gaseous, liquid and solid state of the matter. Laws of thermodynamics, thermochemistry, enthalpy, entropy, chemical potential. Ideal and real gases (general properties of gases, gas laws). Liquids and solutions (colligative features, cryoscopy, ebullioscopy, osmosis, osmotic pressure, diffusion). Dissolution of liquids in liquid phase (fractional distillation, azeotropic mixtures, liquids that are partially soluble, immiscible liquids). Crystal and amorphous states (isomorphism, polymorphism). Phase equilibria and transformations. Phase boundary phenomena. Nernst's law of distribution. Dissolution of solid phase in liquid phase (true solutions, partition coefficient). Colloidal state and colloidal dispersion systems. Molecular-kinetic properties of colloidal systems (Brown motion, diffusion, sedimentation, osmotic pressure, light scattering and viscosity). Electrical properties and phenomena in colloids (electrokinetic potential, electrophoresis, electroosmosis). Colloid coagulation. Gels. Magnetic field and electromagnetic induction. Electrical oscillations and electromagnetic waves. Optics. Light polarization. Laser. X-ray radiation. <i>Practical Classes</i> Selected exercises in chemical thermodynamics. Determination of physicochemical properties of liquids. Determination of viscosity coefficient. Determination of surface tension coefficient. Determination of fluid refractive index. Determination of partition coefficient of compounds in two immiscible solvents. Determining the reaction order. Cryoscopy. Determination of Gibbs and Freundlich adsorption isotherms. Om's Law. Winston Bridge. Pogendorf compensation method. Calorimetry. Determining the focal length of the lens. Microscope (zoom lens and numerous apertures). Computational exercises: Fluid and gas dynamics. Thermal spread. Geometric optics. Computer simulations of experiments. Phase equilibria and colligative properties of the solution. Prediction of

logP. Adsorption at phase boundary. Selected exercises in colloidal chemistry. Determination of reaction kinetics parameters.			
Literature:			
1. Atkins P. W., De Paula J.: Physical Chemistry, 9th Edition, W. H. Freeman and Co., New York, 2010.			
Number of active teaching: 45			
Lectures: 30	Exercises: 15		
Methods of teaching:			
Lectures, interactive and practical tutorials, computational exercises, consultations.			
Grading (maximum 100 points)			
Pre-Exam commitments	Points	Final Exam	Points
Lectures	5	Written exam	70
Practical classes	25		

Organic Chemistry II

Study program: pharmacy
Name of subject: Organic Chemistry II
Subjects status: compulsory
ECTS: 5
Requirement: Organic Chemistry I
Subjects objective: The goal of course is to acquire knowledge of the stereochemical properties of molecules; stereochemical understanding of the characteristics of organic reactions, acquisition of knowledge about the structure and general properties of heterocyclic compounds, understanding of the characteristics of biomolecules - carbohydrates, lipids, peptides and nucleic acids; mastering the technique of basic laboratory operations in multiphase organic synthesis.
Subjects outcome: After passing the subject, the student is able to: understand and recognize stereochemical properties of organic compounds and chemical transformation, understanding the structural characteristics, reactivity and properties of heterocyclic compounds and biomolecules from the class of carbohydrates, lipids, peptides and nucleic acids, and knowledge of basic laboratory techniques of multiphase organic synthesis.
Subjects content:
<i>Lectures</i>
Carbohydrates: nomenclature, structure, chemical properties and reactivity, classification, cyclic structure of monosaccharides, mutarotation, anomer effect, glycosides, esters, ethers, carbohydrates, disaccharides, polysaccharides. derivatives, disaccharides, polysaccharides. Lipids: structure, properties. Peptides: amino acids, peptide bond, polypeptide synthesis, structure and properties of a polypeptide. Nucleic acid: structure and properties of nucleoside and nucleotide synthesis, properties of nucleic acids.
Stereochemistry, working with models. Stereoisomerism, elements of symmetry, chirality, nomenclature, enantiomers, optical activity, configuration, compounds with multiple chiral S-atoms, racemic forms, extract and separation of the racemate, the conformation of acyclic compounds, cyclic compounds, stereochemistry, conformation of unsubstituted and substituted six-membered rings, the structure and chirality Allen, stopping and biphenyls, Stereoselective and stereospecific reactions, asymmetric synthesis, prochiral compounds, Cram's rule. Heterocyclic compounds: nomenclature, physical and chemical characteristics, aromaticity, heteroatom effect on reactivity, acidity, alkalinity, refined, condensed polycyclic derivatives.
<i>Practical Classes</i>
Isolation and purification of carbohydrates, lipids, peptides and nucleic acids: distillation (different types), extraction (different types), centrifugation, chromatography (different types), recrystallisation. Physical and chemical properties exhibit the characteristic reactions of carbohydrates, lipids, peptides and nucleic acids, mutarotation of carbohydrates, proving optical properties of carbohydrates, the choice of solvent for work with each class of biomolecules. Making simple preparations of biomolecules from the class of carbohydrates, lipids, peptides

and nucleic acids, reaction differentiation of reducing / nonreducing properties of carbohydrates. Theoretical exercises of stereochemistry, preparation of the experimental preparation.			
Literature:			
1. Vollhardt K. P., Schore N. E., Organic chemistry, 4 th ed., Haidigraf, Belgrade, 2004.			
2. Mihailovic M.: Basics of theoretical organic chemistry and stereochemistry, textbook, book building, Belgrade, in 1975.			
3. Eliel Ernest Ludwig: Basic Organic Stereochemistry, 1 st ed., Wiley, New York, 2001.			
4. Joule J. A., Smith G. F., Joule John Arthur: <u>Heterocyclic Chemistry</u> , 5 th ed., Wiley-Blackwell, New York, 2010.			
5. Vollhardt K. P, Schore, N. E., Organic Chemistry: Structure and Function, 8 th ed., W. H. Freeman, 2018.			
6. Clayden J., Greeves N., Warren S., Organic Chemistry, 2 nd ed., Oxford University Press, 2012.			
7. Dewick M. Paul: Essentials of Organic Chemistry: For Students of Pharmacy, Medicinal Chemistry and Biological Chemistry, 1 st ed., Willey, New York, 2006.			
Number of active teaching: 75			
Lectures: 45	Exercises: 30		
Methods of teaching:			
lectures, laboratory exercises, group exercises, work with models., discussions.			
Grading (maximum 100 points)			
Pre-Exam commitments	Points	Final Exam	Points
Lectures	5	Written exam	70
Practical classes	25		

Introduction to Academic Writing

Study programmes:	pharmacy, pharmacy – medical biochemistry
Name of subject:	Introduction to Academic Writing
Subjects status:	compulsory
ECTS:	2
Requirement:	none
Subjects objective:	Introduction to research steps: formulating research subject, finding sources and materials, classifying primary and secondary sources, analyzing sources. Formulating conclusions. Adopting scientific ethics. Adopting expertise terminology.
Subjects outcome:	Adopting and implementing methodological principles in writing scientific papers by following these research steps: formulating research subject, draft, researching resources, researching other papers and works, forming draft bibliography, setting up and solving research questions and issues, formulating text, and creating various genres of academic writing (seminal papers, BA thesis, Master thesis, PhD thesis).
Subjects content:	<p><i>Lectures</i></p> <p>Adopting practical principles of writing academic works: organizing research sources, composing the work, scientific style, citation styles and their implementation, creating final bibliography.</p> <p><i>Practical Classes</i></p> <p>Implementing practical principles of writing various genres of academic works and presenting results.</p>
Literature:	<ol style="list-style-type: none"> 1. Sword Helen, Stylish Academic Writing, Cambridge, MA : Harvard University Press, 2012. 2. Breeze Ruth, Rethinking academic writing pedagogy for the European university Amsterdam ; New York, NY : Rodopi, 2012.

3. Barry Marian, Steps to academic writing, Cambridge : Cambridge University Press, cop. 2011.			
4. Leki Ilona, Instructor's manual to accompany Academic writing : exploring processes and strategies, 2nd ed. Cambridge : Cambridge University Press, 1998.			
Number of active teaching: 30			
Lectures: 15	Exercises: 15		
Methods of teaching: Lectures, Practical Classes			
Grading (maximum 100 points)			
Pre-Exam commitments	Points	Final Exam	Points
Lectures	5	Written exam	70
Practical classes	25		

Basics of Informatics

Study programs:	pharmacy, pharmacy – medical biochemistry		
Name of subject:	Basics of Informatics		
Subjects status:	compulsory		
ECTS:	2		
Requirement:	none		
Subjects objective:	The objective of this course is to provide students with the basic knowledge in the area of application of computer science in healthcare institutions, introduction to software tools for word processing and learning computer programs for spreadsheet calculating, statistical processing and presentation results of scientific work.		
Subjects outcome:	After passing the exam, the student is qualified to apply the knowledge of computer hardware, software tools and internet application in real situations in healthcare institutions or to enhance the existing pharmaceutical and laboratory practice. Also, the use of programs for calculating and text processing are important for the management of the pharmacists and medical biochemists in everyday practice.		
Content of the course:	<p><i>Theoretical classes</i></p> <p>Basic terms and features of the computer. Organization of a computer. Software, operating systems, algorithms, word processing, spreadsheets data, scientific calculations, simulations and databases. Multimedia. Computer network, communications software. Internet, websites, internet access, internet protocols, HTML, World Wide Web, the Internet services. Windows. Word. Excell. Power-point.</p> <p><i>Practical classes</i></p> <p>Internet. HTML. Windows. Word. Excell. Power-point. Specialized programmes used in healthcare institutions.</p>		
Literature:	1. Pasewark/Pasewark, Biheller Bunin Rachel, Evans Jessica, Pinard Katherine T., Romer Robin M.: Microsoft Office 2007: Introductory Course, Course Technology, Boston, 2007.		
Number of active teaching: 30			
Lectures: 15	Exercises: 15		
Methods of teaching: interactive lectures, practical exercises, practical work on computer.			
Grading (maximum 100 points)			
Pre-Exam commitments	Points	Final Exam	Points
Lectures	5	Written exam	60
Practical classes	35		

Professional Development and Career Planning I

Study programme:	pharmacy, pharmacy – medical biochemistry
Course title:	Professional Development and Career Planning I

Course status:	compulsory		
ECTS credits:	2		
Prerequisite:	none		
Course goals and objectives:	<p>The goal of the course is to acquaint students with the origin and theory of sociological thought about professions, professional values and principles. A student gets acquainted with the basic elements and dimensions of the profession, the need for professional development and tools for evaluation and continuous professional development (KPR, portfolio, etc.). Introducing students to the development of the pharmaceutical profession in Serbia, its transformation and the need for continuous improvement in accordance with global scientific knowledge and the needs of patients and society. Encouraging students to actively think about professional development, professional goals and an active approach to creating a professional career.</p>		
Course outcome:	<p>A student understands the elements and dimensions of the profession, as well as the need for professional and personal development. The student can define and perceive professional values and principles, understand the professional and social responsibility of the pharmaceutical profession and the obligation of personal, specialized and professional development. The student applies tools for assessment and improvement of competencies, and is able to create the basis of the portfolio and see the framework of professional development.</p>		
Course content:	<p><i>Theory</i></p> <p>Lectures: Development of sociological thought about professions. The notion of profession according to Parsons. Structural analysis of the profession: distinction between profession and occupation; specifics of the pharmaceutical profession. Basic characteristics of the profession (degree of development of theoretical knowledge, degree of monopoly on professional expertise, degree of recognition of the profession in public, degree of organization and degree of development of professional ethics). Characteristics of professional activity: authority, autonomy, altruism. Professional associations and organizations. Students' associations.</p> <p>The concept of lifelong education and lifelong learning. Instruments for assessing and developing pharmacists' competencies. The cycle of continuous professional development. Pharmacist's portfolio - concept, structure and application. Pharmacist's career planning and development: from clinical research, drug manufacturing / marketing, drug marketing and promotion, to pharmaceutical care in health care.</p> <p><i>Practice</i></p> <p>Analysis of examples from practice, panel discussions, homework on a given topic: portfolio development; competence assessment and self-assessment. Cooperation with representatives of pharmaceutical and students' associations.</p>		
Literature:	<p>1. Pharmaceutical Chamber of Serbia. National document for the assessment of pharmacists' competence. Available at: http://www.farmkom.rs/images/stories/dokumenta/onama/ostala_dokumenta/nacionalni-okviri-za-procenu-kompetencija-farmaceuta-final.pdf</p>		
Number of active teaching:	15		
Lectures:	15	Exercises:	0
Applicable teaching methods:	Interactive lectures, practice, discussions		
Grading scheme (maximum 100 points)			
Pre-exam requirements	Points	Final exam	Points
Lectures	5	exam	50
Practical classes	15		
Colloquim	20		
Seminar	10		

Pharmaceutical Inorganic Chemistry

Study programs:	pharmacy, pharmacy - medical biochemistry
Name of subject:	Pharmaceutical Inorganic Chemistry
Subjects status:	compulsory
ECTS:	4

Requirement:	none		
Subjects objective:	The aim of the course is that students gain knowledge about the importance and application of compounds of inorganic origin in pharmacy, ie the use of inorganic compounds in the production of drugs, cosmetics and dietary products, as well as their therapeutic significance.		
Subjects outcome:	The student is expected to understand the mechanisms of action of drugs, analyze the relationships of structure, properties, action and selectivity of farms. act. substances in order to design new and optimize existing farms. act. substances; applies computational methods for determining descriptors of chemical structures of drugs; applies knowledge of inorganic and organic-inorganic compounds of therapeutic importance		
Subjects content:	<p><i>Lectures</i> Introduction to pharmaceutical-medical chemistry. Pharmacopoeia. Water. Impurities in pharmaceutical substances (sources and coatings of impurities). Studies of physical and chemical properties of auxiliary and pharmaceutically active substances of inorganic origin. Acids, bases and buffers in pharmaceutical systems (preparation, stability, determination of buffer capacity, etc.). The main extra and intracellular electrolytes (physiological role of ions, electrolytes in replacement therapy (sodium chloride, potassium chloride, calcium gluconate, etc.), acid-base balance in the body. Dental agents of inorganic origin (dentifrici, fluorides and caries, de caries agents, calcium carbonate, sodium fluoride, zinc oxide, eugenol cement). Radiopharmaceutics, antiseptics and disinfectants.</p> <p><i>Practical classes</i> Pharmacopoeia and monographs of compounds of inorganic origin. Physico-chemical properties of pharmaceutically active substances of inorganic origin. Obtaining, qualitative and quantitative analysis. Examination of the degree of purity. Limit tests. Water analysis (alkalinity, acidity, hardness). Computational tasks.</p>		
Literature:	<ol style="list-style-type: none"> 1. Madhukar A.: A Textbook of Pharmaceutical Inorganic Chemistry, Pharmaplust publications, 2018. 2. Jyoti G., Mohit S., Madhuri G.: Practical Book of Pharmaceutical Inorganic Chemistry, Nirali Prakashan, 2017. 3. Belae John M., Block John H.: Organic Medicinal and Pharmaceutical Chemistry, 12th ed., Lippincott Williams & Wilkins, London, 2011 4. Радловић Д., Владимиров С.: Фармацеутска хемија I, уџбеник, Фармацеутски факултет, Београд, 2005. 5. Bothara K. G.: Inorganic Pharmaceutical Chemistry, Pragati Books Pvt. Ltd., Mumbai, 2008. 6. Graham L. Patrick: Introduction to Medicinal Chemistry, 6th ed., Oxford University Press, New York, 2017. 		
Number of active teaching:	45		
Lectures:	30		
Exercises:	15		
Methods of teaching:	lectures, practical exercises.		
Grading (maximum 100 points)			
Pre-Exam commitments	Points	Final Exam	Points
Lectures	5	written exam	70
Practical classes	25		

Analytical Chemistry

Study programmes:	pharmacy, pharmacy – medical biochemistry
Name of subject:	Analytical Chemistry
Subjects status:	compulsory
ECTS:	8
Requirement:	General Chemistry, Inorganic Chemistry
Subjects objective:	Functional linking and upgrade of the knowledge already acquired under General Chemistry subject in the function of perfecting necessary chemical skills for better understanding of chemical entities and their characterisation. Obtaining theoretical knowledge of qualitative and quantitative chemical analysis and basic principles of analytical method

development. Development of practical skills during the application of chemical methods of analysis as a necessary base for further understanding and application in quantitative chemical analysis and all other core and applied chemical disciplines. Mastering of basic calculations in volumetric and gravimetric analysis, during data analysis and data interpretation. Expansion of knowledge related to the applications and development of classical quantitative chemical methods as well as necessary foundations for the application of instrumental methods in modern analytical chemistry and understanding of other relevant scientific disciplines (drug analysis, bromatology, toxicology etc.).

Subjects outcome:

Upon the successful completion of the subject students will be able to: Safely and correctly use chemicals and basic laboratory tools and devices, apply basic manipulations of semi-micro qualitative analysis on separation process and identification of ions, conduct tests for determination of the organic functional groups; Deduct conclusions about qualitative and quantitative composition of sample based on experimental results and write the laboratory report; Apply theoretical knowledge on the selection of analytical method concerning analyte, independently organise and conduct of all phases of experimental work and practically conduct analytical method in a laboratory setup; Use chemical calculations that are necessary for quantitative determination in volumetry and gravimetry

Subjects content:

Lectures

Introduction to qualitative analysis. Solutions: definitions, classifications, characteristics (solubility, solubility product, pH, buffers, buffer capacity). Properties of solutions and their effect on the separation of complex mixtures and their qualitative analysis. Qualitative analysis of organic compounds of pharmaceutical importance based on the detection of their functional groups.

Introduction to quantitative chemical analysis. Introduction to volumetric analysis, measurement of mass and volume. Important properties that chemical reaction should have to be used in quantitative analysis (reaction speed, constant, primary standard, detection of the end-point of titration). Influence of different analytical experimental parameters on the quality of obtained results, errors in quantitative analytical assessment. Acid-Base titrations in aqueous and non-aqueous conditions. Complexometric titrations. Redox titrations, different types of redox titrations. Precipitation titrations. Gravimetry, gravimetric methods of analysis, basic laboratory operations in gravimetric analysis, gravimetric determinations. Stoichiometric calculations in quantitative analysis. Application of instrumental methods for the detection of the end-point of titration. Selection of an analytical method for the determination of an analyte.

Practical Classes

Chemicals and their use. Laboratory glassware. Basic operations in semi-micro qualitative analysis. Solubility determination and fractional separation (precipitation) based on the differences in solubility of compounds.

Identification of individual compounds. Systematic qualitative analysis. Identification of organic compounds, initial tests, detection of functional groups. Complete qualitative analysis of cations and anions.

Acid-base titrations, preparation and standardisation of solutions, aqueous acid-base titrations. Chelatometric titrations, detections of several compounds in solution. Permanganometric titrations, preparation and standardisation of Potassium-permanganate, Zimmermann-Reinhardt's method. Iodimetry, preparation and standardisation of Sodium-thiosulphate solution, replacement titration. Precipitation titrations, argentometric determination of halogens. Gravimetry, determination by precipitation. Potentiometric titrations of polyprotic systems. Laboratory classes will be based on the application of volumetric and gravimetric in pharmaceutical analysis ie. determination of: acid, saponification, iodine and peroxide number.

Literature:

1. Gary D. C., Purnendu K. D., Kevin A. S.: Analytical Chemistry, 7th Edition, John Wiley & Sons, New York, 2013.
2. Harris D.C., Lucy C.A.: Quantitative Chemical Analysis, 10th ed., W H Freeman & Co, 2019

Number of active teaching: 135

Lectures: 75

Exercises: 60

Methods of teaching:

Grading (maximum 100 points)

Pre-Exam commitments	Points	Final Exam	Points
Lectures	5	Written exam	60
Practical classes	35		

Instrumental Pharmaceutical Analysis

Study programmes:	pharmacy, pharmacy - medical biochemistry		
Name of subject:	Instrumental Pharmaceutical Analysis		
Subjects status:	compulsory		
ECTS:	5		
Requirement:	General Chemistry		
Subjects objective:	Introduction to the theoretical principles, device design and their handling, as well as the application of different instrumental methods relevant to further studies and career of pharmacists. Preparation for the use of selected instrumental methods and robust result analysis.		
Subjects outcome:	After passing the exam the student: will have theoretical knowledge and practical experience to select an appropriate instrumental method to according to the task, and in accordance with the specific requirement of the pharmaceutical profession; will be able to check the fitness of a system and prepare it for the start of the analysis; will be able to utilize provided instructions and independently conduct an experiment on a simple instrument.		
Subjects content:	<p><i>Lectures</i></p> <p>Principles and classification of instrumental methods. Measuring devices. Quality of measuring devices and measurements. Spectrochemical methods. Atomic absorption and emission spectroscopy. Molecular spectroscopy, absorption of UV, VIS and IR radiation, absorption spectroscopy. Lambert-Beer law. Methods based on the light scattering, turbidimetry and nephelometry. Methods based on the rotation and refraction of light, polarimetry and refractometry. Nuclear Magnetic Resonant Spectroscopy (NMR). Mass spectrometry. Electrochemical methods, potentiometry and conductometry. Instrumental methods for separation. Separation techniques based on the principle of adsorption, dissolution, ion exchange, charge mobility, size, and affinity of the particles. Gas and liquid chromatography. Electrophoresis and capillary electrophoresis. Electrochromatography. Ultracentrifugation. Thermal methods.</p> <p><i>Practical classes</i></p> <p>Absorption spectroscopy methods (atomic and molecular). Emission spectrometry methods (atomic and molecular). Methods based on the light scattering (turbidimetry and nephelometry). Polarimetry. Refractometry. Potentiometry and potentiometric titration of various chemical systems. Selected separation methods.</p>		
Literature:	<ol style="list-style-type: none"> 1. Watson David G.: Pharmaceutical Analysis: A Textbook for Pharmacy Students and Pharmaceutical Chemists. 4th ed., Elsevier, Edinburgh, 2016. 2. Craig D.Q.M., Reading M.: Thermal Analysis of Pharmaceuticals, CRC Press, Taylor & Francis, 2007. 		
Number of active teaching:	75		
Lectures:	45	Exercises:	30
Methods of teaching:	lectures, practical classes, demonstrations, exercises.		
Grading (maximum 100 points)			
	Pre-Exam commitments	Points	Final Exam
	Lectures	5	Written exam
	Practical classes	45	50

General Biochemistry

Study programmes:	pharmacy		
Name of subject:	General Biochemistry		
Subjects status:	compulsory		
ECTS:	4		
Requirement:	Organic Chemistry II		
Subjects objective:			

<p>Students should gain basic knowledge of Biochemistry and understand the influence of Biochemistry on other fields of sciences. They should comprehend the connection between the structure and the biological function of biomolecules. Also, they should gain knowledge of structure and cell membranes` function, different metabolic pathways, inter-cell signaling, nucleic acids and biosynthesis of proteins. Students should understand the mechanism of enzyme activity, reactions of biotransformation of some exogenous and endogenous compounds</p>			
<p>Subjects outcome:</p> <p>After students have successfully mastered the subject matter of this course, they are expected to be able to describe and analyze the main catabolic, anabolic and intermediate metabolic pathways, to apply knowledge of enzyme kinetics and inter-cell signaling in interpretation of metabolic pathways regulation in human body, to explain biochemical basis of protein synthesis, regulation and posttranslational modification of proteins, as well as to successfully apply gained knowledge so that they can easily follow and comprehend lectures of medicinal biochemistry</p>			
<p>Subjects content:</p> <p><i>Lectures</i></p> <p>Introduction: Structure and mechanism of enzymes and coenzymes activity, kinetics of enzyme and inhibition. Chemical composition of biological membranes and transport through a membrane. Main principles of bioenergetics. Catabolism of carbohydrates: Glycolysis, Glicogenolysis, Phosphogluconate pathway, catabolism of other hexoses. Catabolism of lipids: Oxidation Pathway of Fatty Acids, acylglycerols, phospholipids, sphingolipids, cholesterol. Catabolism of nitrogen`s compounds: Amino Acids, the Urea Cycle, proteins, nucleotides. Intermediary Metabolism Pathway: Citric Acid Cycle, the Electron Transport Chain and Oxidative Phosphorylation. Anabolism of Carbohydrates: Gluconeogenesis, glycogenesis. Anabolism of lipids. Anabolism of nitrogen`s compounds. Inter-cell signaling: by the receptors which are bound to G-protein, enzymatic receptors, ion-channel receptors and nicotinic acetylcholine receptor. Biotransformation: Cytochrome P450 system, FM- monooxygenase, glucuronic acid conjugation, biotransformation of some exogenous and endogenous compounds. Biosynthesis of proteins and nucleic acids, replication, transcription, translation and post-translation modification of protein in human body.</p> <p><i>Practical Classes</i></p> <p>Renewal of acquired knowledge about biomolecules, structure and function of fibrillar (-collagen, -keratin) and globular proteins (hemoglobin and myoglobin), resolution of problems which are connected with kinetics of enzymatic reaction and enzyme inhibition, examples of some transport system disorders through the cell membrane, presentation of main metabolic pathways, resolution of some problems related to certain metabolic pathways, correlation of theoretical knowledge about metabolism with practical examples. Practical classes are partly performed in a lab.</p>			
<p>Literature:</p> <ol style="list-style-type: none"> 1. Rodwell VW Bender DA, Botham KM,: Harper's Illustrated Biochemistry, 31st Edition, McGraw Hill, 2018. 2. Denise Ferrier: Lippincott Illustrated Reviews: Biochemistry, 7th Edition, LWW Lippincott Williams and Wilkins, 2017. 3. Fischbach F.: A Manual of Laboratory and Diagnostic Tests, 10th Edition, LWW Lippincott Williams and Wilkins, 2017. 			
Number of active teaching: 60			
Lectures: 30	Exercises: 30		
<p>Methods of teaching:</p> <p>lectures, laboratory exercises, computer simulation, disscusion, e-learning</p>			
Grading (maximum 100 points)			
Pre-Exam commitments	Points	Final Exam	Points
Lectures	5	Writte nexam	60
Practical classes	15		
Colloquium	20		

Immunology

Study programmes:	pharmacy, pharmacy - medical biochemistry	
Name of subject:	Immunology	
Subjects status:	compulsory	
ECTS:	4	
Requirement:	none	
Subjects objective:	<p>Introducing pharmacy students with: the inherent characteristics and acquired immunity and their effectoric mechanisms of defense against antigens of infectious microorganisms (bacteria, viruses, parasites and fungi); pathogenetic mechanisms and treatment of diseases caused by dysfunction of the immune system (hypersensitivity reactions, autoimmune diseases, caused by an excessive inflammatory reaction of the body, immune deficiency) immune response to antigens of non-infectious origin (tumor antigens and antigens grafts) and principles of immunotherapy and tumor immunotherapeutic strategies for the prevention of transplant rejection, immunomodulation of innate immune system disorders, principles and application of immunoassay based on the antigen- antibody reaction</p>	
Subjects outcome:	<p>After passing the exam, the student will know effectoric mechanisms of innate and acquired immunity in the defense against infectious agents, known pathogenesis, the most important clinical manifestations and treatment of diseases caused by dysfunction of the immune system, know the immune response to tumors and transplanted tissue, as well as the principles of tumor immunotherapy and transplantation reaction, to master the principles of immunoassay for the qualitative and / or quantitative determination of antigens and antibodies</p>	
Subjects content:	<p><i>Lectures</i></p> <p>Theoretical study: innate immunity. Assumption, processing and presentation of antigens. Antigen receptors on lymphocytes. The development of the immune repertoire. Cell-mediated immune response. Effectoric mechanisms of T-cell mediated immune response. The humoral immune response. Effectoric mechanisms of humoral immune response. Immunological tolerance: importance and mechanisms. Autoimmunity. The immune response to non-infectious antigens (tumors and transplants). Diseases caused by excessive inflammatory reaction of the body. Hypersensitivity diseases. Congenital and Acquired Immune Deficiency Syndrome (AIDS). Immunomodulation of innate immune system disorders.</p> <p><i>Practical classes</i></p> <p>Antigen, immunogen, hapten, immunization, obtaining polyclonal and monoclonal antibodies. Precipitation reactions. Agglutination reaction. Complement fixation test and the determination of total hemolytic complement activity (CH 50 test). Tests with enzyme labeling: ELISA, ELISA spot. Fluorochromes as bookmarks, immunofluorescence and flow cytometry. Immunohistochemistry. Methods for selective removal of cells. Methods for assessment of humoral and cellular immunity in vitro and in vivo. The tests that are performed before transplantation. Detection of immune complexes in tissues and biological fluids.</p>	
Literature:	<ol style="list-style-type: none"> 1. Abbas Abul K., Lichtman Andrew H., Pilai S.: Basic Immunology - Functions and Disorders of the Immune System, 6th edition, Elsevier, 2019. 2. Abbas Abul K., Lichtman Andrew H., Pilai S.: Cellular and Molecular Immunology, 9th edition, Elsevier, 2018. 3. Geha R., Notarangelo L.: Case Studies in Immunology – A Clinical Companion, 7th edition, Garland Science 2016. 4. Turgeon M. L.: Immunology & Serology in Laboratory Medicine, 6th Edition, Elsevier Science, 2018. 	
Number of active teaching:	45	
Lectures:	30	Exercises: 15
Methods of teaching:		

lectures, exercises, discussions, e-learning			
Grading (maximum 100 points)			
Pre-Exam commitments	Points	Final Exam	Points
Lectures	5		60
Practical classes	15		
Colloquium	20		

Physiology I

Study programmes:	pharmacy, pharmacy - medical biochemistry		
Name of subject:	Physiology I		
Subjects status:	compulsory		
ECTS:	5		
Requirement:	none		
Subjects objective:	Providing knowledge about the physical and biochemical functions of cells, tissues, organs and organ systems, their interconnection and the regulatory mechanisms of life processes, ie. understanding the basic physiological principles of functioning of a healthy human.		
Subjects outcome:	After completing the course and passing the exam, students are expected to know and understand the basic functions of cells of different tissues. Also to understand the functions of control regulatory mechanisms by which cells, tissues, organs and organ systems are connected in an organism in order to continue acquiring knowledge about the physiology of individual organs united in a healthy organism, as well as other sciences in the field of human medicine, like pathophysiology of diseases.		
Subjects content:	<p><i>Lectures</i></p> <p>Homeostasis; body fluids; metabolism - the turnover of metabolites and the conversion of metabolites into energy necessary for the living and functioning of cells; basal metabolism; thermoregulation; transport through the cell membrane; membrane resting potential and action potential; central nervous system organization, nerve cell, nerve impulse transmission, synapses, receptors and reflexes; muscle physiology and contractions: transverse, smooth and cardiac muscle; cardiovascular system: urine, blood vessels and blood.</p> <p><i>Practical Classes</i></p> <p>General physiology. Homeostasis: examples of positive and negative feedback; transport through the cell membrane; cell: organelles and intercellular communication; Excitable tissues. Action potential: stages, inhibition and propagation; synapses and neurotransmitters; muscle contraction: blood and coagulation; conduction system of the heart and cardiac work</p>		
Literature:	<p>1. Guyton A. C., Hall J. E.: Textbook of medical physiology, 13th ed, Elsevier, Philadelphia, 2016.</p> <p>2. McCorry J.K. Essentials of Human Physiology for Pharmacy, 2th ed, Routledge, New York, 2008.</p>		
Number of active teaching:	75		
Lectures: 45	Exercises: 30		
Methods of teaching:	Theoretical and practical teaching with computer animations and simulation of physiological processes		
Grading (maximum 100 points)			
Pre-Exam commitments	Points	Final Exam	Points
Lectures	5	Written exam	60
Practical classes	20		

Seminar	15		
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Microbiology and Antibiotic Therapy

Study programmes:	pharmacy, pharmacy - medical biochemistry
Name of subject:	Microbiology and Antibiotic Therapy
Subjects status:	compulsory
ECTS:	5
Requirement:	none
Subjects objective:	<p>Introducing students to the morphology, physiology, genetics and taxonomy of microorganisms, in particular, the virulence factors of pathogenic microorganisms, the routes of transmission and spread of infectious diseases in humans, and prevention measures. Acquiring basic knowledge to work in a microbiology laboratory, learning about microorganisms causing the disease, clinical picture, diagnosis, recommended disease treatments, mechanisms for acquiring antibiotic resistance and measures to prevent the emergence and spread of multidrug-resistant strains mechanisms of action of antimicrobial drugs.</p>
Subjects outcome:	<p>Students acquire basic theoretical knowledge in the field of general and special microbiology as well as the knowledge necessary for aseptic work and performing basic tests/test methods in the microbiology laboratory, pharmaceutical industry and practice, especially in isolation, characterization, and identification of etiological agents of infectious diseases, performance and interpretation of tests in vitro susceptibility of microorganisms to antibiotics and chemotherapeutics, application of the principles of rational antibiotic therapy, chemoprophylaxis, passive and active immunization, good laboratory Ori and good manufacturing practices and the application of microorganisms in industry and quality control.</p>
Subjects content:	<p><i>Lectures</i></p> <p>Bacterial taxonomy, bacterial cell structure and function; Metabolism and kinetics of bacterial growth, modes of transmission of genetic material; The fact of physical and hemical agents for bacteria and other microorganisms; Virulence / pathogenicity factors, antibiotics and chemotherapeutics, human physiological microbiota; Standard and rapid diagnostic tests and molecular methods in identification; Gram positive and Gram negative cocci significant for human pathology, Gram positive asporogenic and sporogenic bacilli, Gram negative enterobacteria, spiral bacteria, chlamydia and mycoplasma; Basic principles of recombinant DNA technology, medically significant polypeptides and proteins derived from DNA technology; Application of microorganisms in the pharmaceutical industry - drug metabolism testing; General features and division of viruses, replication, action of physical and chemical agents on viruses, pathogenesis and control of viral infections; Interferons and antiviral drugs, laboratory diagnosis; DNA and RNA viruses significant for human pathology; Medical parasitology: mycology, fungal morphology and laboratory diagnosis of mycoses, dermatophytes and systemic mycoses, antifungals and their mechanism of action; Microbiological control in the pharmaceutical industry: principles of good laboratory and good manufacturing practice, methods of preventing contamination/cross-contamination with microorganisms, monitoring and control of ambient conditions (air, equipment, work surfaces); Control of raw materials, primary packaging materials and finished products, checking of antimicrobial effectiveness of disinfectants and purpose/significance of their periodic change/application.</p> <p><i>Practical Classes</i></p> <p>Methods of microscopy and staining, sterilization and disinfection, isolation and identification of bacteria, antibiogram, gram positive cocci, gram-negative cocci, gram positive sporogenic and asporogenic bacilli, enterobacteria,</p>

mycoplasma and chlamydia, antimicrobial drugs and their mechanisms of action, microbiological testing of drugs, laboratory diagnosis of viral, parasitic and fungal infections. Case study analysis (selecting relevant methods).			
Literature:			
1. Denyer Stephen P., Hodges Norman, Gorman Sean P. (eds.): Hugo and Russell's Pharmaceutical Microbiology, Willey, New York, 2004			
2. Tortora Gerard J., Funke Berdell R., Case Christine L.: Microbiology: An Introduction, Books a la Carte Edition, 10 th ed., Benjamin Cummings, New York, 2009.			
Number of active teaching: 75			
Lectures: 45	Exercises: 30		
Methods of teaching:			
Lectures, exercises, discussions			
Grading (maximum 100 points)			
Pre-Exam commitments	Points	Final Exam	Points
Lectures	5	Written exam	60
Practical classes	35		

Statistics in Pharmacy

Study programmes:	pharmacy, pharmacy – medical biochemistry		
Name of subject:	Statistics in Pharmacy		
Subjects status:	compulsory		
ECTS:	4		
Requirement:	none		
Subjects objective:	The objective of the course is for students to learn statistical terminology, understand simple statistical methods and result interpretation, the application of statistical tests on examples from pharmacy, and to learn to use the statistical package.		
Subjects outcome:	After passing the exam, the student will be able to: properly select the sample and collect the data, select the appropriate statistical method used to analyze the data, interpret the results, easily use MS Excel and the statistical package.		
Subjects content:	<p><i>Lectures</i></p> <p>Statistical terminology. Population and sample. Variable sizes and data. Editing data. Graphical representation and tabulation. Measures of central tendency. Deviation measures. Normal distribution. The standard normal distribution. Calculation of area under the normal distribution. Testing the hypothesis. Type I and type II errors. P-value. One-sided and two-sided student's test. Variance ratio test. The analysis of variance. The analysis of variance for one classification criterion. Linear regression analysis. The regression equation. Correlation analysis. The coefficient of determination. The coefficient of correlation. Using regression analysis to predict. Non-parametric methods. Parametric t-test (Mann-Whitney U-test). Non-parametric correlation. Chi-square test. Assessment of agreement. Test of independence. Homogeneity test. The confidence interval of expected values.</p> <p><i>Practical Classes</i></p> <p>The application of statistical methods in examples from pharmaceutical practice using the statistical package</p>		
Literature:	1. De Muth J. E.: Basic Statistics and Pharmaceutical Statistical Applications, Chapman & Hall, Washington, DC, 2006.		
Number of active teaching: 45			
Lectures: 30	Exercises: 15		
Methods of teaching:			
lectures, work with the statistical software package, addressing examples from pharmacy practice, e-learning.			
Grading (maximum 100 points)			
Pre-Exam commitments	Points	Final Exam	Points
Lectures	5	Written exam	50

Practical Classes	25		
Colloquium	20		

Physiology II

Study programmes: pharmacy, pharmacy - medical biochemistry			
Name of subject: Physiology II			
Subjects status: compulsory			
ECTS: 5			
Requirement: none			
Subjects objective: Providing knowledge about the work and role of human organ systems, their connection in the organism and the functioning of control mechanisms that ensure human life in different environmental conditions and certain health conditions of the organism.			
Subjects outcome: Respiratory function testing: pneumography, spirometry, blood gas analysis; Digestive function testing: gastrointestinal hormones and enzymes, gastric function testing, metabolic, synthetic and excretory liver function tests (analysis of liver biochemical syndrome tests), digestion of nutrients, stool testing; examination of urinary function: physical and biochemical characteristics of urine, calculation of creatinine clearance; and examination of the function of individual glands with endocrine secretion.			
Subjects content: <i>Lectures</i> Respiratory system; urinary system and acid-base status; digestive system; endocrine system; reproductive system; skin. <i>Practical Classes</i> Respiratory function testing: pneumography, spirometry, blood gas analysis; Digestive function testing: gastrointestinal hormones and enzymes, gastric function testing, metabolic, synthetic and excretory liver function tests (analysis of liver biochemical syndrome tests), digestion of nutrients, stool testing; examination of urinary function: physical and biochemical characteristics of urine, calculation of creatinine clearance; and examination of the function of individual glands with endocrine secretion.			
Literature: 1. Guyton A. C., Hall J. E.: Textbook of Medical Physiology, 13 th ed, Elsevier, Philadelphia, 2016. 2. McCorry J.K. Essentials of Human Physiology for Pharmacy, 2 th ed, Routledge, New York, 2008.			
Number of active teaching: 60			
Lectures: 30	Exercises: 30		
Methods of teaching: Theoretical and practical teaching with computer animations and simulation of physiological processes			
Grading (maximum 100 points)			
Pre-Exam commitments	Points	Final Exam	Points
Lectures	5	Written exam	60
Practical classes	20		
Seminar	15		

Pharmacognosy I

Study programmes: pharmacy
Name of subject: Pharmacognosy I

Subjects status: compulsory			
ECTS: 4			
Requirement: Botany, Organic Chemistry I			
Subjects objective: Acquiring knowledge about the division, path of biosynthesis, distribution, localization, physico-chemical characteristics, role and application in pharmacy of primary and secondary pharmacologically active natural molecules; knowledge of the structure of secondary natural products; knowledge of methods for qualitative and quantitative analysis, extraction, isolation and purification of pharmacologically active natural molecules; use and evaluation of professional literature and specific methods of quality control in pharmacognosy described in valid pharmacopoeias.			
Subjects outcome: After passing the exam, the student is able to: know the biosynthetic origin and chemical structure of natural pharmacologically active ingredients; knows the prevalence of active ingredients in plants and selected animals; perform qualitative and quantitative analysis of selected natural active ingredients; conceives and performs the procedure of extraction and separation of compounds of natural origin; knows the natural raw materials used to isolate compounds for the needs of the pharmaceutical industry; defines drugs and their biological source, knows morphological and anatomical characteristics of drugs, knows chemical components of drugs, performs drug identification, performs drug quality testing, knows the possibility of drug use, participates in conceiving, organizing and managing the drug production process and quality assurance.			
Subjects content: <i>Lectures</i> Introduction. Products of primary plant metabolism (chemical structure, pharmacological activity and application) and general metabolic pathways. Secondary metabolites of plants: biological function, classification. Relationship between primary and secondary plant metabolism. Definition, division, use of drugs. Drug production. Drug quality. Pharmacopoeial monographs of drugs. Definition, presence in nature, distribution, localization, biological function, physicochemical properties, structure, proof, determination, extraction, purification, pharmacological activity, application in pharmacy: alkaloids, cyanogenic and sulfur heterosides. Drugs with alkaloids, cyanogenic and sulfur heterosides. <i>Practical Classes</i> Macroscopic, microscopic and chemical identification of drugs. Examination of the quality of official drugs.			
Literature: 1. Haensel R., Sticher O.: Pharmakognosie-Phytopharmazie, Springer, Berlin, 2007. 2. Evans W. C.: Trease and Evans' Pharmacognosy, WB Saunders, Edinburgh, 2002.			
Number of active teaching: 60			
Lectures: 30	Exercises: 30		
Methods of teaching: Lectures, exercises, discussions			
Grading (maximum 100 points)			
Pre-Exam commitments	Points	Final Exam	Points
Lectures	5	Written exam	70
Practical classes	25		

Pharmaceutical Organic Chemistry I

Study programmes: pharmacy	
Name of subject: Pharmaceutical Organic Chemistry I	
Subjects status: compulsory	
ECTS: 4	
Requirement: Organic Chemistry II	
Subjects objective:	

The student should acquire knowledge about pharmaceutically active compounds of organic origin: physico-chemical properties, synthesis, metabolism, mechanism of action from the aspect of chemical structure, stability..			
Subjects outcome: Knowledge of drug chemistry: physico-chemical properties of drugs, chemical characterization and classification of drugs, structure-activity relationship, relationship between structure and mechanism of action of drugs, stability of drugs.			
Subjects content: <i>Lectures</i> Introduction to drug chemistry. Physico-chemical properties of drugs: lipophilicity, solubility, degree, ionization. Drug biotransformation (reactions of the first and second phase of metabolism). Drug stability. Antibiotics: beta-lactam antibiotics, aminoglycosides, macrolide antibiotics, tetracyclines, sulfonamides and folate reductase inhibitors, quinolones and fluoroquinolones, glycopeptide antibiotics, chloramphenicol and analogues, etc. Antivirals. Antifungals. Drugs in the treatment of endocrine disorders: antidiabetics, thyrostatics, etc. Antineoplastics. Sex hormones: estrogens, progestogens, antiestrogens, antiprogestagens, contraceptives, androgens, anabolics, antiandrogens. Minerals and corticosteroids. Disinfectants and antiseptics. Vitamins. <i>Practical Classes</i> Functional groups and reactions of functional groups. Qualitative analysis of compounds of organic origin. Flow analysis. Extraction of pharmacologically active compounds. Crystallization, purification, determination of melting temperature and identification of newly synthesized compounds. Elementary microanalysis of a newly synthesized substance.			
Literature: 1. Williams D. A., Lemke T. L.: Foye`s Principles of Medicinal Chemistry, 8 th ed., Lippincott Williams & Wilkins, Baltimore, 2019. 2. Wilson E. Gisvold J. B.: Textbook of Organic Medicinal and Pharmaceutical Chemistry, 12 th Lippincott Company London, Philadelphia, 2011. 3. Graham P, An introduction to medicinal chemistry, fifth edition. Oxford university press; 2013. Wermuth C, Aldous D, Raboisson P and Rognan D, 4. The Practice of Medicinal Chemistry, 4th Edition. Academic Press, London, 2015.			
Number of active teaching: 90			
Lectures: 45	Exercises: 45		
Methods of teaching: Lectures, exercises, discussions			
Grading (maximum 100 points)			
Pre-Exam commitments	Points	Final Exam	Points
Lectures	5	Written exam	70
Practical classes	25		

Bromatology

Study programmes: pharmacy, pharmacy – medical biochemistry
Name of subject: Bromatology
Subjects status: compulsory
ECTS: 4
Requirement: General Chemistry
Subjects objective: The aim of the subject: Familiarization with food composition, macro and micronutrient content, energy value and food potential to fulfill nutritive and human energy requirements; possibility of food combining and food replacement in order to gain specific nutritive effect; giving the information regarding chemical and nutritive changes during the thermal treatment; information about nutrient–drug interactions.
Subjects outcome:

After finishing the course student will be able to give information concerning appropriate choice of food stuffs and their combination for different population groups; to provide the information to patients concerning basic food–drug interactions.

Subjects content:

Lectures

Food and nutrient definition. Factors influencing food selection/choice. Food energy value. Basic food components, energy value, chemical properties, basic role in organism, biological value. Protective nutrients. Non-nutritive biologically active food components. Types of food according to their role in organism. Water as a food. Food additives and contaminants. Influence of thermal treatment and processing on food biological value. Interactions of nutrients in food, in digestive tract and in organism.

Practical Classes

Analytical methods in food and nutrients. Food composition and quality parameters of different food products; determination of: dry matter content, ash, starch, cellulose and fat content, fat acidity and peroxide value of fats as methods used to determine spoilage of fats and oils, saponification value as a measure of the average chain length of all the fatty acids present and iodine number of fats and oil as a measure of present fatty acid saturation, protein content determination, sodium-chloride determination etc.

Literature:

1. Belitz H. D., Grosch W.: Food Chemistry, 3rd ed., Springer, Berlin, 2004.
2. Hui Y. H. (ed.): Handbook of Food Science, Technology and Engineering, Vol.1, Taylor & Francis, Philadelphia, 2006.
3. Arendt Elke K., Dal Bello Fabio (eds.): Gluten-free cereal products and beverages, Elsevier, Waltham, Massachusetts, 2008.
4. Greenfield H., Southgate D.A.T.: Food Compositions, Food and Agriculture, Organization of the United Nations, 2nd ed., Rome, 2003.
5. Coultate T. P.: Food - The chemistry of it's Components, Royal Society of Chemistry, Herts, 1995.
6. Hoffman, J.R., Falvo, M.J. PROTEIN – WHICH IS BEST?, International Society of Sports Nutrition Symposium, June 18-19, 2005, Las Vegas NV, A - Symposium - Macronutrient Utilization During Exercise: Implications For Performance And Supplementation
7. Simopoulos AP: The importance of the ratio of omega-6/omega-3 essential fatty acids. Biomed Pharmacother. 2002 Oct; 56(8):365-79. Review
8. Casimir C. Akoh , David B. Min: FOOD LIPIDS Chemistry, Nutrition, and Biotechnology, CRC Press Taylor & Francis Group, 2008
9. Wood, J.D., Enser, M., Fisher, A.V., Nute, G.R., Sheard, P.R., Richardson, R.I., Huges, S.I. and Whittington, F.M. (2008). Fat deposition, fatty acid composition and meat quality: A review. Meat Sci., 78, 343-358.
10. Wood, J.D., Richardson, R.I., Nute, G.R., Fisher, A.V., Campo, M.M., Kasapidou, E., Sheard, P.R. and Enser, M. (2003). Effect of fatty acids on meat quality: A review. Meat Sci., 66, 21-32.
11. EFSA Panel on Dietetic Products, Nutrition, and Allergies (NDA); Scientific Opinion on Dietary Reference Values for fats, including saturated fatty acids, polyunsaturated fatty acids, monounsaturated fatty acids, trans fatty acids, and cholesterol. EFSA Journal 2010; 8(3):1461. [107 pp.]. doi:10.2903/j.efsa.2010.1461. Available online: www.efsa.europa.eu
12. Daniela Sumczynski, Zuzana Bubelová, Miroslav Fišera (2015). Determination of chemical, insoluble dietary fibre, neutral-detergent fibre and in vitro digestibility in rice types commercialized in Czech markets. Journal of Food Composition and Analysis, 40, 8–13.
13. FAO. (2003). Food Energy – Methods of analysis and conversion factors. In Report of a technical workshop. FAO Food and Nutrition Paper 77. Rome: FAO.
14. Commission Directive 2008/100/EC, of 28 October 2008 amending Council Directive 90/496/EEC on nutrition labelling for foodstuffs as regards recommended daily allowances, energy conversion factors and definitions. Annex II, Official Journal of the European Union, L285 (2008), pp. 9–12
15. De Vries J. W., The Definition of Dietary Fiber, Cereal Foods World , New York, 2001.

16. Guillon F., Champ M., Thibault J., Dietary fibre functional products, Gibson G. R. and Williams C.M. Cambridge, England, 2000.			
17. Stojanović, T., Psodorov, Đ., Tešanović, D. (2006). Prehrambena vlakna u ljudskoj ishrani kao novi trend savremene gastronomije, Dietary fibers in human nutrition as a new trend in modern gastronomy. Zbornik radova Departmana za geografiju, turizam i hotelijerstvo 35, 231-236.			
18. Englyst, H.N., and Kingman, S.M., Dietary Fiber (Kritchevsky, D., Bonefield, C., and Anderson, J.A., eds.), Plenum Publishing Corporation, New York, 1990, p. 49.			
19. Dapčević Hadnađev, T., Torbica, A., Hadnađev, M., (2013). Influence of Buckwheat Flour and Carboxymethyl Cellulose on Rheological Behaviour and Baking Performance of Gluten-Free Cookie Dough. Food and Bioprocess Technology, 6(7), 1770-1781			
20. Dapčević Hadnađev, T., Dokić, Lj., Hadnađev, M., Pojić, Torbica, A.M. (2014). Rheological and Breadmaking Properties of Wheat Flours Supplemented with Octenyl Succinic Anhydride-Modified Waxy Maize Starches, Food and Bioprocess Technology, 7(1), 235-247			
Number of active teaching: 60			
Lectures: 30	Exercises: 30		
Methods of teaching: lectures, laboratory exercises, case analysis			
Grading (maximum 100 points)			
Pre-Exam commitments	Points	Final Exam	Points
Lectures	5	Exam	60
Practical classes	35		

Neuroscience

Study programmes:	pharmacy, pharmacy – medical biochemistry
Name of subject:	Neuroscience
Subjects status:	compulsory
ECTS:	4
Requirement:	Physiology II
Subjects objective:	The overall goal of the course is to capture the strong interdisciplinary flavor of the contemporary study of the nervous system and to expose students to a variety of neuroscience theory and methods that makeup neuroscience inquiry that leads to better understanding higher courses in neuropharmacology and pain therapy as well as generally clinical neurotherapeutics for neurological, psychiatric and neuropsychiatric disorders. The objectives of this course are to: define the molecular, cellular, and tissue-level organization of the central and peripheral nervous system, understand the properties of cells that make up the nervous system including the propagation of electrical signals used for cellular communication, relate the properties of individual cells to their function in organized neural circuits and systems, understand how the interaction of cells and neural circuits leads to higher-level activities such as cognition and behavior.
Subjects outcome:	When they successfully complete the Neuroscience course, students will: demonstrate knowledge of, and recognize the relationships between the structure and function of molecules and tissues involved in neurobiological systems at all levels: molecular, cellular, and organismal, recognize that all areas of pharmaceutical sciences are integrated and interconnected, acknowledge that the best decision-making is based on evidence.
Subjects content:	<i>Lectures</i> NEUROSCIENCE - Fundamentals of Neuroscience - Introduction

CELLULAR AND MOLECULAR NEUROSCIENCE - Cellular Components of Nervous Tissue Neurons, Specific Examples of Different Neuronal Types, Neuroglia, Cerebral Vasculature, BBB (blood brain barrier), blood-cerebrospinal fluid barrier (B-CSF-B), Subcellular Organization of the Nervous System: Organelles and Their Functions, Axons and Dendrites: Unique Structural Components of Neurons, Protein Synthesis in Nervous Tissue, Cytoskeletons of Neurons and Glial Cells, Molecular Motors in the Nervous System, Building and Maintaining Nervous System Cells, Electrotonic Properties of Axons and Dendrites, Toward a Theory of Neuronal Information Processing, Basic Tools: Cable Theory and Compartmental Models, Spread of Steady-State Signals, Spread of Transient Signals, Electrotonic Properties Underlying Propagation in Axons, Electrotonic Spread in Dendrites, Dynamic Properties of Passive Electrotonic Structure, Membrane Potential and Action Potential, Neurotransmitters, Several Modes of Neuronal Communication Exist, Chemical Transmission, Classical Neurotransmitters, Nonclassical Neurotransmitters, Peptide Transmitters, Unconventional Transmitters, Synaptic Transmission in Perspective, Release of Neurotransmitters, Transmitter Release Is Quantal, Excitation–Secretion Coupling, Molecular Mechanisms of the Nerve Terminal, Quantal Analysis: Probing Synaptic Physiology, Short-Term Synaptic Plasticity, Neurotransmitter Receptors, Ionotropic Receptors, G-Protein Coupled Receptors, Intracellular Signaling, Signaling Through G-Protein-Linked Receptors, Modulation of Neuronal Function by Protein Kinases and Phosphatases, Intracellular Signaling Affects Nuclear Gene Expression, Postsynaptic Potentials and Synaptic Integration, Ionotropic Receptors: Mediators of Fast Excitatory and Inhibitory Synaptic Potentials, Metabotropic Receptors: Mediators of Slow Synaptic Potentials, Integration of Synaptic Potentials, Complex Information Processing in Dendrites, Brain Energy Metabolism

NERVOUS SYSTEM DEVELOPMENT - Neural Induction and Pattern Formation, Cellular Determination, Neurogenesis and Migration, Growth Cones and Axon Pathfinding, Target Selection, Topographic Maps, and Synapse Formation, Programmed Cell Death and Neurotrophic Factors, Synapse Elimination, Dendritic Development, Early Experience and Sensitive Periods

SENSORY SYSTEMS - Fundamentals of Sensory Systems, Chemical Senses: Taste and Olfaction, Somatosensory System, Peripheral Mechanisms of Somatic Sensation, Nociception, Thermo-reception, and Itch, CNS Components of Somatic Sensation, Thalamic Mechanisms of Somatic Sensation, The Path from Nociception to Pain, The Trigeminal System, Cortical Representation of Touch, Audition, Vision

MOTOR SYSTEMS - Fundamentals of Motor Systems, The Spinal and Peripheral Motor System, Descending Control of Movement, The Basal Ganglia, Cerebellum, Eye Movements,

THE HYPOTHALAMUS: An Overview of Regulatory Systems, Central Control of Autonomic Functions: Organization of the Autonomic Nervous System, Neural Regulation of the Cardiovascular System, Neural Control of Breathing, Food Intake and Metabolism, Water Intake and Body Fluids, Neuroendocrine Systems, Circadian Timekeeping, Sleep and Wakefulness, Reward, Motivation, and Addiction

BEHAVIORAL AND COGNITIVE NEUROSCIENCE - Human Brain Evolution, Cognitive Development and Aging, Visual Perception of Objects, Spatial Cognition, Attention, Learning and Memory: Basic Mechanisms, Learning and Memory: Brain Systems, Language and Communication, The Prefrontal Cortex and Executive Brain Functions, The Neuroscience of Consciousness

Practical Classes

Cells of the nervous system - case 1, neuron - case 2, electrical features of the neuron and membrane potential - resting - case 3, myelin sheath and action potential - case 4, neural synapse - case 5, synaptic integration - case 6, neurotransmitters - types - case 7, neurotransmitter receptors - case 8, neuromuscular junction - case 9, neurogenesis - case 10, neuronal migration - case 11, spinothalamic tract - case 12, clinical correlation of neuroscience, nociception - case 13, hypothalamus regulatory functions - case 14, sympathetic nervous system - case 15, parasympathetic nervous system - case 16, sleeping and the limbic system - case 17, clinical correlation of neuroscience – pain, critical thinking, reticular-activating system - case 18, neural respiration control - breathing - case 19, clinical correlation of neurosciences – depression, anxiety and mood disorders - new theories and treatments, practical work - check your knowledge.

Literature:

1. Dale Purves (Editor), George J. Augustine (Editor), David Fitzpatrick (Editor), William C. Hall (Editor), Anthony-Samuel LaMantia (Editor), Richard D. Mooney (Editor), Michael L. Platt (Editor), Neuroscience, Sinauer Associates is an imprint of Oxford University Press; 6 edition (October 12, 2017), ISBN-10: 1605353809, ISBN-13: 978-1605353807

Number of active teaching: 45

Lectures: 30	Exercises: 15		
Methods of teaching: Direct instruction, high tech approach to learning, active learning techniques and methods by using case studies, case series and simulations			
Grading (maximum 100 points)			
Pre-Exam commitments	Points	Final Exam	Points
Lectures	5	Written exam	70
Practical classes	10		
Colloquium	15		

Introduction to Pharmaceutical Technology

Study programmes: pharmacy	
Name of subject: Introduction to Pharmaceutical Technology	
Subjects status: compulsory	
ECTS: 2	
Requirement: none	
Subjects objective: Introducing a concept of a pharmacy, its role and parts of the pharmacy, pharmaceutical regulations. Training in the use of literature. Introducing basic pharmaceutical dosage forms, its characteristics and types, basic principles of formulation, processes in preparation and testing.	
Subjects outcome: Student is familiar with the Rulebook on the form and content of a doctor's prescription, the method of dispensing and prescribing medicines and with the principles of Good Pharmaceutical Practice. Student is familiar with types, characteristics, methods of preparation, pharmaceutical-technological testing and Pharmacopoeia requirements for pharmaceutical dosage forms, basic principles of the formulation and characteristics and usage of auxiliary substances in preparation of pharmaceutical dosage forms.	
Subjects content: <i>Lectures</i> Importance of the subject and general concepts. Importance of Good Pharmaceutical Practice. Pharmaceutical regulations. Usage of literature. Basic principles of a drug development. Types and characteristics of pharmaceutical dosage forms. Magistral and galenic preparations and its testing. Types and roles of auxiliary substances in the formulation of pharmaceutical dosage forms. <i>Practical Classes</i> Pharmaceutical health activity. Good Pharmaceutical Practice. Requirements for the space and the organization of work in a pharmacy. Signification and storage of substances in the pharmacy. Pharmacopoeia (national and international), magistral formulas, manuals, registers of medicines. Types of pharmaceutical dosage forms. Prescription and dispensation of medicines. The prescription and its parts. The dosage and dosage validation. Practical measures and calculations in the pharmacy.	
Literature: 1. British Pharmacopoeia, 2004. 2. Sweetman S.C.: Martindale: The complete drug reference, 36th ed., Pharmaceutical Press, London, Chicago, 2009. 3. Remington G.: The Science and Practice of Pharmacy, Lippincott Williams&Wilkins, New York, 2005. 4. Rang H. P.: Drug Discovery and Development, Churchill Livingstone Elsevier, Edinburg, 2006.	
Number of active teaching: 30	
Lectures: 15	Exercises: 15
Methods of teaching: interactive lectures, practical classes, problem based learning	
Grading (maximum 100 points)	

Pre-Exam commitments	Points	Final Exam	Points
Lectures	5	Written exam	50
Practical classes	45		

Patophysiology

Study programmes:	pharmacy, pharmacy – medical biochemistry		
Name of subject:	Patophysiology		
Subjects status:	compulsory		
ECTS:	5		
Requirement:	Physiology I, Physiology II		
Subjects objective:	<p>The subject should provide students with knowledge about the mechanisms of cell damage tissues and organs, and introduce them to the morphological changes that underlie diseases; enable them to recognize morphological changes in cells, tissues and organs; enable them to meet the etiology, pathogenesis and clinical manifestations of major metabolic disorders and functional disorders of organs and organ systems, the causes and mechanisms of neoplastic cell transformation and growth characteristics of the tumor and the changes it causes in the body.</p>		
Subjects outcome:	<p>After completing the course the student is familiar with basic medical terminology and is able to adequately present the relevant medical facts, understand the etiology and pathogenesis of primary metabolic and functional disorders of organs and organ systems of man, is able to link their clinical manifestations of the causes and mechanisms of their formation and has the pathobiological base for understanding the mechanisms of action of chemical agents and drugs, as well as diagnostic strategy in the case of pathologies.</p>		
Subjects content:	<p><i>Lectures</i> Adaptation, aging, cell death. Morphological changes of the cells. Etiopathogenesis of acute and chronic inflammation. Malignant cell transformation and growth. Disturbance of water and electrolytes. Disturbances of acid-base balance. Etiopathogenesis: malnutrition, obesity, diabetes mellitus, atherosclerosis, cardiovascular dysfunction, respiratory dysfunction, renal dysfunction, dysfunction of the nervous system, dysfunction of the endocrine glands and the neuroendocrine regulation of digestive disorders, disorders of the composition and function of blood, dysfunction skin.</p> <p><i>Practical Classes</i> Cell injury and cell death. Etiopathogenesis of inflammation. Malignant cell transformation and growth. Functional disorder of water, sodium and potassium. Metabolism of calcium, magnesium and phosphate. Etiopathogenesis of diabetes mellitus, atherosclerosis, acid-base balance. Functional disorders of cardiovascular system, respiratory system, kidney function, nerve function, the function of the endocrine glands and neuroendocrine regulation and function of the digestive tract, liver, composition and functions of blood.</p>		
Literature:	<ol style="list-style-type: none"> 1. Hammer GH, Mc Phee JS. Pathophysiology of disease. An Introduction to Clinical Medicine, 7th ed. Lange Medical Books/McGraw-Hill; 2014. 2. Silbernagl S, Lang F. Color Atlas of Pathophysiology, Thieme; 2016. 3. Huether SE., McCance K L. Understanding Pathophysiology, 6th ed. Elsevier Science; 2016. 4. Porth C. Essentials of Pathophysiology: Concepts of Altered States. Lippincott Williams and Wilkins; 2014 		
Number of active teaching:	75		
Lectures:	45	Exercises:	30
Methods of teaching:	Lectures, solving of pathophysiological problems, case studies.		
Grading (maximum 100 points)			
Pre-Exam commitments	Points	Final Exam	Points
Lectures	5	Written exam	60

Practical classes	10		
Colloquium	25		

Medical Biochemistry

Study programmes:	pharmacy
Name of subject:	Medical Biochemistry
Subjects status:	compulsory
ECTS:	5
Requirement:	General Biochemistry
Subjects objective:	Studying and measuring biochemical changes in the state of disease, learning about biochemical concentrations of constituents in the body fluids, metabolism disorders of carbohydrates, proteins, lipids, water, and electrolytes, laboratory testing of organ function, endocrine function and biochemical changes during the disease, the selection of appropriate tests for the diagnosis and interpretation of results.
Subjects outcome:	After passing the exam, students will understand the role of biochemical laboratory in the diagnosis, monitoring and treatment of disease, will distinguish between different types of biological material used in biochemical laboratories, will know the ways of using it, storing and influences of various factors, know the theoretical principles of methods used in biochemical laboratories, as well as factors that influence the choice, will know how to handle the instruments, to understand the clinical significance of determining biochemical parameters, will know how to interpret data of laboratory tests, known to use specialized literature, know how to recognize and solve the problem.
Subjects content:	<p><i>Lectures</i></p> <p>Regulation of carbohydrate metabolism, disorders. Laboratory diagnosis and monitoring of diabetes. Features and functions of the major plasma proteins and changes in concentration. Disorders in protein metabolism. The metabolism of lipids, lipoproteins, apolipoproteins, disorders. Laboratory testing of hyperlipidemia. Biochemical markers and risk factors for atherosclerosis. Regulation of osmolality and volume of body fluids. Disorders in the metabolism of water: dehydration and hyperhydration. Regulation of the electrolyte in the body fluids and electrolyte disorders in metabolism. Acid-base balance and disorders in acid-base balance. Metabolic regulation of Ca, P and Mg metabolism disorders. Iron metabolism, iron serum binding capacity, metabolism disorders. Hemoglobin, hemoglobinopathies, thalassemia. Tests of glomerular and tubular function. Physico-chemical analysis of urine and urine sediment. Creatinine, urea, uric acid levels. Liver function. The metabolism of bilirubin and hyperbilirubinemia. Bile acid and metabolism disorders. The biochemical aspects of liver disease. Investigation of gastrointestinal function. Diagnostic monitoring of enzyme activity. Laboratory findings in disorders of the hypothalamus, pituitary, thyroid, adrenal glands and gonads. Tumor markers</p> <p><i>Practical Classes</i></p> <p>Types and routes of biological material. Biochemical laboratory diagnostic methods: using automatic pipettes; preparation of solutions; execution method of indentifying protein and sugar solutions (fluids) and knowledge of the use of colorimeter measurement of the concentration of the analyte in the test sample (using a standard curve of standard solution or molar absorption coefficient); use centrifuges; biochemical methods for the quantitative determination of glucose, triacylglycerols, cholesterol, creatinine, urea, bilirubin, uric acid, electrolyte concentrations, measurement of enzyme activity in body fluids. Calculating concentration of biochemical parameters. Quantitative determination of serum: glucose, total protein, cholesterol, bilirubin, urea, creatinine. Determination of blood: hemoglobin. Enzymes: determination of acid and alkaline phosphatase, aspartate-aminotransferase and alanine-aminotransferase. Chemical examination of urine. Examination of the urine sediment.</p>
Literature:	<ol style="list-style-type: none"> 1. Baynes JW, Dominiczak MH: Medical Biochemistry, 5th edition, Saunders Elsevier, 2018. 2. Laposata M.: Laposata's Laboratory Medicine Diagnosis of Disease in Clinical Laboratory, 3rd Edition, McGraw Hill, 2019.

Number of active teaching: 90			
Lectures: 45	Exercises: 45		
Methods of teaching: interactive lectures, work in labs, workshops, seminars, discussions, case studies			
Grading (maximum 100 points)			
Pre-Exam commitments	Points	Final Exam	Points
Lectures	5		50
Practical classes	15		
Colloquiums	15+15		

Pharmacology

Study programmes:	pharmacy, pharmacy – medical biochemistry
Name of subject:	Pharmacology
Subjects status:	compulsory
ECTS:	5
Requirement:	Physiology I, Physiology II
Subjects objective:	To provide knowledge about mechanisms of action of drugs, therapeutic and adverse effects of different groups of drugs, dosage, basic pharmacokinetic processes, pharmacodynamic groups of drugs, most significant indications and counterindications, basic principles of preclinical and clinical studies and drug registration.
Subjects outcome:	After completion the exam, a student is expected to be able to identify mechanisms of different effects of drug groups, connect therapeutic and adverse effects of different drug groups with their different pharmacological effects, to know principles of drug dosage, indications, counterindications of different pharmacodynamic groups of drugs, and principles of preclinical and clinical studies.
Subjects content:	<p><i>Lectures</i></p> <p>History of pharmacology. Definition of drug. Drug development and registration of a new drug. Ways of application of drugs. Dosage. LAMDER (liberation, absorption, distribution, metabolism and elimination of drugs and body response to drugs). Mechanisms of action of drugs. Agonists and antagonists. Competitive and non-competitive antagonists. Factors that influence drug effects. Drug interactions. Adverse effects of drugs. Drug addiction. Basics of clinical pharmacology. Pharmacological groups of drugs. Pain and analgetics. Nonsteroidal anti-inflammatory drugs. Pharmacology of antimicrobial drugs. Antiseptics and disinfectants. Chemotherapy of malignant diseases. Immunosuppressants and immunostimulators. Anticoagulant and antiaggregation drugs. Pharmacology of cardiovascular disease. Drugs for therapy of dyslipidemia. Drugs for therapy of obesity. Pharmacology of respiratory tract. Antiallergic drugs. Pharmacology of alimentary tract. Pharmacology of vitamins. Pharmacology of endocrine disorders and diabetes.</p> <p><i>Practical Classes</i></p> <p>Drug development and registration of a new drug. Preclinical and clinical studies. Operating with drug registers and pharmacological data basis on Internet. ATC and JKL classification of drugs. Drug definition. Pharmacological groups of drugs. Drugs prescribed on recipe and <i>over the counter</i> drugs (OTC drugs). Prescription of drugs. Recipe. Recognition and report of adverse drug effects. Recognition of clinically significant drug interactions. Drug dosage of specific groups of patients.</p>
Literature:	1. Rang H. P., Ritter J. M., Flower R. J., Henderson G: Rang and Dale: Pharmacology, 8 th ed., Data Status, Belgrade, 2019.

2. National drug registry, Medicines and Medical Devices Agency of Serbia, Belgrade, 2019.			
Number of active teaching: 105			
Lectures: 60	Exercises: 45		
Methods of teaching: Lectures, practical work - drug/ receipt prescribing, drug registry search, drug data basis, case studies.			
Grading (maximum 100 points)			
Pre-Exam commitments	Points	Final Exam	Points
Lectures	5	Written exam	40
Practical classes	20	Oral exam	15
Colloquium	20		

Pharmacognosy II

Study programmes: pharmacy	
Name of subject: Pharmacognosy II	
Subjects status: compulsory	
ECTS: 4	
Requirement: Botany, Organic Chemistry I	
Subjects objective: The course provides students with knowledge of the most important natural medicinal raw materials (drugs) of importance for medicine and pharmacy including definition and characteristics, identification methods, secondary metabolites, quality, action and application.	
Subjects outcome: After passing the exam, the student is able to: know the biosynthetic origin and chemical structure of natural pharmacologically active ingredients; knows the prevalence of active ingredients in plants; perform qualitative and quantitative analysis of natural active ingredients; conceives and performs the procedure of extraction and separation of compounds of natural origin; knows the natural raw materials used to isolate compounds for the needs of the pharmaceutical industry; defines drugs and their biological source, knows morphological and anatomical characteristics of drugs, knows chemical components of drugs, performs drug identification, performs drug quality testing, knows the possibility of drug use, participates in conceiving, organizing and managing the drug production process and quality assurance.	
Subjects content: <i>Lectures</i> Definition, distribution, localization, biological function, physicochemical properties, structure, proof, determination, extraction, purification, pharmacological activity, application in pharmacy: phenolic compounds, coumarin, lignans, flavonoids, anthocyanins, anthranoids, naphthodiantrons, tannins, saponins, cardiotoxic heterosides, derivatives of phloroglucinol and orcinol, phytosterols, terpene compounds, essential oils, resins, balms, oleoresins. Drugs as sources of these metabolites. Vitamin drugs. Wrapping material. <i>Practical Classes</i> Basic principles of work in the laboratory for pharmacognosy tests. Qualitative and quantitative analysis of plant secondary metabolites.	
Literature: 1. Haensel R., Sticher O.: Pharmakognosie-Phytopharmazie, Springer, Berlin, 2007. 2. Evans W. C.: Trease and Evans' Pharmacognosy, WB Saunders, Edinburgh, 2002.	
Number of active teaching: 60	
Lectures: 30	Exercises: 30
Methods of teaching: Lectures, exercises, discussions	
Grading (maximum 100 points)	

Pre-Exam commitments	Points	Final Exam	Points
Lectures	5	Written exam	70
Practical classes	25		

Pharmaceutical Organic Chemistry II

Study programmes: pharmacy			
Name of subject: Pharmaceutical Organic Chemistry II			
Subjects status: compulsory			
ECTS: 5			
Requirement: Organic Chemistry II			
Subjects objective: Acquiring knowledge from the aspect of chemistry about pharmaceutically active compounds of organic origin that have application in the therapy of diseases of the cardiovascular, nervous, respiratory and gastrointestinal tract, etc.			
Subjects outcome: Knowledge of drug chemistry: physico-chemical properties of drugs, chemical characterization and classification of drugs, structure-activity relationship, the relationship between the structure and mechanism of action of drugs.			
Subjects content: <i>Lectures</i> Drugs in the treatment of diseases of the cardiovascular system: antihypertensives, antiarrhythmics, antithrombotic drugs, drugs in the treatment of angina pectoris, drugs in the treatment of heart failure. Antihyperlipidemics. Drugs in the treatment of diseases of the nervous system: antipsychotics, anxiolytics, antidepressants, antimigraines, antiepileptics, analeptics, hypnotics, etc. Drugs in the treatment of diseases of the gastrointestinal system: antiemetics, gastroprokinetics. Sympathomimetics and sympatholytics. Parasympathomimetics and parasympatholytics. Histamine receptor antagonists. Nonsteroidal anti-inflammatory drugs. Opioid analgesics. General and local anesthetics. Antitussives and expectorants. <i>Practical Classes</i> Synthesis of pharmacologically active compounds: problem setting, synthesis, isolation, purification, identification. Qualitative analysis of compounds of organic origin. Identification of pharmaceutically active compounds using spectroscopic methods (infrared spectroscopy, nuclear magnetic resonance, mass spectrometry). Interpretation of IR, NMR and MS spectra of pharmaceutically active compounds.			
Literature: 1. Williams D. A., Lemke T. L.: Foye's Principles of Medicinal Chemistry, 8 th ed., Lippincott Williams & Wilkins, Baltimore, 2019. 2. Wilson E. Gisvold J. B.: Textbook of Organic Medicinal and Pharmaceutical Chemistry, 12 th Lippincott Company London, Philadelphia, 2011. 3. Graham P, An introduction to medicinal chemistry, fifth edition. Oxford university press; 2013. Wermuth C, Aldous D, Raboisson P and Rognan D, 4. The Practice of Medicinal Chemistry, 4th Edition. Academic Press, London, 2015.			
Number of active teaching: 90			
Lectures: 45	Exercises: 45		
Methods of teaching: Lectures, exercises, discussions			
Grading (maximum 100 points)			
Pre-Exam commitments	Points	Final Exam	Points
Lectures	5	Written exam	70
Practical classes	25		

Endocrinology

Study programmes: pharmacy, pharmacy – medical biochemistry			
Name of subject: Endocrinology			
Subjects status: compulsory			
ECTS: 3			
Requirement: none			
Subjects objective: Familiarity with the role and function of the endocrine system, regulatory mechanisms in maintaining energy balance, diseases of glands with internal secretion, diagnostic and therapeutic procedures. In the diagnostic part, special attention is paid to laboratory analyzes and tests in endocrinology, proper sampling of body fluids, interpretation of results and possible influence of substances on the results of analyzes. Endocrine therapy involves the mechanism of action of drugs and therapeutic procedures.			
Subjects outcome: Mastering the basics of pathophysiology of endocrinological diseases, diagnostics and therapy. Student masters diagnostic procedures in endocrinology, is able to recognize endocrinological diseases, understand the importance of precision diagnostics and proper therapy in endocrinology.			
Subjects content: <i>Lectures</i> Regulatory mechanisms in endocrinology; Pituitary diseases; Thyroid and parathyroid diseases; Adrenal disease; Obesity; Diabetes; Common diseases of the reproductive system; Osteoporosis. <i>Practical classes</i> Functional diagnostics tests of the endocrine system; Preparation of Patients for Sampling of Body Fluids for Diagnosis of Endocrine Disease, Case Studies			
Literature: 1. Greenspan's Basic & Clinical endocrinology. Eight edition. 2007.			
Number of active teaching: 45			
Lectures: 30	Exercises: 15		
Methods of teaching: Presentation prepared by lecturers and students, interactive teaching, panel discussion, test			
Grading (maximum 100 points)			
Pre-Exam commitments	Points	Final Exam	Points
Lectures	5		70
Practical classes	25		

Neuropharmacology

Study programmes: pharmacy, pharmacy – medical biochemistry			
Name of subject: Neuropharmacology			
Subjects status: compulsory			
ECTS: 4			
Requirement: Neuroscience			
Subjects objective: To provide knowledge about mechanisms of action of drugs used in treatment of nervous system disease, therapeutic pharmacological and non-pharmacological approach in the therapy of anxiety, insomnia, depression, psychosis, neurodegenerative disease, interactions and adverse effects of these groups of drugs.			
Subjects outcome:			

<p>After completion the exam, a student is expected to be able to identify mechanisms of different effects of drug groups used in the treatment of nervous system disease, connect therapeutic and adverse effects of different groups of neuropsychopharmacological drugs with their different pharmacological effects, to know principles of drug dosage, indications, counterindications of different groups of neuropsychopharmacological drugs.</p>			
<p>Subjects content:</p> <p><i>Lectures</i></p> <p>Basic neuropharmacology, neurotransmitters, receptors. Pharmacology of vegetative nervous system. Acetylcholine. Biogenic amines. Amino acids as neurotransmitters. Anxiolytics, hypnotics. General and local anesthetics. Antidepressants. Antipsychotics. Neurodegenerative disease. Drugs in the therapy of Parkinson`s and Alzheimer`s disease. Central and peripheral pain. Strong and weak opioids. Hallucinogens. Psychostimulants. Болести Addictive disorders. Inflammatory brain disease.</p> <p><i>Practical Classes</i></p> <p>Operating with drug registers and pharmacological data basis on Internet. Prescription of drugs used in treatment of nervous system disease. Recognition and report of adverse drug effects. Recognition of clinically significant interactions of neuropsychopharmacological drugs.</p>			
<p>Literature:</p> <p>1. Rang H. P., Ritter J. M., Flower R. J., Henderson G: Rang and Dale: Pharmacology, 8th ed., Data Status, Belgrade, 2019.</p> <p>2. National drug registry, Medicines and Medical Devices Agency of Serbia, Belgrade, 2019.</p>			
<p>Number of active teaching: 60</p>			
<p>Lectures: 30</p>	<p>Exercises: 30</p>		
<p>Methods of teaching:</p> <p>Lectures, practical work - drug/ receipt prescribing, drug registry search, drug data basis, case studies.</p>			
<p>Grading (maximum 100 points)</p>			
<p>Pre-Exam commitments</p>	<p>Points</p>	<p>Final Exam</p>	<p>Points</p>
<p>Lectures</p>	<p>5</p>	<p>Written exam</p>	<p>70</p>
<p>Practical classes</p>	<p>25</p>		

Pharmaceutical Technology I

<p>Study programmes: pharmacy</p>
<p>Name of subject: Pharmaceutical Technology I</p>
<p>Subjects status: compulsory</p>
<p>ECTS: 8</p>
<p>Requirement: Introduction to Pharmaceutical Technology</p>
<p>Subjects objective:</p> <p>Introducing student with the role and importance of excipients specific for different types of pharmaceutical forms; learning about the basic principles of formulation, technological processes in manufacturing and testing of pharmaceutical forms such as powders, liquid pharmaceutical forms such as solutions, suspensions, emulsions, semi-solid pharmaceutical forms such as ointments, gels, creams, pastes, and homeopathic preparations; training for the preparation of magistral and galenic preparations and their testing.</p>
<p>Subjects outcome:</p> <p>Student is trained to: know types, characteristics, methods of production, pharmaceutical and technological tests and Pharmacopoeia requirements for pharmaceutical forms powders, liquid forms for external and internal use - solutions, suspensions, emulsions, semi-solid forms - ointments, gels, creams, pastes and homeopathic preparations; know the types, characteristics and use of excipients for the manufacture of pharmaceutical forms; be able to propose an appropriate pharmaceutical form and to inform patients, based on the acquired knowledge.</p>
<p>Subjects content:</p> <p><i>Lectures</i></p>

<p>Definition of the subject, importance and general concepts. Types and roles of excipients in the formulation of pharmaceutical dosage forms. Types, characteristics, preparation and testing of powders, solutions, suspensions, emulsions, ointments, gels, creams, pastes and homeopathic preparations. Rheological properties of pharmaceutical dosage forms.</p> <p><i>Practical Classes</i></p> <p>Getting to know the rules of preparation, dosage, dosage validation, packaging, storage, dispensing of medicines and testing of pharmaceutical forms - powders, solutions, suspensions, emulsions, ointments, gels, creams, pastes and homeopathic preparations.</p>			
<p>Literature:</p> <ol style="list-style-type: none"> 1. British Pharmacopoeia, 2004. 2. Sweetman S.C.: Martindale: The complete drug reference, 36th ed., Pharmaceutical Press, London, Chicago, 2009. 3. Remington G.: The Science and Practice of Pharmacy, Lippincott Williams&Wilkins, New York, 2005. 4. Allen L. V., Popovich N. G., Ansel H. C.: Ansel's Pharmaceutical Dosage Forms and Drug Delivery Systems, 9th ed., Lippincott Williams &Wilkins, Philadelphia, 2011. 5. Rang H. P.: Drug Discovery and Development, Churchill Livingstone Elsevier, Edinburg, 2006. 			
Number of active teaching: 165			
Lectures: 75	Exercises: 90		
<p>Methods of teaching:</p> <p>interactive lectures, practical classes, problem-based learning, case study</p>			
Grading (maximum 100 points)			
Pre-Exam commitments	Points	Final Exam	Points
Lectures	5	Written exam	50
Practical classes	15		
Colloquiums	15+15		

Oncology Pharmacy

Study programmes: pharmacy, pharmacy - medical biochemistry	
Name of subject: Oncology Pharmacy	
Subjects status: compulsory	
ECTS:	3
Requirement:	none
<p>Subjects objective:</p> <p>To provide knowledge about the pathophysiology and molecular biology of common types of cancer in the society, to understand their classification and diagnosis. To give the student generalist knowledge to evidence based, patient-centered medication therapy and treatment methods. Oncology pharmacy course is designed to cover the basic principles of therapeutics used in cancer therapy. To provide the student with the knowledge to be able to prevent/reduce drug interactions and side effects and to provide an effective service, to be able to understand supportive treatment/care options and use this knowledge in practice in fields of personalized oncology and predictive molecular diagnostics.</p>	
<p>Subjects outcome:</p> <p>After passing the exam, the student understands the pathological changes of the common types of cancer in the society, is able to use clinical pharmacy skills in oncology pharmacy; understands treatment methods; optimizes oncology pharmaceutical care and is able to influence clinical outcomes for cancer patients.</p>	
<p>Subjects content:</p> <p><i>Lectures</i></p>	

Cancer biology: Molecular and genetic basis. Bladder cancer. Breast cancer. Colon and rectal cancer. Endometrial cancer. Kidney cancer. Leukemia. Liver and lung cancer. Melanoma. Non-Hodgkin Lymphoma. Pancreatic cancer. Prostate cancer. Thyroid cancer. Formulations and pharmacokinetics of antineoplastic drugs.			
<i>Practical Classes</i>			
Working on case studies and concrete examples. Problem based learning and problem solving. Role of oncology pharmacist in identification of clinical features and management of common types of cancer.			
Literature:			
1.Emadi A., Karp J. Cancer Pharmacology, Springer 2019.			
2.Polovich M., Olsen M., Safe Handling of Hazardous Drugs, Oncology Nursing Society, 2018.			
Number of active teaching: 30			
Lectures: 15	Exercises: 15		
Methods of teaching:			
interactive lectures, practical classes, analysis and problem solving.			
Grading (maximum 100 points)			
Pre-Exam commitments	Points	Final Exam	Points
Lectures	5	Written exam	60
Practical classes	35		

Dietetics

Study programmes: pharmacy, pharmacy – medical biochemistry
Name of subject: Dietetics
Subjects status: compulsory
ECTS: 3
Requirement: Bromatology
Subjects objective:
Objectives are to teach the student about the parameters of health for a person or a group, specific nutritive needs of various ages of people, specific status of the body and for patients with some disease and guidances and recommendations for creating the proper dietetic regime.
Subjects outcome:
Student will be able to give advices about proper nutrition for various ages, persons with specific needs and those with some diseases, to recognize and advice about different diets, to recognize and advice about nutritive disorders.
Subjects content:
<i>Lectures</i>
Importance, role and types of nutrients, RDA and DRI values. Different categories of food. Rationale nutrition principles and methods to realize them. Guidances for proper combining of food and their recommended daily intake. Energy needs. Balanced diet designing. Dietary regime recommended for lowering the risk and/or co-treatment of the disease. Alergies and food intolerances. Nutritive disorders (anorexia, bulimia). Basis of nutrition epidemiology. Actual legislation. The role of the pharmacists in giving informations about proper nutrition.
<i>Practical Classes</i>
Nutrition assessment. Practical calculation of energy requirements, macronutrient content in total daily energy consumption. Established macro- and micro- nutrient needs. Examples of usage of food composition tables. Calculation of food energy value. Preparation of diet diary and analysis regarding energy value and frequencies of certain nutriments. Formulation of balanced diet for defined person. Practice communication with patients in order to get specific needs and creating the proper advices about the nutrition. Practice communication with patients in simulated situations which requires support for a particular diet: pregnancy, breastfeeding, infant nutrition, dyslipidemia, diabetes, cancer, gastrointestinal diseases, kidney diseases. Discussion about organic and genetically modified and novel food. Introduction of legislation and legal obligations.

Literature:			
1. Brown JE (editor): Nutrition through the life cycle, 4 th ed., Wadsworth Belmont, USA, 2011.			
2. Ross AC, Caballero B, Cousins RJ, Tucker KL, Ziegler TR: Modern Nutrition in health and disease, 11 th ed., Lippincott Williams & Wilkins, Baltimore, Philadelphia, USA, 2014.			
3. Paliyath G, Bakovic M, Shetty K: Functional foods, nutraceuticals, and degenerative disease prevention, Wiley-Blackwell, John Wiley & Sons Ltd, London, UK, 2011.			
4. Escott-Stump S. Nutrition and diagnosis-related care, 6 th ed., Wolters Kluwer/Lippincott Williams & Wilkins, Baltimore, SAD, 2008.			
5. Mahan LK, Escott-Stump S. Krause's food & nutrition therapy, International edit., 12 nd ed., Saunders, Elsevier Inc. SAD, 2008.			
Number of active teaching: 45			
Lectures: 30	Exercises: 15		
Methods of teaching: interactive lectures, practical classes, analysis and problem solving.			
Grading (maximum 100 points)			
Pre-Exam commitments	Points	Final Exam	Points
Lectures	5	Written exam	65
Practical classes	30		

Professional Development and Career Planning 2

Study programme:	pharmacy, pharmacy – medical biochemistry
Name of subject:	Professional Development and Career Planning 2
Subject status:	compulsory
ECTS credits:	3
Prerequisite:	none
Course goals and objectives:	The goals of the course is to acquaint students with the challenges that accompany the career of a pharmacist, the need for lifelong learning and the development of competencies in accordance with the areas of work and career development. Development of awareness of professional responsibility of pharmacists. Development of student's self-awareness as a future pharmacist. Enabling students for self/critical self/assessment of knowledge and skills, as well as the development of attitudes and affinities towards certain areas of pharmacists' work. The student gets acquainted with the professional challenges of pharmacists in health care and beyond. Encouraging students to think critically, actively, creatively, and systematically manage their professional orientation and career development.
Course outcome:	A student is introduced to different areas of work of pharmacists in health care, science, education and economy; the student adopts the postulate of learning as a lifelong student and teacher. The student is trained to effectively and independently identify their own competencies as strengths or areas for improvement and reflection on professional orientation and development. The student continuously develops his/her own portfolio based on professional values and standards. The student acquires the skills to assess their professional affinities and manage their own career development. Students connect the acquired theoretical knowledge with professional development skills.
Course content:	<p><i>Theory</i></p> <p>Transformation of the role of pharmacists in society. The traditional and new role of pharmacists in society. World Federation of Pharmacists / World Health Organization: Eight-Star Pharmacists. Professional challenges in pharmacy - changes in society, science, economy. Innovative approaches in pharmacy - new molecules, new technologies, new markets, new knowledge. Development of a proactive approach in pharmacy.</p> <p>Motivation for learning and professional development. Motivation theories. Self-actualization and profession. Korthagen model and development of professional identity.</p> <p>Experiences from the practice of pharmacists in the fields of health care, clinical research, production, wholesale and marketing of drugs: requirements and challenges facing pharmacists. Leadership and entrepreneurship development in the pharmaceutical industry.</p> <p>Collaborative and interdisciplinary practice.</p> <p><i>Practical classes</i></p>

Analysis of examples from practice, panel discussions, homework on a given topic: portfolio analysis; assessment and self-assessment competence. Cooperation with representatives of pharmaceutical representative offices, industry, wholesalers, private pharmacy practices, hospital pharmacists.			
Literature: 1. Remington: The Science and Practice of Pharmacy, 21th ed., Lippincott Williams and Wilkins, London, 2006. 2. Pharmaceutical Chamber of Serbia. National document for the assessment of pharmacists' competence. Available at: http://www.farmkom.rs/images/stories/dokumenta/onama/ostala_dokumenta/nacionalni-okviri-za-procenu-kompetencija-farmaceuta-final.pdf			
Number of active teaching: 15			
Lectures: 15	Exercises: 0		
Applicable teaching methods: Interactive lectures, practice, discussions.			
Grade scheme (maximum points 100)			
Pre-exam requirements	Points	Final exam	Points
Lectures	5	exam	50
Practical classes	15		
Colloquium	20		
Seminar	10		

Drug Analysis and Quality Control

Study programmes:	pharmacy
Name of subject:	Drug Analysis and Quality Control
Subjects status:	compulsory
ECTS:	6
Requirement:	Analytical Chemistry, Instrumental Pharmaceutical Analysis
Subjects objective:	Advancement of knowledge in the fields of analytical chemistry and instrumental pharmaceutical analysis and its application in the analysis of raw materials and end products. Introduction to the common laws and regulations which govern the drug analysis and their application. Knowledge development pertinent to the analysis and the quality control of the drugs. Development of skills necessary for independent laboratory work and data analysis through creation and application of Standard Operating Procedures (SOPs), laboratory instructions and analytical methods.
Subjects outcome:	Upon the completion of the subject students will be able to: Apply analytical knowledge and principles of the Good Laboratory Practice (GLP) of the routine pharmaceutical analysis within the laboratory for the quality control of drugs; Regularly follow the changes and apply the knowledge related to the regulatory aspects of the drug quality control; Suggest, develop and validate methods for the analysis of pharmaceutically important materials; Decide on the quality of the analysed product based on the its manufacturing specification.
Subjects content:	<p><i>Lectures</i></p> <p>Regulatory aspects pertained to drug registration. Total Quality Management (TQM), Current Good Manufacturing Practice (cGMP), Good Laboratory Practice (GLP), Quality Assurance (QA), Quality Control (QC). ICH, FDA, MHRA, USP, BP and Ph EUR method validation requirements and compliance. Standard Operating Procedures (SOPs), Working procedures I analytical methods in pharmaceutical analysis and quality control. Use of statistical methods in pharmaceutical analysis and quality control. Sampling and preparation of the representative sample for the analysis. Application of chemical, instrumental and none-instrumental methods in pharmaceutical analysis. Official methods used for qualitative and quantitative pharmaceutical analysis in quality control of raw materials and end products. Impurities, their origin in pharmaceutical products, classification and assessment. Methods of sample extraction used in pharmaceutical analysis. Titrations (acid-base, argentometric, iodometric, redox, complexometric and precipitation titrations), gravimetric, spectroscopic (UV/VIS, IC) separation (HPLC, GC and TLC), thermal methods. Physico-chemical profile of pharmaceutical compounds. Routine analysis according to official monographs of raw materials and end products. Biological and microbiological assessments. Stability assessment of the end products.</p>

Practical Classes

Assessment and control of the raw materials according to official pharmacopoeial methods and internally validated methods. Application of quantitative UV/VIS spectroscopic and titrimetric methods (acid-base, argentometric, iodometric, redox, complexometric and precipitation titrations) in pharmaceutical analysis. Quantitative assessment of precipitates by gravimetric analysis. Melting point determination in the identification of raw materials and purity assessments. Extraction methods: liquid-liquid extraction, liquid-solid extraction. Thin Layer Chromatography (TLC), determination of the quantity of impurities. Gas Chromatography (GC), detection and quantification of residual solvents and preservatives in pharmaceutical products. Assay of active substance and degradation products using HPLC. Analytical method development – influence of different chromatographic parameters on the separation of compounds in complex mixtures.

Literature:

1. European Pharmacopoeia, European Directorate for the Quality of Medicine and Health Care, 10th ed., Strasbourg, 2019.
2. British Pharmacopoeia, The British Pharmacopoeia Secretariat, London, 2020.
3. Pedersen-Bjergaard S. Gammelgaard B., Halvorsen T. G.: Introduction to Pharmaceutical Analytical Chemistry, 2nd ed., John Wiley & Sons, 2019.
4. Watson David G.: Pharmaceutical Analysis: A Textbook for Pharmacy Students and Pharmaceutical Chemists. 4th ed., Elsevier, Edinburgh, 2016.
5. Davani B.: Pharmaceutical Analysis for Small Molecules, John Wiley & Sons, 2017.

Number of active teaching: 105

Lectures: 60

Exercises: 45

Methods of teaching:

interactive lectures, laboratory exercises, e-learning, computer simulation

Grading (maximum 100 points)

Pre-Exam commitments	Points	Final Exam	Points
Lectures	5	Written exam	60
Practical classes	35		

Phytotherapy

Study programmes:	pharmacy
Name of subject:	Phytotherapy
Subjects status:	compulsory
ECTS:	4
Requirement:	Pharmacognosy I, Pharmacognosy II
Subjects objective:	Providing knowledge about place and role of phytotherapy in primary health care system and self-medication, herbal remedies (active components are herbal drugs or preparations of herbal drugs), validity of their use for recovery, preservation and improvement of health.
Subjects outcome:	Student should know principles of rational phytotherapy, active components of herbal remedies and mechanisms of action of active ingredients, carry out procedures for provision and control of quality of active ingredients and herbal remedies, suggest active component(s) of herbal remedies, build a critical attitude towards certain herbal remedies, evaluate benefit/harm ration of herbal remedies, know indications, contraindications, adverse effects and interactions of herbal medicines, provide valid information and patient counseling about usage of herbal medicines.
Subjects content:	<i>Lectures</i> General part. Definition of term Phytotherapy and usage of herbal medicines through rational and traditional phytotherapy, herbalism and homeopathy. Definition of self-medication and role and importance of herbal medicines. Definition of herbal medicines and informing about relevant laws and regulations. Types of herbal medicines. Provision of quality of herbal medicines. Basic information about other relevant herbal products in medicine and pharmacy (dietary and cosmetic products). Special part. Safe application of herbal medicines: indications, dosage,

<p>contraindications, adverse effects, precautions, tips, interactions. Herbal medicines appliance to the functional disorders and diseases of central nervous system, cardiovascular system, respiratory, gastrointestinal, genitourinary tract, skin and mucosa, metabolism disorders. Herbal medicines with immunomodulatory, adaptogenic, anti-inflammatory, antimicrobial, antioxidant and citostatic activity.</p> <p><i>Practical classes</i></p> <p>Analysis and control of the quality of herbal medicines: analysis of tea mixtures, identification and analysis of active components of herbal medicines. Analysis of instruction for usage of herbal medicines. Case study analysis.</p>			
<p>Literature:</p> <ol style="list-style-type: none"> 1. Conway Peter, The Consultation in Phytotherapy, Churchill Livingstone, Elsevier, 2010. 2. Schulz V., Haensel R., Tyler V. E.: Rational Phytotherapy, Springer, Berlin, 2001. 3. Blumenthal M. (ed.): The ABC Clinical Guide to Herbs, American Botanical Council, Austin, 2003. 4. ESCOP Monographs, Georg Thieme Verlag, Stuttgart, 2003. 5. Heinrich M, Barnes J, Gibbons S.: Williamson E. Fundamentals of Pharmacognosy and Phytotherapy, Churchill Livingstone, Edinburgh, 2004. 			
Number of active teaching: 60			
Lectures: 30	Exercises: 30		
<p>Methods of teaching: lectures, analysis of case studies, practical classes.</p>			
Grading (maximum 100 points)			
Pre-Exam commitments	Points	Final Exam	Points
Lectures	5	Written exam	70
Practical classes	25		

Pharmacokinetics with Pharmacodynamics

Study programmes:	pharmacy, pharmacy – medical biochemistry
Name of subject:	Pharmacokinetics with Pharmacodynamics
Subjects status:	compulsory
ECTS:	4
Requirement:	Pharmacology
Subjects objective:	To understand kinetic processes on drugs throughout body, pharmacokinetic data analysis and importance of pharmacokinetic parameters in defining and/or correction of dosing regimen of drugs with the aim of rational pharmacotherapy.
Subjects outcome:	After completion of the exam it is expected that a student knows pharmacokinetic processes and factors that influence these processes, knows different approaches in pharmacokinetic data analysis, estimates/calculates pharmacokinetic parameters after single and multiple doses, knows factors that influence variability of therapeutic response, knows methods for analysis of bioavailability and bioequivalence of drugs, estimates need for drug therapy monitoring, interpret measured drug concentrations, knows and applies principles of clinical pharmacokinetics.
Subjects content:	<p><i>Lectures</i></p> <p>General pharmacokinetics (pharmacokinetic processes on drugs throughout body, resorption, distribution, metabolism and elimination – ADME system). Pharmacokinetic data analysis from plasma and calculating pharmacokinetic parameters (i.v. and e.v. application of drug – one- and two-compartment model; non-compartment – model independent; population analysis; pharmacokinetic-pharmacodynamic modeling and other analysis; repeated doses – steady state). Preparations with modified liberation of drug – depot preparations. Bioavailability and bioequivalence of drugs. Clinical pharmacokinetics - factors that lead to pharmacokinetic variability; principles of clinical pharmacokinetics. Drug safety – interactions and adverse effects of drugs, pharmacovigilance.</p> <p><i>Practical Classes</i></p>

Pharmacokinetic data analysis and calculating pharmacokinetic parameters (half-time elimination, constant of elimination, volume of distribution, clearance, biological availability, steady-state concentration). Graphic analysis of pharmacokinetic parameters. Basics of clinical pharmacokinetics. Clinical cases.			
Literature:			
1. Rang H. P., Ritter J. M., Flower R. J., Henderson G: Rang and Dale: Pharmacology, 8 th ed., Data Status, Belgrade, 2019.			
2. Sims PJ. Applied Pharmacokinetics & Pharmacodynamics Principles of Therapeutic Drug Monitoring. American Journal of Pharmaceutical Education, 2006.			
Number of active teaching: 60			
Lectures: 30	Exercises: 30		
Methods of teaching:			
Lectures, case studies.			
Grading (maximum 100 points)			
Pre-Exam commitments	Points	Final Exam	Points
Lectures	5	Written exam	70
Practical classes	25		

Pharmaceutical Technology II

Study programmes: pharmacy
Name of subject: Pharmaceutical Technology II
Subjects status: compulsory
ECTS: 5
Requirement: Pharmaceutical Technology I
Subjects objective:
Introducing the types, composition and properties of conventional and new dosage forms for oral (capsules, tablets), parenteral (injections, infusions, concentrates, implants), ophthalmological, rectal and vaginal use, pharmaceutical forms for inhalation, modified release formulations of the drugs, therapeutic systems. Learning about new trends in the formulation of biotechnological drugs, technological processing methods, pharmacopoeia requirements, auxiliary substances and colloidal carriers of active substances. Training in the use of literature, writing reports of the characteristics of the tested drug.
Subjects outcome:
It is expected that the student knows the types, composition, formulation, technological processing methods and means of storage (storage conditions) of solid pharmaceutical dosage forms, parenteral preparations, pharmaceutical forms for ophthalmological, rectal and vaginal use, preparations for inhalation, modified release formulations of the drugs. The student can provide information to the patient, analyze and interpret the results and has skills to formulate dosage forms and to recognize basic auxiliary substances in pharmaceutical practice.
Subjects content:
<i>Lectures</i>
Sterilization and sterilization methods. Isotonic solutions. Parenteral and ophthalmological preparations. Immunobiological preparations (serums and vaccines). Radiopharmaceutical preparations. Solutions for hemodialysis and peritoneal dialysis. Preparations for inhalation, capsules, tablets, preparations for rectal and vaginal use. Modified release formulations of drugs for oral and parenteral application. Preparations with proteins and other biotechnological active substances. Therapeutic systems for ophthalmological, intrauterine or intra-vaginal, oral, parenteral, pulmonary, buccal, nasal and transdermal application. Therapeutic systems with targeted drug release. Colloidal drug carriers.
<i>Practical Classes</i>
Sterile medical preparations, sterilization, methods. Getting to know the terms of the aseptic process of preparing a pharmaceutical form. Preparation and pharmaceutical-technological testing of parenteral and ophthalmological preparations. Preparations for inhalation, demonstration of application. Pharmaceutical-technological testing of:

capsules, tablets. Preparation and pharmaceutical-technological testing of suppositories, pessaries. Modified release preparations. Therapeutic systems.			
Literature:			
1. British Pharmacopoeia, 2004.			
2. Sweetman S.C.: Martindale: The complete drug reference, 36th ed., Pharmaceutical Press, London, Chicago, 2009.			
3. Allen L. V., Popovich N. G., Ansel H. C.: Ansel's Pharmaceutical Dosage Forms and Drug Delivery Systems, 9th ed., Lippincot Williams &Wilkins, Phyladelphia, 2011.			
4. Crommelin D. J. A., Sindelar R. D.: Pharmaceutical Biotechnology: Fundamentals and applications, 3rd ed., Informa Healthcare, New York, London, 2008.			
Number of active teaching: 105			
Lectures: 60	Exercises: 45		
Methods of teaching:			
interactive lectures, practical classes, problem-based learning			
Grading (maximum 100 points)			
Pre-Exam commitments	Points	Final Exam	Points
Lectures	5	Written exam	50
Practical classes	15		
Colloquiums	15+15		

Pharmacotherapy of Pain

Study programes:	pharmacy, pharmacy - medical biochemistry
Name of subject:	Pharmacotherapy of Pain
Subjects status:	compulsory
ECTS:	3
Requirement:	Pharmacology
Subjects objective:	The course aims to develop the knowledge about neurophysiology of pain, explain the pathogenesis of pain, including hyperalgesia, peripheral sensitization, and central sensitization and pain syndromes classification (e.g., acute, subacute, chronic, nociceptive, nociplastic, neuropathic, inflammatory, central, or mixed). To provide the student with a sufficient understanding of the pharmacology of non-opioid, adjuvant, and opioid analgesics at a level to provide instruction to the patient. Students will be introduced to the evidence-based use of rational pharmacotherapy for individual pain syndromes based on patient-specific, drug-specific, and environmental-specific variables.
Subjects outcome:	After passing the exam, the student understands the neurophysiology of pain, the multidimensional nature of pain, and pain classification. The student is familiarized with the most common painful conditions and understands their etiology and therapy. Upon course completion students have developed the optimal level of education on pain, its assessment, and management with a particular focus on pharmacological interventions. The student understands the role and responsibility of the pharmacist in promoting the safe and effective use of analgesic medicines.
Subjects content:	<p><i>Lectures</i></p> <p>Definitions of Pain. Types of pain. Pain nomenclature. Epidemiology of pain. Multidimensional nature of pain. Neuroanatomy and neurophysiology relevant to nociception and pain. Pharmacology of nociception and pain transmission. Pain Assessment and Measurement. Pharmacological interventions for pain. Acute pain. Postoperative pain. Persistent non-cancer pain. Musculoskeletal pain. Headache. Neuropathic pain. Cancer pain. HIV-associated pain. Choice of analgesia in renal and hepatic impairment. Pain and analgesia in pregnancy, labor, and breast feeding.</p> <p><i>Practical Classes</i></p> <p>Working on case studies and concrete examples. Critical thinking and analysis, problem solving, scientific inquiry, self-directed learning and the effective use of modern technology for professional practice. Role of pharmacist in promoting the safe and effective use of analgesic medicines.</p>

Literature:			
1. Argoff C. Dubin A. Pilitsis J. Pain management secrets. Elsevier 2018.			
2. DiPiro J., Yee G., Posey M.L., Haines S., Nolin T., Ellingrod V. Pharmacotherapy: A Pathophysiologic Approach, 11th Edition New York; Toronto: McGraw-Hill Medical. 2020.			
Number of active teaching: 30			
Lectures: 15	Exercises: 15		
Methods of teaching: interactive lectures, practical classes, analysis and problem solving			
Grading (maximum 100 points)			
Pre-Exam commitments	Points	Final Exam	Points
Lectures	5		70
Practical classes	25		

Pharmacotherapy I

Study programmes: pharmacy
Name of subject: Pharmacotherapy I
Subjects status: compulsory
ECTS: 4
Requirement: Pharmacology
Subjects objective: The course aims to integrate previously acquired knowledge about the symptoms, pathogenesis, and etiology of various diseases and to understand the basis for selecting appropriate pharmacotherapeutic options. The course aims to develop knowledge, competencies, and skills for making clinical decisions to support the efficient and safe use of drugs in therapy. To enable the student to identify therapeutic problems that occur as a consequence of the use of a large number of drugs (polypharmacy), as well as a critical evaluation of information about drugs.
Subjects outcome: After passing the course, the student understands the relation between symptoms, pathogenesis, and etiology on the choice of drug/drugs and pharmacotherapeutic approach. The student can understand, analyze, evaluate, and integrate drug information to make rational, responsible, and ethical pharmacotherapeutic decisions. The student understands the importance of providing evidence-based information to patients and healthcare professionals and is aware of the importance of lifelong learning to improve their knowledge and skills. The student can compare the therapeutic benefit and risks of using certain drugs in the treatment of the same diseases.
Subjects content: <i>Lectures</i> Pharmacotherapy of cardiovascular diseases: Therapy of arterial hypertension. Therapy of hyperlipidemia and dyslipidemia. Therapy of ischemic heart disease. Therapy of cardiac arrhythmias. Therapy of heart failure. Thrombosis therapy. Therapy of anemia. Pharmacotherapy of respiratory system diseases: Pharmacotherapy of asthma. Pharmacotherapy of chronic obstructive pulmonary disease. Pharmacotherapy of upper respiratory tract infections. Pharmacotherapy of allergic rhinitis. Pharmacotherapy of tuberculosis and pneumonia. Pharmacotherapy of diseases of the gastrointestinal system: Pharmacotherapy of peptic ulcer and gastroesophageal disease. Pharmacotherapy of inflammatory bowel disease, nausea, vomiting, diarrhea, and constipation. Pharmacotherapy of diseases of the musculoskeletal system: Pharmacotherapy of osteoporosis. Pharmacotherapy of rheumatic diseases. <i>Practical Classes</i> Work on case studies and concrete examples from clinical practice. Critical thinking and analysis, problem-solving, scientific research, self-directed learning, and efficient use of modern technology in professional practice. The role of pharmacists in rational pharmacotherapy.
Literature: 1. Veličković-Radovanović R. Pharmacotherapy. Galaxy and the Faculty of Medicine Niš. Niš, 2011 2. DiPiro J., Yee G., Posey M.L., Haines S., Nolin T., Ellingrod V. Pharmacotherapy: A Pathophysiologic Approach, 11th Edition New York; Toronto: McGraw-Hill Medical. 2020

Number of active teaching: 60			
Lectures: 30		Exercises: 30	
Methods of teaching: interactive lectures, practical classes, analysis and problem solving.			
Grading (maximum 100 points)			
Pre-Exam commitments		Points	Final Exam
Lectures		5	Written exam
Practical classes		35	
			60

Ethics and Legislation

Study programme:	pharmacy, pharmacy – medical biochemistry
Name of subject:	Ethics and Legislation
Subject status:	compulsory
ECST Value:	2
Prerequisite:	none
Course goals and objectives:	Mastering the basics of applied ethics in pharmacy; understanding the practical importance of ethics in pharmaceutical industry and understanding the differences between ethical and legal issues; developing critical thinking in the process of ethical analysis, understanding national, European and international legislation, knowledge of rights and obligations in health care and health insurance (compulsory and other types of insurance), as well as the rights and obligations of health care providers, users and third parties.
Course outcomes:	After passing the exam students will be able to evaluate which of the normative principles is important in solving situations from practice, think critically about them, understand the difference between legal and ethical problems; students will have the knowledge to critically assess, in various situations in the provision of health care, whether it involves moral duties, they will gain the competencies (knowledge, skills and attitudes) to apply the laws governing aspects of the healthcare industry, the rights and obligations of the healthcare professional (pharmacist), patient and third party.
Course outcome:	<p><i>Theory</i></p> <p>Historical aspects of the emergence and development of ethics in pharmacy. Normative ethics in pharmacy. Ethical principles relevant to the pharmaceutical profession. Ethical theories of pharmaceutical ethics. Bioethics. Ethics in advertising health care services and pharmaceuticals. Pharmaceutical deontology. Failure to adhere to codified principles. Ethics in preclinical and clinical trials (basics). Ethics Committee. Ethics in the pharmaceutical industry and drug marketing. European and international medicines regulation - basic guidelines. National health policy and regulation in health and pharmacy (Health Care Law, Health Insurance, Health Chambers, Medicines and Medical Devices Act, Patient Rights Act). Agency for medicinal products and medical devices of Serbia, its role, tasks, organization, activities. Procedure and process for registration of medicines and medical devices. Pharmaceutical regulation - principles (national by-laws and professional acts). Professional associations (national and international). Pharmaceutical chamber of Serbia. Pharmacist license. Court of Honor.</p> <p><i>Practice</i></p> <p>Case study analysis and discussion (generation and critical evaluation of information and data). Problem based learning (problem solving with proper explanation of ethical concept and legal framework). Panel discussions, application of ethics and the law on current issues: keeping confidential information about patient and medicines, dispensing medicines, misusing medicines, using narcotics. Analysis of oaths, guidelines, principles and codes; Ethical analyzes of pharmaceutical practice cases-moral values, errors and consequences of unethical practices in pharmaceutical healthcare, misjudgment; ethical controversies. Analysis of international and national ethical standards for pharmacists; Analysis of international and European medicines regulations; Analysis of the place and role of the Agency for Medicines and Medical Devices in national health care.</p>
Literature:	<ol style="list-style-type: none"> Actual Laws and other Acta of Republic of Serbia in the medical and pharmaceutical area ICH regulation Beauchamp T. L., Childress J. F.: Principles of Biomedical Ethics, 5th ed., Oxford University Press, New York, 2001

Number of active teaching: 30		
Lectures: 15	Exercises: 15	
Applicable teaching methods: Interactive lectures, workshops: case-study analysis, problem-based learning.		
Grading Scheme (max. 100 points)		
Pre-exam requirements	Points	Final exam
Lectures	5	Written exam
Practical classes	15	
Colloquim	20	
Seminar	10	
		50

Pharmacotherapy II

Study programmes: pharmacy
Name of subject: Pharmacotherapy II
Subjects status: compulsory
ECTS: 5
Requirement: Pharmacology
Subjects objective: The course aims to integrate previously acquired knowledge about the symptoms, pathogenesis, and etiology of various diseases and to understand the basis for selecting appropriate pharmacotherapeutic options. The course aims to develop knowledge, competencies, and skills for making clinical decisions to support the efficient and safe use of drugs in therapy. To enable the student to identify therapeutic problems that occur as a consequence of the use of a large number of drugs (polypharmacy), as well as a critical evaluation of information about drugs.
Subjects outcome: After passing the course, the student understands the relation between symptoms, pathogenesis, and etiology on the choice of drug/drugs and pharmacotherapeutic approach. The student can understand, analyze, evaluate, and integrate drug information to make rational, responsible, and ethical pharmacotherapeutic decisions. The student understands the importance of providing evidence-based information to patients and healthcare professionals and is aware of the importance of lifelong learning to improve their knowledge and skills. The student can compare the therapeutic benefit and risks of using certain drugs in the treatment of the same diseases.
Subjects content: <i>Lectures</i> Pharmacotherapy of neurological diseases: Pharmacotherapy of epilepsy. Pharmacotherapy of neurodegenerative diseases. Pharmacotherapy of psychiatric disorders: Pharmacotherapy of psychotic disorders. Pharmacotherapy of mood disorders. Pharmacotherapy of anxiety and related disorders. Pharmacotherapy of sleep disorders. Pharmacotherapy of endocrine diseases and metabolic diseases: Pharmacotherapy of diabetes. Pharmacotherapy of thyroid disease. Hormonal contraception, hormone therapy in menopause, and erectile dysfunction. Pharmacotherapy of eye diseases. <i>Practical Classes</i> Work on case studies and concrete examples from clinical practice. Critical thinking and analysis, problem-solving, scientific research, self-directed learning, and efficient use of modern technology in professional practice. The role of pharmacists in rational pharmacotherapy.
Literature: 1. DiPiro J., Yee G., Posey M.L., Haines S., Nolin T., Ellingrod V. Pharmacotherapy: A Pathophysiologic Approach, 11th Edition New York; Toronto: McGraw-Hill Medical. 2020
Number of active teaching: 60
Lectures: 30 Exercises: 30
Methods of teaching: interactive lectures, practical classes, analysis and problem solving.
Grading (maximum 100 points)

Pre-Exam commitments	Points	Final Exam	Points
Lectures	5	Written exam	60
Practical classes	35		

Toxicology

Study programmes: pharmacy, pharmacy - medical biochemistry	
Name of subject: Toxicology	
Subjects status: compulsory	
ECTS: 3	
Requirement: Pharmacology	
<p>Subjects objective:</p> <p>The course aims to enable students to understand basic concepts of toxicology and the importance of absorption, distribution, cellular penetration, metabolic conversion, and elimination of toxic agents. Students focus on the application of these concepts to understanding the interaction of foreign chemicals with biological systems. The course aims at 3 main elements: general toxicology (including mechanisms of toxicity), evaluation of drug toxicology (organ and tissue toxicology, genotoxicity, reproduction toxicity, carcinogenicity, preclinical studies) and clinical toxicology of drugs and essential xenobiotics (toxic dose, diagnosis, and treatment with a focus on antidotes).</p>	
<p>Subjects outcome:</p> <p>Upon completing this course, students will be able to: understand toxicological terms, describe basic toxicological principles and describe how different xenobiotics are taken up by, processed in and eliminated from the body, Describe molecular, cellular and pathophysiological responses resulting from exposure to chemical agents relevant to human health, Discuss in depth the toxicology of selected organs and agents. The student shall obtain an understanding of the principal of toxicological testing and assessment of new drugs and toxicovigilance. Students understand the poisoning symptoms and signs, treatments with special focus on antidote therapy. The student understands the importance of pharmacists in the prevention and preservation of the health of the general population and applies the acquired knowledge in the everyday professional environment.</p>	
<p>Subjects content:</p> <p><i>Lectures</i></p> <p>General Principles of Toxicology: Definition of poison, dose-response relationship, toxicity factors, the kinetics of toxins, the effects of toxins in the body, mechanisms of toxicity, the basic principles of treatment of poisoning and antidotes, selection and preparation of materials, methods of qualitative and quantitative analysis of poisons in toxicological practice, the interpretation of the results concerning our and international legislation. The most important poisons based on systematic research criteria: gaseous, highly volatile, mineral, herbal and synthetic toxins: their chemical properties, separation, mechanisms of toxicity, metabolism, target organs of toxicity, first aid basis and treatment in poisoning, antidotes, analytics, interpretation of results and their importance in different areas of toxicology. Fundamentals of ecotoxicology and the most important pollutants of the atmosphere, hydrosphere and lithosphere; principles of risk assessment. Medication toxicology. Toxicology of environmental and industrial toxins. Toxicology of heavy metals. Toxicology of drugs of abuse. Pesticide toxicology. Toxicology of chemical agents of terrorism.</p> <p><i>Practical Classes</i></p> <p>Practical teaching is an integral continuation of theoretical lectures and designed with the goal that students master the complete procedure of toxicological analysis: choice of material for toxicological analysis, performance, and significance of toxicity tests, calculation and interpretation of toxicokinetic parameters, methods of identification and determination of major ecopollutants, drugs, poisons and their metabolites in biological samples, interpretation of results, the basic principles of risk assessment to human health.</p>	
<p>Literature:</p> <ol style="list-style-type: none"> 1. Dreisbach R. Lorraine-Bev L. Poisoning: Prevention, Diagnosis and Treatment, Data Status, 2005. 2. Casarett and Doull's Essentials of Toxicology, 8th edition, C.D. Klaassen and J.B. Watkins III, eds. McGraw Hill Medical, NY, 2013. 	
Number of active teaching: 60	

Lectures: 45	Exercises: 15		
Methods of teaching: interactive lectures, practical classes, analysis and problem solving.			
Grading (maximum 100 points)			
Pre-Exam commitments	Points	Final Exam	Points
Lectures	5	Written exam	70
Practical classes	25		

Biopharmacy

Study programmes: pharmacy
Name of subject: Biopharmacy
Subjects status: compulsory
ECTS: 3
Requirement: Pharmaceutical Technology I
<p>Subjects objective:</p> <p>The objective of theoretical and practical classes of Biopharmacy is for students to gain adequate knowledge about: the impact of physical, chemical, biological and pharmaceutical-technological factors on the process of drug release from the dosage form; the concept of a biopharmaceutical drug classification system (BCS); methodology of <i>in vitro</i> testing of dissolution rate of drug from dosage form.</p>
<p>Subjects outcome:</p> <p>It is expected that students know and understand the concepts and definitions related to the impact of biological, physical, chemical and pharmaceutical-technological factors on the release and absorption of drug from the dosage form; know how to evaluate the impact of certain factors and to apply them in the formulation of dosage forms; know and understand the basic theoretical principles and application of the BCS and be able to, using literature and experimental data, suggest a model in drug classification according to BCS; know the importance and possibilities of testing of the release of drug from dosage forms, as well as the basic principles of the establishment and application of the <i>concept in vitro - in vivo</i> correlations; think critically about the choice of the experimental conditions during the development of the test for studying the rate of dissolution of drug from medicinal products; know how to communicate in writing with the use of relevant literature present results and discuss the experimental work.</p>
<p>Subjects content:</p> <p><i>Lectures</i></p> <p>Definition and basic concepts of biopharmacy. The influence of biological, physical, chemical, and pharmaceutical-technological factors on the release rate and absorption of medicinal substances from drug dosage forms. Biopharmaceutical classification system of drugs. Planning of drug dosage forms with the desired drug release. The mechanism and kinetics of drug release from various dosage forms. <i>In vitro</i> testing of kinetics of drug release from the drug dosage forms.</p> <p><i>Practical Classes</i></p> <p>Testing, identification and / or assessment of factors relevant to the kinetics of drug release from the drug dosage forms (the degree of ionization and the pH value, the partitioning coefficient, solubility, dissolution rate). Dissolution rate of drug from drug dosage forms (Dissolution test). Analysis of the influence of experimental conditions on the dissolution rate of drug from drug dosage forms. The development of methods for studying the rate of dissolution of drug from drug dosage forms. Comparison of the release profiles of drugs.</p>
<p>Literature:</p> <ol style="list-style-type: none"> 1. Derendorf, H., Schmidt, S: Rowland and Tozer's Clinical Pharmacokinetics and Pharmacodynamics: Concepts and Applications, 5th ed., Lippincott Williams and Wilkins, 2019. 2. Aulton M. E.: Pharmaceutics: The Science of Dosage Form Design, 3rd ed., Churchill Livingstone, Edinburgh 2002. 3. Gibaldi M.: Biopharmaceutics and Pharmacokinetics, 4th ed., Lea & Febiger, Philadelphia, 1991.

Number of active teaching: 45			
Lectures: 30		Exercises: 15	
Methods of teaching: lectures, practical exercises, case study			
Grading (maximum 100 points)			
Pre-Exam commitments	Points	Final Exam	Points
Lectures	5	Written Exam	50
Practical classes	45		

Pharmaceutical Biotechnology

Study programmes: pharmacy, pharmacy – medical biochemistry
Name of subject: Pharmaceutical Biotechnology
Subjects status: compulsory
ECTS: 3
Requirement: Pharmaceutical Technology I, Microbiology
<p>Subjects objective:</p> <p>Introducing students to the historical development of pharmaceutical biotechnology (retrospective); Drug discovery and identification of target tissues and organs, through preclinical studies and clinical studies, molecular pharmacopoeia and routes of administration of biological drugs. Application of industrial microorganisms in biotechnological drug production; Separation, purification, identification of active pharmaceutical ingredient (API), isolation, stabilization and formulation to the final <i>BioTech</i> product. Understand the importance of marketing in the professional presentation and placement / maintenance of products on the market. Informing students about the application of modern and innovative approaches, techniques and methods in various fields of pharmaceutical biotechnology, for drug design and optimization, in cosmetics, diagnostics and production of vaccines, as well as the development of tissue and organ replacement biomaterials. Getting acquainted with the latest developments resulting from the rapid development and expansion of biopharmaceuticals based on recombinant DNA, RNA and protein technologies, the use of which has received additional impetus at the beginning of the postgenomic era. Training in critical analysis of data / information on biotechnology drugs, their safety and ethical aspects. Objectives of the course are defined taking into account the requirements of both domestic and international companies working in the field of research and development of medicines and vaccines. Developing the ability to use professional literature and preparing written or oral reports (seminar papers, discussions).</p>
<p>Subjects outcome:</p> <p>After passing the exam, students will: be able to work independently on an innovative application of modern biotechnology in the pharmaceutical field, research and development, the diagnosis, the production of biomaterials, vaccines, and in cosmetics. Students will gain a thorough knowledge of and ability to apply the methodology for the production, development, analysis, and pharmacological and toxicological evaluation of biotechnological molecules and biomaterial of pharmaceutical, diagnostic and cosmetic importance, knowledge of relevant legal, ethical and security aspects of the application of biotechnology pharmaceutical biotechnology, the ability to use and critically evaluate primary specialized literature.</p>
<p>Subjects content:</p> <p><i>Lectures</i></p> <p>Summary (history) of the development of biopharmaceuticals with special reference to the most significant discoveries and prospects for the future; Fundamentals of molecular biotechnology; Eukaryotic and prokaryotic cells, gene expression, recombinant DNA technology; Fundamentals of genomics, transcriptomics and proteomics and their application in the discovery of new biotech drugs; Application of bioinformatics in pharmaceutical biotechnology; The structure of proteins; Techniques for preparation, purification and characterization of protein stability; Formulation of biotech drugs; Protein distribution, routes of administration and improvement of absorption, Fasteners and mechanisms for targeted delivery of protein drugs, mechanical pumps, osmotic-dependent systems, bio-degradable microspheres, biosenzorne pumps, self-regulating systems for the distribution of proteins, microencapsulated cells for the distribution of secretory proteins, colloidal particle systems for targeted delivery of proteins; Choice of excipients in the formulation of biotech drugs for parenteral use; Stability study and shelf-life of protein drugs. Microbiological aspects of protein</p>

drugs; Monoclonal antibodies as targeted carriers, human and humanized antibodies, biospecific antibody immunoconjugate; The development of biotechnological vaccines; Gene therapy; Using recombinant DNA technology in obtaining/producing drugs in the example of insulin, human growth hormones, vaccines for hepatitis B, interferon, interleukin, etc; Legislation in the patent protection and registration of *BioTech* drugs and prescription of biotech drugs; Ethical aspects and safety of production and application of *BioTech* drugs.

Practical Classes

Introducing students to the most important *BioTech* products in the pharmaceutical industry and a scientific approach to developing new primarily protein drugs potential candidates; PCR (Polymerase Chain Reaction) method; Gene cloning and expression; The development of protein production systems using recombinant DNA technology; Purification and isolation of recombinant proteins; The development of recombinant protein pharmaceutical forms; Protein production and isolation at the lab level, protein sequencing; Scale up - technology transfer from laboratory to semi-industrial and industrial levels; Bioprocess engineering; Monitoring and control of the environmental conditions (HVAC-Heating, Ventilation, Air Conditioning), cleanliness of production and storage facilities; Keeping and archiving documentation in the Pharmaceutical industry; Validation in the pharmaceutical industry; Good manufacturing practice; Good practice in the distribution of biotech drugs; Preclinical and clinical trials to obtain FDA certification for biotechnology medicine

Literature:

1. Kayser O., Mueller R. H. (eds.): Pharmaceutical Biotechnology: Drug Discovery and Clinical Applications, Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim, Second, Completely Revised, and Greatly Enlarged Edition 2012. Wiley-VCH Verlag & Co. KGaA, Boschstr. 12, 69469 Weinheim, Germany.
2. Groves M. J. (ed.): Pharmaceutical Biotechnology, 2nd ed., CRC Press Taylor & Francis Group, Boca Raton, Philadelphia, 2006.
3. Rho J. P., Louie S. G. (eds.): Handbook of Pharmaceutical Biotechnology, Pharmaceutical Products Press, Binghamton, New York, 2003.
4. Crommelin D. J. A., Sindelar R. D. (eds.): Pharmaceutical Biotechnology, 2nd ed., Taylor & Francis Inc., Philadelphia, 2002.
5. Klefenz H.: Industrial Pharmaceutical Biotechnology, Wiley, Chichester, 2001.
6. Banga A.: Therapeutic peptides and proteins, Formulation processing and delivery systems, Technomic Lancaster, Pennsylvania, 1995.

Number of active teaching: 45

Lectures: 30

Exercises: 15

Methods of teaching:

lectures, practical exercises

Grading (maximum 100 points)

Pre-Exam commitments	Points	Final Exam	Points
Lectures	5	Written exam	60
Practical classes	25		
Seminar	10		

Communication in Healthcare

Study programmes:	pharmacy, pharmacy – medical biochemistry
Name of subject:	Communication in healthcare
Subjects status:	compulsory
ECTS:	3
Requirement:	none
Subjects objective:	Student by active participation in the process of learning acquires the knowledge in the field of communications, in order to obtain communication competencies and skills needed for professional work in organisational and team communication and communication with partners, and establishing quality contact with users of healthcare services, emphasizing the importance of consultation skills.
Subjects outcome:	

After completion of the exam it is expected that a student is competent and qualified for communication and application of acquired knowledge and skills of communication; to implement acquired communication skills among profession and the team, with patients and members of the patients' family, in interprofessional communication, in communication with general public.

It is expected that after completion of the exam a student shows adequate knowledge and understanding of the structure of communication and the role of communication in healthcare with emphasis on consultation skills.

Subjects content:

Lectures

General terms, aspects, types, parts of communication. Vertical and horizontal communication. Verbal and nonverbal communication. Communication styles. Assertiveness. Political and social correctness in communication. Communication competence in professional practice. Professional identity and communication. Establishing the first contact and leading the conversation with patients. Collecting data from patients – informed consent. Provide information to patients. Ethics in communication. Barriers in communication. Communication and psychological distress. Motivation of patients for collaboration with medical staff.

Specificity of application of communicational health-educative methods. Communication and health educative counselling – supportive methods. Communication in the function of social support.

Communication in the function of better adherence. Emotional communication, empathy. Therapeutic and informative communication. Psychological-social aspect of communication. Communication with stressed persons and people in crisis. Communication with people with sensory and speech deficits. Communication with the patients' family. Communication with elderly people and their families. Communication in grief. Teamwork and social partners. Interpersonal communication. Communication in the team. Public relations. Communication in crisis. Management of conflict.

Practical work

Creative workshop trainings for acquiring techniques of verbal communication. Application of SOLER technique. Development of skills of listening, examination, rhetoric, empathy, providing reverse information. Practice for application of clinical knowledge in the process of consultation during patient counselling about pharmacotherapy, effects and rational use of drugs, therapy and outcomes monitoring (DADER method), history of medication (SOAP method). Skills of asking questions, detection and solving (potential) non-adherence, motivation of patients and removing barriers or conflict in communication. Practicing communication: simulation of communication with specific groups of patients; specific conditions; members of family.

Teamwork: Communication in a team. Communication with media – public performance. Creating health promotion materials. Practicing health-educative methods. Creating written instruction for drug use for specific patient groups. Pictograms. Communication with management and HR.

Literature:

1. Robert S. Beardsley, Carole L. Kimberlin, William N. Tindall. "Communication Skills in Pharmacy Practice: A Practical Guide for Students" Lippincott Williams & Wilkins, 2012.
2. Hugman B.: Healthcare Communication, Pharmaceutical Press, London, 2009.
3. 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.
4. National framework of competencies of pharmacists, Pharmaceutical Chamber of Serbia, 2014.

Number of active teaching: 30

Lectures: 15

Exercises: 15

Methods of teaching:

Lectures, practice, work in small groups, consultations, presentations in a group, method of development of communication skills.

Grading (maximum 100 points)

Pre-Exam commitments	Points	Final Exam	Points
Lectures	5	Written exam	60
Practical classes	35		

Cosmetology

Study programmes: pharmacy
Name of subject: Cosmetology
Subjects status: compulsory

ECTS:	4		
Requirement:	Pharmaceutical Technology I		
Subjects objective:	Actual legal rules about cosmetic and borderline products, types, forms and purposes of the products, skin structure and function, special rules in formulating the products for various purposes, important cosmetic ingredients, introduction of nanotechnology and other innovative technologies in cosmetics, production and testing methods of cosmetic products, ecological impact, advices to the consumer for proper selection of the products, side effects, cosmetovigilance.		
Subjects outcome:	Familiarity with the legal obligations and rules for cosmetic products and ingredients, differentiation the cosmetic products from the borderline products, knowledge about skin structure and function, new technologies, types, forms, production and testing methods, effects of the products on the skin and the environment, critical consideration of marketing informations, giving advices to the consumers for proper selection and application of products, potential side effects and importance of cosmetovigilance.		
Subjects content:	<p><i>Lectures</i></p> <p>Actual legal rules in RS, EU and in the world, mandatory efficacy and safety evaluation, information for the consumers, possible side effects and cosmetovigilance, borderline products – similarities and differences, skin structure and function, cosmetic ingredients, nano- and other new technologies in cosmetics. Cosmetic products for cleaning/washing the skin, antiaging products, sun protection products, baby care products, shampoos, haircare and products for changing the hair look, depilatories, nailcare and decorative nail products, toothpaste and mouthwash cosmetic products, footcare products, deodorants and antiperspirants, anticelulite products, bleaching and products for stretch marks.</p> <p><i>Practical Classes</i></p> <p>Discussion about the product declaration and other informations pertaining the commercial products, their ingredients, purposes of the ingredients, special features of products with different purposes, formulation, production and testing the cosmetic products, giving advices to the consumers, ecological impact of cosmetic products, cosmetovigilance.</p>		
Literature:	<ol style="list-style-type: none"> 1. Miljković S, Tomić M, Hut I, Pelemiš S. Nanomaterials for skin care. In: Commercialization of Nanotechnologies - A Case Study Approach, <i>Springer</i> 2018 2. Yu Heng K, Yee Kei T, Jaspreet K, Hairun L, Ai Ling P, Li Feng K. Handbook of Cosmeceutical excipients and their safeties. Woodhead Publishing, 2014. 3. Sivamani RK, Jagdeo J, Elsner P, Maibach H. Cosmeceuticals and Active Cosmetics. 3rd ed. CRC Press, 2015. 4. Draelos ZD. Cosmeceuticals E-book: Procedures in Cosmetic Dermatology. 3rd ed. Elsevier, 2014. 5. Baumann L. Cosmeceuticals and Cosmetic Ingredients. 1st edition. McGraw Hill, 2014. 		
Number of active teaching:	60		
Lectures: 30	Exercises: 30		
Methods of teaching:	lectures, case studies		
Grading (maximum 100 points)			
Pre-Exam commitments	Points	Final Exam	Points
Lectures	5		65
Practical classes	30		

Pharmaceutical Practice

Study programmes:	pharmacy
Name of subject:	Pharmaceutical practice
Subjects status:	compulsory

ECTS:	3		
Requirement:	none		
Subjects objective:	<p>Mastering the basic concepts of pharmaceutical practice at all levels of the health care system (primary, secondary, tertiary). An essential drug list, drug lists in Serbia. The role of public pharmacy in primary health care. Classification of products relevant to the key processes of pharmaceutical practice (rent, sales, consulting). Understanding the basic sources of information about medications. Knowledge of the processes about prescribing medications, dispensing medical products. Electronic prescribing. Refund and pharmacy administration, the process of dispensing OTC drugs in pharmacies. Drug safety (monitoring the use of drugs). Pharmaceutical pricing policy.</p>		
Subjects outcome:	<p>After passing the exam, the student will: know the pharmaceutical health care system, know the types, forms, and classifications of drugs and medical devices in a public and hospital pharmacy, will understand the importance and role of certain information and know-how to analyze them, will understand the importance of prescriptions and orders in pharmaceutical practice, will understand the importance and need for clinical practice (separate course), will understand the purpose of promoting health in public pharmacies. The student is familiar with pharmaceutical pricing policy and terminology.</p>		
Subjects content:	<p><i>Lectures</i></p> <p>Introduction to the pharmaceutical health care system, the World Health Organization, and the concept of essential drugs; national drug list; hospital drugs list. Pharmaceutical practice: public and hospital pharmacies in the health care system; practice activities (planning, procurement, storage, issuance, distribution). Pharmaceutical products: groups, forms, classifications; medical devices, and products within health care (preventive, diagnostic, therapeutic, and rehabilitative means). Prescription and order - the structure, prescribing medications and medical devices, calculations, reimbursement, and administration. Information resources in pharmaceutical science and practice, types of information, sources, levels, information management; special sources of information. Health promotion and disease prevention, basic programs of public pharmacies. Advising patients. Clinical practice - basic terms and concepts to improve treatment and outcomes in a public and hospital pharmacy. Private and public sector.</p> <p><i>Practical Classes</i></p> <p>Case study analysis - selected work activities in public or hospital pharmacy (examples with lists of medications, procedures, etc.). Simulation of working with prescription, e-prescription, calculations, and computations. Simulation of patient counseling. Working with basic pharmaceutical sources of information (manuals and electronic databases). Workshop on the topic of pharmaceutical practice, analysis, discussion. Part of the exercise is done in a pharmacy.</p>		
Literature:	<ol style="list-style-type: none"> 1. Winfield A. J.: Pharmaceutical Practice, Churchill Livingstone, Edinburg, 3rd ed., 2004. 2. Smith M. C., Wertheimer A. I.: Social and Behavioral Aspects of Pharmaceutical Care, Pharmaceutical Press, London, 1996. 3. Smith F.: Research Methods in Pharmacy Practice, Pharmaceutical Press, London, 2005. 4. Kayne S. B.: Pharmacy Business Management, Pharmaceutical Products Press, London, 2005. 5. Remington G.: The Science and Practice of Pharmacy, 21st ed., Lippincott Williams & Wilkins, London, 2005. 		
Number of active teaching:	30		
Lectures:	15	Exercises:	15
Methods of teaching:	interactive lectures, practical classes, analysis and problem solving.		
Grading (maximum 100 points)			
Pre-Exam commitments	Points	Final Exam	Points
Lectures	5		70
Practical classes	25		

Clinical Research

Study programmes:	pharmacy, pharmacy - medical biochemistry
Name of subject:	Clinical Research
Subjects status:	compulsory
ECTS:	3
Requirement:	none
Subjects objective:	<p>The objective of the course</p> <p>The course aims to provide students with theoretical and practical knowledge of qualitative and quantitative clinical research designs and mixed clinical research methods and techniques, specifically related to clinical research in pharmacy, medical biochemistry, pharmaceutical clinical practice, and clinical, biochemical practice.</p>
Subjects outcome:	<p>The outcome of the course</p> <p>Upon completion of the course, the student will have the necessary theoretical knowledge and practical experience of qualitative, quantitative and mixed designs, clinical research methods and techniques, as well as the design of clinical trials of pharmaceuticals, para-pharmaceuticals and diagnostic methods and techniques. Upon completion of the course and practical instruction during the course, each course student will have a clinical research plan developed according to his/her affinities.</p>
Subjects content:	<p><i>Lectures</i></p> <p>Introduction to clinical research. Planning and creation of clinical research in pharmacy and pharmaceutical sciences (research questions, literature search, variables, and their measurements, human subjects in clinical research, the committee for the protection of human subjects in clinical research, consent of a human subject to participate in clinical research). Qualitative clinical research designs (case studies, clinical case series, interview, questionnaire design, field research, focus groups). Examples of qualitative clinical research in clinical pharmacy (analysis and discussion). Quantitative clinical research designs (descriptive quantitative clinical research, correlational clinical research, quasi-experimental research, experimental clinical research). Examples of quantitative clinical research in clinical pharmacy (analysis and discussion). Mixed methods in clinical research (mixed-method research strategies, mixed-method design selection, triangulation, embedding design, reconnaissance design, explanation design). Mixed-Method Examples in Pharmaceutical Clinical Research (Analysis and Discussion). Database development, sample size, quality control, data collection, research control. Small clinical experiments (examples of the small pharmaceutical clinical research experiment, analysis and discussion). Clinical trials of potential drug substances, drugs, para pharmaceuticals, diagnostic agents, clinical interventions (an example of a clinical trial in pharmacy). Additional titles (responsible conduct of clinical research, funding of clinical research, control of research budget). Analysis and presentation of clinical research results. Translational research in pharmacy and clinical practice.</p> <p><i>Practical Classes</i></p> <p>Developing Pharmaceutical Research Proposal - Patient-Oriented Research. Finding research questions. Research goals, specific goals, research questions, and assumptions - hypotheses. Preparation of preliminary data. Literature review (how to successfully review the literature and data analysis). Research notes (research goals, specific goals, mechanisms, research hypotheses, testing of hypotheses to be measurable, ethical, important). Variables and their measurement. Human subjects in clinical research. Masking. Sample size estimation. Database development. Data collection and quality control. Supervision of experimental interventions. Final research proposal in clinical pharmaceutical practice.</p>
Literature:	<p>1. Presentations and additional literature (preliminary textbook script, revised edition 2019) provided by the teacher during the course teaching</p> <p>Recommended literature:</p>

1. John I. Gallin (Editor), Frederick P Ognibene (Editor), Laura Lee Johnson (Editor). Principles and Practice of Clinical Research, Academic Press; 4 edition (November 30, 2017), ISBN-10: 0128499052, ISBN-13: 978-0128499054			
2. Natasha Martien, Jeff Nelligan, The Sourcebook for Clinical Research: A Practical Guide for Study Conduct, Academic Press; 1 edition (August 22, 2018), ISBN-10: 0128162422, ISBN-13: 978-0128162422			
Number of active teaching: 30			
Lectures: 15	Exercises: 15		
Methods of teaching: lecturing including active learning methods and techniques, discussion, case study, simulation			
Grading (maximum 100 points)			
Pre-Exam commitments	Points	Final Exam	Points
Lectures	5	Test	35
Practical classes	25		
Seminar	35		

Clinical Pharmacy

Study programmes: pharmacy
Name of subject: Clinical Pharmacy
Subjects status: compulsory
ECTS: 5
Requirement: Pharmacology
Subjects objective: The course aims to develop the knowledge, competencies, and skills of a clinical pharmacist through an introduction to the concept of pharmaceutical care and the rational use of drugs. To develop skills necessary for: solving clinical problems in different clinical settings, communication with patients; assessment and management of adherence, pharmaco-economic analysis of rational pharmacotherapy; development and implementation of a pharmaceutical health plan as well as monitoring the outcome of therapy. The role of the clinical pharmacist in primary, secondary, and tertiary health care.
Subjects outcome: After passing the exam, the student understands and applies: the concept of pharmaceutical care and rational pharmacotherapy; the concept of evidence-based medicine/pharmacy; critically evaluates sources of information on drugs; skills needed to solve clinical problems in different clinical settings by working as part of a multidisciplinary healthcare team. The student understands the role of the clinical pharmacist in the implementation of rational pharmacotherapy; identification, assessment, and solving problems regarding drug use; monitoring and counseling the patient regarding the drug use; communication with health professionals and patients about rational pharmacotherapy and promotion of health.
Subjects content: <i>Lectures</i> The concept of pharmaceutical care. Evidence-based medicine. Sources of drug information. Drug interactions. Adverse drug reactions and pharmacovigilance. Communication skills. Compliance, adherence, concordance. Diagnostic and laboratory data for monitoring treatment outcomes. Pharmacoeconomics. Pharmaceutical care plan. Implementation of a pharmaceutical care plan. Monitoring therapy outcomes. Pharmaceutical care documentation. Clinical Services provided by clinical pharmacists. <i>Practical Classes</i> Work on case studies and concrete examples from practice. Problem-based learning. The role of the clinical pharmacist in identifying problems related to therapy. Communication skills. Interpretation of diagnostic and laboratory data to monitor treatment outcomes. Finding reliable information about drugs and therapies. and quality assessment of clinical studies. Pharmaco-economic analysis.
Literature:

1. Vezmar Kovacevic S. Miljkovic B. Clinical pharmacy in theory and practice. University of Belgrade - Faculty of Pharmacy, 2018.			
2. Whittlesea C. Hodson K. Clinical Pharmacy and Therapeutics, International Edition, 6th, Elsevier Science 2018.			
Number of active teaching: 75			
Lectures: 45	Exercises: 30		
Methods of teaching: interactive lectures, practical classes, analysis and problem solving.			
Grading (maximum 100 points)			
Pre-Exam commitments	Points	Final Exam	Points
Lectures	5	Written exam	50
Practical classes	25		
Seminar	20		

Industrial Pharmacy

Study program: pharmacy
Name of subject: Industrial Pharmacy
Subjects status: compulsory
ECTS: 3
Requirement: Pharmaceutical Technology II
Subjects objective: To introduce students to principles and characteristics of industrial production of drugs in terms of drug development, drug stability, regulatory requirements, providing conditions for drug production, types and selection of equipment used in the manufacture of drugs, quality systems and quality assurance.
Subjects outcome: After passing the subject, the student is trained in applying the information necessary for the formulation, development and stability of drugs in pharmaceutical industry, has the knowledge of contemporary requirements for quality systems in the pharmaceutical industry, knowledge of the principles of operation and types of devices used in the pharmaceutical industry in the drug development processes.
Subjects content: <i>Lectures</i> Quality Assurance. Basic concepts and definitions. Standardization. International ISO standards, European standards are important for the production and distribution of drugs. Good manufacturing practices in the production, storage and distribution of medicines, the active pharmaceutical ingredients and excipients, distribution and storage. Basic concepts reformulation and formulation of medicinal preparations in the development laboratories of pharmaceutical industries. Formulation and development of conventional and modern medicinal preparations, tendencies. Incompatibilities in the formulation. Stabilization. The transfer procedure for the preparation of medicinal preparations from laboratory conditions to industrial production. Overview of pharmaceutical-technological operations in drug production. Influence of formulation factors and production process on final product. <i>Quality by Design</i> method in drug formulation. Overview of devices used for drug production. Filling and packaging of medicinal preparations. <i>Practical Classes</i> Quality Assurance. Examples from practice. Implementation of the principles of good manufacturing practice and quality management system requirements (ISO 9001). The formulation of medicinal preparations. Theoretical tasks related to formulation of pharmaceutical dosage form. Case study. Tasks related to stabilization and determination of shelf life of medicinal preparations. Pharmaceutical unit operations. Professional excursions to drug factory.
Literature: 1. Gibson, Mark: Pharmaceutical Preformulation and Formulation: A Practical Guide from Candidate Drug Selection to Commercial Dosage Form, 2 nd ed, CRC Press, Boca Roca, 2009.

2. Carstensen, Jens T.: Drug Stability, Revised, and Expanded: Principles and Practices, 3 rd ed, CRC Press, Bosa Roca, 2000.			
Number of active teaching: 45			
Lectures: 30	Exercises: 15		
Methods of teaching: interactive lectures, practical classes, case study, calculation exercises			
Grading (maximum 100 points)			
Pre-Exam commitments	Points	Final Exam	Points
Lectures	5	Written exam	50
Practical classes	45		

Drug Interactions and Adverse Drug Effects

Study programme: pharmacy, pharmacy – medical biochemistry			
Name of subject: Drug Interactions and Adverse Drug Effects			
Subject status: compulsory			
ECTS: 4			
Requirement: Pharmacokinetics with Pharmacodynamics			
Subjects objective: To understand the clinical value of drug interactions and ways of prevention, recognition, reduction and elimination of adverse drug effects.			
Subjects outcome: After passing the exam, the student is trained to know: mechanisms and types of drug interactions; clinical significance of drug-drug interaction, drug-disease interaction, drug-food interaction, drug -herbal product interaction, drug supplement interaction; the types and significance of adverse drug reactions; procedures to monitor and report side effects.			
Subjects content: <i>Lectures</i> Mechanisms and types of drug interactions. Clinically important interactions with case examples. Types of adverse drug reactions (ADR). SOC classification. Side effect of drugs in vulnerable patients. Clinically important side effects of drugs with case examples. Procedures of adverse drug reactions monitoring. Roles of pharmacovigilance in monitoring ADRs. Based evidence medicine. Statistical evaluating of ADR monitoring studies. Assessment of cause-effect risks associate with adverse events and drugs with case studies. <i>Practical work:</i> Discussion, analysis of selected case examples from practice, workshops.			
Literature 1. Jakševac-Mikša M. (ed.): Drug interactions, Handbook (according to: Zuccherro F. J., Hogan M. J., Eds. Washington: APA, Evaluations of Drugs Interactions, 2 nd ed.), Zagreb: HFD, 1998. 2. Stockley Ivan (ed.): Stockley's Drug Interactions, 6 th ed., Pharmaceutical Press, London, 2002. 3. Dictionary of Pharmacovigilance, Pharmaceutical Press, 2004.			
Number of active teaching: 45			
Lectures: 30	Exercises: 15		
Methods of teaching: Interactive lectures, practical classes, case study.			
Grading (maximum 100 points)			
Pre-Exam commitments	Points	Final Exam	Points
Lectures	5	Written exam	70

Practical classes	25		
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Study Research

Study programme: pharmacy	
Name of subject: Study Research	
Subject status: compulsory	
ECTS: 5	
Requirement: Passed all compulsory subjects of I-V years and all elective courses I-III years	
Subjects objective: Study research work enables the student to approach the preparation of the final (diploma) thesis. Understanding and learning the basics of scientific research methodology, independent literature search and critical interpretation of results. Introduction to the ethical and professional behavior of researchers. Training for independent work in the laboratory. Acquiring knowledge about the way of presenting research results.	
Subjects outcome: Students will be trained to: <ul style="list-style-type: none"> – find and analyze scientific literature relevant to the given topic of the thesis, – with the help of a mentor make an experimental plan, – independently perform laboratory experiments, – on the basis of the obtained results, complete and choose the whole that they will present, – treat the problem in the light of data from the literature and – write a paper in accordance with the world-accepted rules of writing a scientific paper. 	
Number of active teaching: 150	
Methods of teaching: individual work with a mentor, independent work, discussion	
Grading (maximum 100 points)	
preparation and literature review	30
experimental work	30
discussion of results	40

Professional Internship

Study programme: pharmacy	
Name of subject: Professional Internship	
Subject status: compulsory	
ECTS: 15	
Requirement: Passed all compulsory subjects of I-V years and all elective courses I-III years	
Subjects objective: During the tenth semester, a student who has completed and practiced all the required subjects, should be able to prepare for independent professional work. During the internship, the student learns to apply and develop the knowledge and skills acquired during the study, builds a personal professional attitude, behavior and responsibility towards the profession and service users.	
Subjects outcome: During the professional practice, the student applies the knowledge and skills acquired during the nine semesters of practical and theoretical teaching. Professional practice takes place in institutions with which the Faculty has signed Agreements on business and technical cooperation: pharmacies (public and hospital pharmacies), health care institutions and the pharmaceutical industry, or in pharmaceutical institutions whose activity is the production, marketing and distribution of pharmaceuticals, as well as pharmaceutical institutions dealing with the organization of clinical trials.	

The student acquires and develops new knowledge and skills whose contents include:

- aspect of pharmaceutical health care
- pharmacotherapeutic aspect
- pharmaceutical-technological aspect
- aspect of production, distribution and marketing of pharmaceutical preparations
- aspect of pharmaceutical regulations and legal regulations

Aspect of pharmaceutical health care:

- health promotion and disease prevention
- application of standards in pharmacy practice
- selection, planning and supply of medicines and medical devices
- issuance and sale of medicines and medical devices
- advising patients on the proper use of drugs
- recognizing and distinguishing milder diseases from symptoms and conditions that require the patient to see a doctor
- selection and counseling when dispensing over-the-counter medications
- monitoring, reporting and reporting of adverse drug reactions
- monitoring and recording drug interactions
- identifying problems related to the use of drugs and developing a pharmaceutical health care plan
- professional communication with patients and healthcare professionals
- keeping documentation on therapy for an individual patient
- getting acquainted with the way of informing about medicines and pharmacy practice
- monitoring the use of drugs
- control of drug stocks and records of drugs under a special regime of dispensing (narcotics), handling of pharmaceutical waste and its disposal
- quality of service and customer satisfaction

Pharmacotherapeutic aspect:

- knowledge of indications, contraindications, interactions and adverse reactions to drugs and medical devices
- individualization of therapy
- knowledge of aspects of rational use of drugs
- monitoring the efficacy and safety of the drugs used
- knowledge of the principles of good clinical practice

Pharmaceutical-technological aspect:

- pharmaceutical calculations
- production of magistral and galenic drugs in the pharmacy
- monitoring the stability of manufactured medicinal preparations
- calculation of prices of manufactured preparations
- keeping records of manufactured medicinal preparations
- handling of hazardous substances that require precautions
- handling of cytotoxic drugs (potential hazards and precautions)
- proper storage and storage of finished drugs, active and auxiliary substances and packaging
- production of certain cosmetic preparations in pharmacy conditions

Aspect of production, distribution and marketing of pharmaceutical preparations:

- knowledge of legal regulations concerning the production, distribution and marketing of pharmaceutical preparations
- knowledge of the principles and guidelines of Good Manufacturing Practice (GMP)

- knowledge of the principles and guidelines of Good Practice in Distribution (GDP)
- knowledge of the principles of quality control and quality assurance (QA) system

Aspect of pharmaceutical regulations and legal regulations:

- knowledge and application of the Law on Medicines and Medical Devices, the Law on Health Care, the Law on Chambers of Health Workers, the Law on Health Insurance, the Law on Substances Used in the Illicit Production of Narcotic Drugs and Psychoactive Substances
- knowledge and application of bylaws arising from the said Laws
- knowledge and application of the Essential List of Medicines and the List of Medicines and Medical Devices that are prescribed and issued at the expense of health insurance funds
- knowledge and application of regulations governing work in the pharmacy
- application of the code of ethics in practice, ethical decision making, assessment of professional responsibility
- knowledge of the regulations necessary for the preparation, organization and conduct of clinical trials
- knowledge of the principles and guidelines of Good Laboratory Practice (GLP) in clinical trials

Subjects content:

Professional practice in the study program of integrated academic studies in Pharmacy includes a total of 450 hours. Depending on the individual affinities and interests of students, professional practice can be organized in 3 ways: professional practice is performed by the student within 375 hours in a public sector pharmacy and 75 hours in a hospital sector pharmacy (hereinafter option A), or 450 hours in a pharmacy or a public sector health facility (hereinafter option B), or 200 hours in a pharmacy or public sector health facility and 250 hours in the pharmaceutical industry (hereinafter option C), depending on the available capabilities of the health system.

The content of professional practice and activities during the same are defined in the instructions that the Faculty sends to the institution, ie. a mentor of professional practice from the institution that accompanies the student. The mentor is obliged to keep the Student Diary on professional practice. The control and supervision of professional practice in front of the Faculty is performed by a teacher appointed as a coordinator of professional practice.

Activities within the professional practice in a pharmacy or public health institution:

- procurement planning, reception and storage of medicines and medical devices
- dispensing of medicines and medical devices
- sale of OTC preparations
- production of magistral and galenic drugs
- providing information and advice on the method of application, dosing regimen, storage conditions of pharmaceutical preparations
- application of valid legal and professional regulations, as well as the code of professional ethics
- administrative tasks

Activities within the professional practice in the hospital pharmacy:

- procurement planning, reception and storage of medicines and medical devices
- issuance and distribution of medicines and medical devices
- production of medicines
- administrative tasks

Activities within the professional practice in the pharmaceutical industry are defined depending on the institution.

Number of active teaching: 450

Methods of teaching:

The professional internship is performed by the student under the supervision of a mentor, ie a pharmacist with at least 5 years of experience in performing pharmaceutical health care activities in a pharmacy or health care institution. Professional practice implies involvement in the work process with continuous communication and consultation with the mentor. During the internship, the mentor is obliged to keep the Student Diary of the internship. The performance of all activities that are planned within the subject Professional Practice, which are listed in the Student Diary of Professional Practice, is confirmed by the signature of the mentor of professional practice, and the institution where the professional practice is performed is stamped. The diary must contain: name, surname and

student index number, study program, place and time of professional practice, number of professional practice hours, name of mentor, date of professional practice with a short description of activities, mentor grades for all professional practice activities, student signatures and mentor with date.
<p>Grading (maximum 100 points)</p> <p>By certifying the Student Diary on professional practice by the mentor, it is confirmed that the student has successfully completed the professional practice. In Dnevnik, the mentor evaluates the student's work with a grade of 5-10, with a grade of 5 meaning that the student did not meet the required minimum, and a grade of 6-10 that it did, with a minimum score of 51 out of a total of 100.</p>

Thesis

Study programme: pharmacy
Name of subject: Thesis
Subject status: compulsory
ECTS: 10
Requirement: Passed all compulsory subjects
<p>Course objective</p> <p>The student is trained to apply basic, theoretical and methodological, scientific-professional and professional-applied knowledge and methods for solving specific problems within the chosen topic of the final work. Within the final work, the student, studying the available literature, or experimental work in the laboratory, studies the problem, its structure and complexity and, based on the conducted analyzes, draws conclusions about possible ways to solve it. Also, the student is trained to write the final paper, present it within the given deadline and discuss the work with experts.</p>
<p>Course outcome</p> <p>Based on the acquired knowledge and skills during the study, the student is able to experimentally do work in the laboratory or bibliographically collect professional literature, write a paper and present it to a competent committee.</p>
<p>Course content</p> <p>The final work is a research work of the student in which he gets acquainted with the research methodology in all areas of importance for pharmacy. The topic of the paper can be experimental or bibliographic. After the research, the student prepares the final paper in the form that contains the following chapters: Introduction, Theoretical part, Experimental part (if the work is done experimentally), Results and discussion, Conclusion, Literature review. The defense of the paper consists of an oral presentation of the paper by the student, questions asked by the members of the commission and the student's answers to the questions asked.</p>
Number of active teaching: 150
<p>Methods of teaching:</p> <p>During the preparation of the final paper, the mentor gives the necessary instructions to the student, refers him to certain literature, helps with the choice of research methods, analysis and processing of the obtained results, drawing the correct conclusions, etc. Within this part of the final work, the student performs additional consultations with the mentor, and if necessary with other teachers who deal with issues in the field of the final work. If the final work involves experimental work, the mentor introduces the student to the work in the laboratory, the selection of chemicals, protection measures, handling instruments, etc.</p>
<p>Grading (maximum 100 points)</p> <p>The grade on the final paper is the sum of points obtained for: experimentally done work (if the work is experimental) 30 points, written work 30 points, presentation of the work 20 points and answers to questions related to the topic before the committee 20 points.</p>

Elective courses

Public health

Study programmes:	pharmacy, pharmacy – medical biochemistry
Name of subject:	Public Health
Subjects status:	elective
ECTS:	2
Requirement:	none
Subjects objective:	Students should recognize the health values and determinants, role and assignment of one person, families, local communities, and society in order to protect health, role of the pharmacists in public health activities, introduction of national project for health promotion and disease prevention, as well as the strategies of EU health polices, principles of proper nutrition of health and diseased population, health education in Serbia, application of the theory into the field work.
Subjects outcome:	Students will be able to recognize and actively influence on health factors, to recognize the role of the pharmacists in public health activities as well as health promotion, to differentiate health education and health promotion, to apply the knowledge and previous public health campaigns' experiences in solving the problems in everyday work.
Subjects content:	<p><i>Lectures</i></p> <p>Public health – definition, development and activities, legislative. Health promotion, features and activities. Importance of health for the society, health indicators, global health challenges, influences on personal and population health. Strategy „Health for all in 21. century“, adopted strategies and national projects for health promotion and disease prevention in RS. Experiences of successful public health campaigns. Health system levels, healthcare for vulnerable groups. Prevention and health education. Forms, methods and fields of work, motivations and communications in health education. Importance of food for health, principles and guidelines for healthy diet. Importance and role of pharmacists in public health activities, advice about healthy way of life and disease prevention, various fields of health promotion in pharmacies, proper use and prevention of side effects of the drugs, medical devices, cosmetic and other products in the pharmacies, connecting the gaps in healthcare system and care for the patients, environmental protection activities.</p> <p><i>Practical Classes</i></p> <p>Understanding the health challenges in direct and global environment. Consideration of different models/methods of public health activities. Discussion about successful public health campaigns, keeping the experiences, overcoming the problems. Consideration of adopted strategies and national preventive projects in RS, and proposing the new ones. Creating a proposal, plan and way of realization public health campaign in the pharmacy, with defined problem, aims and determinants of success. Proposal of pharmacy activities in various field of health promotion and disease prevention, connecting with the healthcare system on different levels, environmental protection, with documented results. Defining the problem based on the data about drugs or other products in pharmacy use, and creating the plan for public health activities. Activities of the pharmacists in providing the proper use of drugs and other products in pharmacy, communication with patients/consumers, creating the educational materials. Advice for healthy nutrition.</p>
Literature:	<ol style="list-style-type: none">1. Fleming ML, Parker E, Correa-Velez I. Introduction to Public Health, 4th Edition. Elsevier, 2019.2. Rees JA, Smith I, Watson J. Pharmaceutical Practice. 5th Ed. Elsevier Edinburgh, UK, 2014.3. Ross AC, Caballero B, Cousins RJ, Tucker KL, Ziegler TR: Modern Nutrition in health and disease, 11th ed., Lippincott Williams & Wilkins, Baltimore, Philadelphia, USA, 2014.
Number of active teaching:	30
Lectures: 15	Exercises: 15
Methods of teaching:	

lectures, case studies			
Grading (maximum 100 points)			
Pre-Exam commitments	Points	Final Exam	Points
Lectures	5	Written exam	65
Practical classes	30		

Business English

Study programme: pharmacy, pharmacy-Medical Biochemistry			
Course title: Business English			
Course status: elective			
ECTS credits: 2			
Requirement: none			
Course goals and objectives			
The aim of the course is to master the peculiarities of business English, learn phrases and patterns necessary for communication at a professional level and master the techniques of written and oral expression in professional communication.			
Course outcome			
The student will be able to apply the acquired knowledge for the purpose of professional communication, create appropriate written forms in accordance with his/her professional communication and use speech patterns adapted to the situation.			
Course content			
<i>Theory</i>			
CV, basic characteristics, models, elements, rules for writing. Motivational letter. A job interview. Business correspondence: business letter, job application letter, response to an official letter, requesting information, writing an e-mail. Telephone communication at the official level. Business lunch, cocktail, ceremony. Greetings. Random meeting, business meeting, high level meeting, conference call, video conference call. Public address. Creating a business plan. Writing analysis reports. Writing journal and scientific professional text (chemical, pharmaceutical, medical).			
<i>Practice</i>			
Preparation: CV, motivation letter, business letter, job application letter, response to the official letter, request for information, mail, business plan, analysis report, review professional text, scientific professional text. Oral interpretation: telephone communication at the official level, business lunch, greeting, business meeting, conference call, public address.			
Literature			
1. Baade Kate, Duckworth Michael, Grant David, Holloway Christopher, Hudson Jane, Hughes John, Naunton Jon, Scrivener Jim, Turner Rebecca: Business Results, Oxford, 2009.			
2. Cotton David, Falvey David, Kent Simon: Market Leader, Longman, Harlow, 2001.			
3. Field Marion: Improving Your Written English, 3 rd ed., How To Books Ltd., McMilan, London, 2001.			
4. Business texts from practice (selection).			
5. Commercial (authentic) texts on pharmaceutical products (selection).			
6. Scientific professional pharmaceutical texts (selection).			
Number of active teaching: 30			
Lectures: 15		Exercises: 15	
Applicable teaching methods			
Interactive classes, discussions			
Grading (maximum 100 points)			
Pre-exam requirements	points	Final exam	points
Lectures	5	Written exam	30
Practical classes	25	Oral exam	20

Colloquim	20		
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Management in Healthcare

Study programme:	pharmacy, pharmacy - medical biochemistry		
Name of subject:	Management In Healthcare		
Subject status:	elective		
ECST Value:	3		
Prerequisite:	none		
Course goals and outcomes:	The objective of the course is to introduce the student with the basic principles of management and organization in contemporary business conditions in healthcare, entrepreneurship and the company milieu; to master the knowledge and skills necessary of management in a competitive economic environment and healthcare system, respecting its specificities, levels and modalities.		
Course outcomes:	After taking the course, the student will be able to: understand the specifics of business in healthcare and pharmacy, master basic management methods in the medical field, pharmaceutical market and biochemical laboratory; recognise and apply basic organization/management skills in healthcare through the knowledge of work standards and good practice; understand the processes of supply chain manufacturer-wholesaler-pharmacy-user; apply management skills to the competitive business of the medical laboratory, pharmacy and other market entities.		
Course content:	<p><i>Theory</i></p> <p>Management and organization theory - mission, vision, leadership. Organization management (planning, organizing, personnel selection, leading and controlling). Decision making and problem solving. SMART principles as goals of the organization. Specificities of management in healthcare (PEST approach). Donabedian cycle and principles. Pharmaceutical management. SWOT analysis, benchmarking, globalization, outsourcing in the pharmaceutical business. Good Practice Guides GxP (manufacturing, distribution, laboratory, clinical, pharmaceutical). Good practice in pharmacovigilance. ISO standards (ISO 9001, 14000, 31000); integrated quality management. Deming's management paradigm. Pharmaceutical supply chain management. Product category management. Quality Management Systems (QMS) and risk management. Human resource management (HRM). Management of employee competencies, continuous professional development. Motivation. Financial and project management. Marketing management in pharmacy. Management of public health activities, services and medicines. Management of disease treatment. Resource and process management in the biochemical laboratory.</p> <p><i>Practice</i></p> <p>Discussion on topics from processes and functions of management: industry, distribution channels, biochemical laboratory, pharmacy. Donabedian's model of structure, processes and outcomes. SWOT analysis. Good laboratory and pharmaceutical practice. Quality standards in work practice. Cost analysis and rational use of medicines. Case study risk management, quality, marketing, promotional activities, inventory, finance, human resources, education, projects, therapy and disease. Management and motivation.</p>		
Literature:	<ol style="list-style-type: none"> 1. Kotler Ph. Marketing management. Naklada, Zagreb 2004. 2. National Drug Policy WHO (World Health Organization) 2002, Essential drug list 13th, Organization of United Nations, New York, 2005. 		
Number of active teaching:	30		
Lectures:	15	Exercises:	15
Applicable teaching methods:	Lectures, practice, case analysis, e-learning.		
Grading (max. 100 points)			

Pre-exam requirements	Points	Final exam	Points
Lectures	5	Written exam	50
Practical classes	15		
Colloquim	20		
Seminar	10		

Basics of Allergology

Study programes:	pharmacy, pharmacy – medicinal biochemistry		
Name of subject:	Basics of Allergology		
Subjects status:	elective		
ECTS:	3		
Requirement:	none		
Subjects objective:	Make students familiar with basic knowledge of morphology, anatomy, physiology and ecology of plants important for pharmacy learning about the classification systems as information systems, knowledge of a select group of medicinal plants, application of acquired knowledge in problem botanical herbs and other useful plants.		
Subjects outcome:	Independently planning and implementing studies of allergic plants, processing the results, their interpretation and presentation.		
Subjects content:	<p><i>Lectures</i></p> <p>The concept of allergies and the allergy. Contact allergy and plant species that cause them. Morphological and biochemical characteristics of plants that cause contact allergies. Pollen allergy and plant species that cause them. Morphological and micro-morphological characteristics of plants causing pollen allergy. Types of the allergy from groups: Cl. Magnoliopsida: Subcl. Magnoliidae, Subcl. Ranunculidae, Subcl. Hamamelididae, Subcl. Caryophyllidae, Subcl. Dileniidae, Subcl. Rosidae, Subcl. Lamiidae, Subcl. Asteridae. Cl. Monocots: Subcl. Liliidae, Subcl. Commelinidae, Subcl. Arecidae.</p> <p><i>Practical classes</i></p> <p>Getting to know the actual representatives of allergic plants from group Cl. Magnoliopsida: Subcl. Magnoliidae, Subcl. Ranunculidae, Subcl. Hamamelididae, Subcl. Caryophyllidae, Subcl. Dileniidae, Subcl. Rosidae, Subcl. Lamiidae, Subcl. Asteridae. Cl. Monocots: Subcl. Liliidae, Subcl. Commelinidae, Subcl. Arecidae.</p>		
Literature:	<ol style="list-style-type: none"> 1. Abbas Abul K., Lichtman Andrew H., Pilai S.: Основна имунологија - функционисање и poremeћaji имунског система, 5. издање, Дата Статус, Београд, 2016. 2. Abbas Abul K., Lichtman Andrew H., Pilai S.: Cellular and Molecular Immunology, 9th edition, Elsevier, 2018. 3. Geha R., Notarangelo L.: Case Studies in Immunology – A Clinical Companion, 7th edition, Garland Science 2016. 4. Kleine-Tebbe J, Jakob T, editors. Molecular allergy diagnostics: innovation for a better patient management. Springer; 2017. 5. Global Atlas of Allergy. European Academy of Allergy and Clinical Immunology, 2014. 		
Number of active teaching:	30		
Lectures:	15	Exercises:	15
Methods of teaching:	lectures, excersises, case studies		
Grading (maximum 100 points)			
Pre-Exam commitments	Points	Final Exam	Points
Lectures	5	Written exam	50

Practical classes	25		
Colloquium	20		

Rare Diseases

Study programmes:	pharmacy, pharmacy-medicinal biochemistry
Name of subject:	Rare Diseases
Subjects status:	elective
ECTS:	3
Requirement:	none
Subjects objective:	The aim of the course is acquiring knowledge about rare diseases, problems faced by patients with rare diseases, inheritance, epidemiology, clinical picture, diagnostic: clinical and laboratory methods used in medical-biochemical and genetic laboratories in the country and the world, possibilities and method of treatment, social status and prospects for improving the quality of life of patients.
Subjects outcome:	After completing and passing the course, the student will gain knowledge about rare diseases, ways of inheritance, activities undertaken to solve the problems faced by patients with rare diseases, the method of clinical and laboratory diagnosis, types of therapy and methods of treatment. Students will gain knowledge about the most common rare diseases from the group of congenital metabolic diseases, selective tests, basic and specialized enzyme and other diagnostic methods. At the same time, he will acquire knowledge about the status of patients with rare diseases in Serbia and other countries in Europe and the world.
Subjects content:	<p>Theoretical classes</p> <p>Inherited metabolic disease, rare diseases, ways of inheritance, frequency of rare diseases. Division of rare diseases. Symptomatology of certain rare diseases, treatment options and new therapeutic approaches. Integrative algorithms in the diagnosis of rare diseases. Non-selective and selective search for metabolic diseases. Basic metabolic tests, diagnostic tests, confirmation tests. Molecular diagnosis of rare diseases. Biological materials used in the diagnosis of rare diseases. Neonatal screening of hypothyroidism, phenylketonuria, cystic fibrosis. Carbohydrate metabolism disorders, aminoacidopathy, organoacidopathy, lysosomal diseases, peroxisomal disorders, mitochondrial disorders. Diagnosis of lysosomal diseases (sphingolipidosis, mucopolysaccharidosis), oligosaccharidosis, glycogenosis, lipidosis, bullous epidermolysis, tyrosinemia, adrenal insufficiency, Wilson's disease, hemochromatosis.</p> <p>Practical Classes</p> <p>Application of various diagnostic methods in medical-biochemical laboratories used for diagnostics of rare diseases: qualitative tests, chromatographic and electrophoretic techniques, enzyme diagnostic methods - spectrofluorimetric methods, immunochemical methods, mass spectrometry, molecular biotechnology.</p> <p>Searching and obtaining information from NORBS, EURORDIS and ORFANET databases.</p> <p>Introduction to the National Strategy for Rare Diseases of the Republic of Serbia.</p>
Literature:	<ol style="list-style-type: none"> 1. Scriver CR, Beaudet AL, Sly WS, Valle D, eds. The metabolic and molecular basis of inherited disease. New York: McGraw Hill Inc 1995: 2641–70. 2. Blau N, Duran M, Gibson KM, Blaskovics, et al. Physician ' guide to the laboratory diagnosis of metabolic diseases. Heidelberg, Germany: Springer 2002. 3. Kahler SG, Mayatepek E. Disorders of Intermediary Metabolism. In: Hoffmann GF, Nyhan WL, Yschocke J, Kahler SG, Mayatepek E, eds. Inherited metabolic diseases. Philadelphia: Lippincott Williams & Wilkins 2002. <p>Jadranka Sertić. Clinical chemistry and molecular diagnostics. Medicinska naklada, Zagreb, 2008. (Fumić Ksenija, Bilić Karmen. Laboratory diagnostics of hereditary metabolic disorders, 118-122)</p>

Number of active teaching: 30			
Lectures: 15		Exercises: 15	
Methods of teaching: lectures, exercises, e-learning, use of ORFANET database, NORBS, EURORDIS			
Grading (maximum 100 points)			
Pre-Exam commitments	Points	Final Exam	Points
Lectures	5		45
Practical classes	10		
Colloquium	30		
Seminar	10		

Sociology and Healthcare

Study Programme:	pharmacy, pharmacy – medical bioshemistry
Name of subject:	Sociology and Healthcare
Subject status:	elective
ECST Value:	3
Prerequisite:	none
Course Goals and Objectives:	The objective of the course is to acquaint students with the origin and theory of sociology in healthcare, the interactions of sociology and healthcare, social pharmacy. The goal of the course is to point out the interconnection and impact of society on the health of an individual / population and vice versa. Defining and perceiving health and illness and transitioning into one another. Point out the social determinants of health and illness. Point to the convergence of social disciplines related to population health (anthropology, sociology, epidemiology). A sociological account of the role of the healthcare professions in society, obligations and responsibilities, from its inception to the present. Familiarity with the concept and importance of healthcare culture and public health promotion.
Course outcomes:	The student is familiar the historical basics of the development of the healthcare profession in society, and the impact of society on the development of the healthcare professions. The student understands the professional and social role of the pharmaceutical profession and its modification through social, demographic and epidemiological transition. The student is familiar with the social factors that influence health and new philosophies of health promotion and disease prevention. The student knows the concept and role of healthcare professionals in promoting health and promoting healthcare culture. The student recognizes social and health aspects and indicators of health/disease, their evolutionary development and differentiation. The student is competent to recognize the health risks and resources of the community.
Course content:	<p><i>Theory</i></p> <p>Lectures: Subject of healthcare sociology and social pharmacy. Sociology in healthcare and pharmacy. Relationship between society and health / illness. Health and drug policy. Socio - epidemiological model of disease. Professional and layman's concept of health and disease. Basic principles and limitations of biomedical paradigm and reasons for proliferation of alternative and complementary medicine. Parsons functional concept of social role of healthy/ill individual. Interpretation of the <i>disease, illness, sickness</i> paradigm. Health and disease indicators within a community. Development of the concept of health promotion, the role of pharmacists in society and the promotion of public health. Social marketing. Professional associations and organizations (chambers), organizations and associations for the promotion and preservation of health</p> <p>Analytical - critical discourse: causes and consequences of medicalization of life and society; commercialization of health; media influence; placebo effect; stigmatization in society; symbols of stigma; vulnerable groups; stress;</p> <p><i>Practice</i></p> <p>Case study analysis, panel discussions, homework on a given topic: cause-and-effect relationship between health/illness and society; the role of health professionals in society; public healthcare activities - health, economic and social aspects</p>

Literature:			
1. Taylor S., Field D. (eds):“Sociology of Health and Health Care“. Third Edition. Blackwell Publishing, 2003.			
Number of active teaching: 30			
Lectures: 15	Exercises: 15		
Applicable teaching methods: Interactive lectures, practice, discussions.			
Grading Scheme (max. 100 points)			
Pre-exam requirements	Points	Final exam	Points
Lectures	5	Written exam	50
Practical classes	15		
Colloquim	20		
Seminar	10		

Natural raw material in pharmaceutical industry

Study programes: pharmacy	
Name of subject: Natural raw material in pharmaceutical industry	
Subjects status: elective	
ECTS: 3	
Requirement: none	
Subjects objective: Introduction with biology, ecology and the basis of prokaryotic and eukaryotic taxonomy of algae, fungi and lichens, to be able to understand their phylogeny, distribution and importance in natural ecosystems.	
Subjects outcome: After completing the course student should be able to recognize morphology and active principles in of most significant raw material in pharmaceutical industry. The outcome of this course is to understand the essence of phylogenetic relatedness, and in particular the diversity of algae, fungi and lichens, as well as their indicator properties.	
Subjects content: <i>Lectures</i> General characteristics of algae and their basic stages of the talus. Establishing knowledge prokaryotic and eukaryotic algae cell structure, and a summary of their methods of reproduction, development cycle and ecology. Introduction to biology of most significant phylum of algae, fungi as well as the characteristics and biology of lichenes. Introducing the most significant organic products and their active principles. <i>Practical classes</i> Practical learning from lectures through the introduction of individual genera of algae, fungi and lichen-members of the taxa treated in the theoretical teaching. E-learning, field teaching. Preparations for field work. The choice of equipment and materials depending on the type of research and the type of terrain. Place for the collection of plants, selection of individuals, the manner warehousing plants until maturity in the lab, writing characters that are changing the collected material, the necessary data to the temporary labels. Specific procedures in gathering moss, ferns, woody and herbaceous plants, succulents. Specifics of the determination of the selected groups. Visit to Ettera- Essential oil producer.	
Literature: 1. Brodie J, Lewis J, Unravelling the algae: the past, present, and future of algal systematics (Systematics Association Special Volumes Book 75) 1st Edition, Kindle Edition, CRC Press, London, 2007.	
Number of active teaching: 30	
Lectures: 15	Exercises: 15
Methods of teaching: lectures, excercises	
Grading (maximum 100 points)	

Pre-Exam commitments	Points	Final Exam	Points
Lectures	5	exam	50
Practical classes	30		
Colloquium	15		

First Aid

Study programs: pharmacy, pharmacy - medical biochemistry			
Name of subject: First Aid			
Subjects status: elective			
ECTS: 3			
Requirement: none			
Subjects objective: Introducing students to principles of initial help to suddenly injured or diseased patients. Acquisition of basic knowledge and skills in the field of first aid, basic measures of resuscitation and the basics of assessment of life threatening patients and first aid in case of injuries and other emergencies. Learning skills for immediate management of the injured, protecting their life as well as the life of a helper and the environment.			
Subjects outcome: Student: Acquires the skills of examining and recognizing signs and symptoms that require prompt and immediate reaction; Acquires knowledge about safe handling of defibrillators and recognition of life-threatening conditions; Acquires the skills to perform a "rapid trauma examination"; Introduced to the conditions in which first aid can be useful.			
Subjects content: <i>Lectures</i> Definition and significance of first aid. Cardiorespiratory arrest and resuscitation. Basic life support procedures. Defibrillator application. Systematic approach to the life-threatening patient. Initial assessment of the severely injured. First aid for injuries and other emergencies. Resuscitation. <i>Practical classes</i> Practical teaching is done on models and situation simulations-students among themselves: Examination and triage of the injured. Evacuation of the injured (retrieval, removal and transport). Assessment of vital functions and states of consciousness. Airway maintenance and securing airways. Bolus obstruction - partial, total, procedure algorithms in adults and children. Artificial respiration with expiratory air. Appropriate positions for injured or suddenly diseased patients (lateral-relaxing, semi-lateral, abdominal, semi-lying, semi-sitting, sitting, knee-elbow, kneeling, autotransfusion position). Sudden cardiac arrest - recognition and basic resuscitation methods in adults and children. Application of automatic external defibrillators (AED). Algorithm of basic resuscitation measures in adults and children. Bleeding-recognition and care procedures for external and internal bleeding. Care procedure for traumatic amputation. Open injuries (wounds). Injuries of the musculoskeletal system (term, types). Temporary immobilization. Injuries to the head and spine. Chest and abdomen injuries. Disposal procedures. Complications and prevention of their occurrence. Heat and electricity damage and disposal. Special injuries, diseases, conditions and care.			
Literature 1. ERC (european resuscitation council) e-platform 2016. BLS manual 2016 (PDF). 2. ERC (european resuscitation council) ALS manual 2016 (PDF). Pediatric ALS 2016 (PDF).			
Number of active teaching: 30			
Lectures: 15		Exercises: 15	
Methods of teaching: Interactive lectures, practical classes: demonstrations and simulations of suddenly injured and sick people, providing immediate and initial care. Work on models.			
Grading (maximum 100 points)			
Pre-Exam commitments	Points	Final Exam	Points
Lectures	5	Written exam	50

Practical classes	25		
Colloquium	20		

Dietary Products

Study programmes: pharmacy, pharmacy – medical biochemistry			
Name of subject: Dietary Products			
Subjects status: elective			
ECTS: 3			
Requirement: Dietetics			
Subjects objective: Introduction of dietary products, food for specific population groups, foods specifically formulated to have particular nutritive content, food supplements and novel food, their content and purposes, relevant legislative in Republic of Serbia, EU, and in the world, in order to give proper advices to the consumer.			
Subjects outcome: Student will be able to consider critically informations about the product on the declaration, helps with the dosage and way of application, advice about possible side effects and interactions, give advice to the consumer in selection of the product, compatible with its health status and needs.			
Subjects content: <i>Lectures</i> Definition of various food categories and subcategories, actual legislative in RS, EU and in the world, main rules in giving advices to the consumers, main ingredients in various food categories, quality, quantity of the ingredients, purpose, side effects, interactions: vitamins, minerals, antioxidants, macronutrients, novel food, different types of herbal ingredients, algae and mushrooms, probiotics etc. <i>Practical Classes</i> Introduction of actual legislative in RS, EU and in the world pertaining the named categories of food. Declaration analysis of commercially available products – ingredients, claims, mandatory notes, nutritive declaration etc. Simulation of communication with the consumer in order to get important informations from him and giving the proper, personalized advice about food selection and purchase. Creating the new, defined product, from the ingredient list to the launching on the market.			
Literature: 1. Coates PM, Betz JM, Blackman MR, Cragg GM, Levine M, Moss J, White JD. (editors): <i>Encyclopedia of dietary supplements</i> , 2 nd ed. (2010). Informa Healthcare, New York, London. 2. Caballero B. <i>Guide to nutritional supplements</i> (2009). Elsevier Ltd., Oxford, UK. 3. Hendler SS, Rorvik D. <i>PDR for nutritional supplements</i> , 2nd Ed. (2008). Thompson Reuters, USA 4. Braun L, Cohen M.: <i>Herbs and natural supplements</i> , An evidence-based guide, 3 rd ed. (2010). Elsevier, Australia. 5. <i>ESCOP monographs on the medicinal uses of plant drugs</i> , 2 nd ed. (2009). Completely revised and expanded, Supplement, ESCOP, Devon, UK.			
Number of active teaching: 30			
Lectures: 15	Exercises: 15		
Methods of teaching: lectures, case studies, e-learning			
Grading (maximum 100 points)			
Pre-Exam commitments	Points	Final Exam	Points
Lectures	5		65
Practical classes	30		

Integrative medicine

Study program: pharmacy
Name of subject: Integrative medicine
Subjects status: elective
ECTS: 3
Requirement: none
Subjects objective <p>The aim of the course is to provide students with basic information about the new approach in medicine that is developing at the beginning of this century in the west and in the east, and involves combining all knowledge of medicine, ie integration of conventional, allopathic medicine with clinically and scientifically proven branches of complementary medicine. Here the patient is placed in the center and an individual, ie personalized approach is developed. Each patient is unique and is viewed holistically, as a unity of body, ie matter, energy and soul, where health is influenced by numerous internal and environmental factors. The aim of the program is to acquaint the student with the scientific bases and evidence (evidence-based) of integrative medicine, especially those branches that are the most researched and have the most studies. Basic information is obtained on individual techniques as principles of operation of the most important complementary branches of medicine, indications and efficacy as well as new clinical studies where they are applied together with conventional medicine in both diagnostic procedures and therapy; provides prerequisites for considering an integrative, comprehensive, holistic approach in diagnosis and therapy.</p>
Subjects outcome <p>After completing the course, the student will be able to make logical judgments about different approaches to therapy and treatment; approaches to therapy and treatment studied by integrative medicine; will have broader horizons, will better understand patients as individuals; will have a better understanding of the personalized and individual approach to the patient; will have knowledge about the indications and effects of treatment of complementary branches of medicine, the current situation of different types of complementary medicine in the world and in Serbia, as well as trends in the development of integrative medicine in the world. Also, the student will be able to interpret the current legal regulations in Serbia related to the branches of complementary medicine.</p>
Subjects content <p><i>Lectures</i></p> <p>Scientific basis, based on psycho-immuno-neuro-endocrinology (PNEI). Presentation of basic concepts and definitions of conventional, integrative, complementary and alternative medicine, as well as the principles of holistic approach and approach of integrative medicine. Historical development and presentation of the prevalence of integrative medicine in the world. Concepts and techniques that today are classified as unconventional treatment techniques. Basics of Traditional Medicine, primarily Traditional Chinese Medicine which includes Acupuncture and related branches (acupressure, laser therapy, magnetotherapy, moxa, etc.), Chinese phytotherapy, Tai-yin (Chinese yoga), Tuina massage, Tai-chi-chuen, Qi-gong; Traditional Indian branches (Ayurveda, Yoga, Unani, Sidha and Homeopathy); Quantum medicine (Bioresonance therapy-BRT; Microresonance therapy-MRT; Bi-Digital O-Ring Test-BDORT, Information medicine: color therapy, music, sound -MMT, aromatherapy, crystal therapy, dance; oxidative stress and antioxidants; herbal, vitamin, mineral, peptide supplements, homeopathy, unconventional dietary approaches, food intolerance, liki-gat syndrome (permeable bowel syndrome), application of cold-pressed and essential oils, manipulative therapies (osteopathy, chiropractic), naturopathy, body-mind relaxation techniques (yoga, meditation, tai chi, autogenic training, hypnosis, NLP, Theta Healing, etc.), the importance of prayer, massage (shiatsu, reflexology), Bowen technique, use of saunas, organization of wellness and spa centers, anthroposophical medicine, mud therapy, water therapy, reiki, environmental and housing medicine -toxins, non-ionizing (antennas, mobile phones, electrical devices, wireless internet) and ionizing electromagnetic radiation, protection, detoxification of the organism. An integrative approach to women's health and reproductive health; Integrative approach to children's health (autism, attention deficit, hyperactivity disorder), Integrative approach in oncology; Integrative approach in internal medicine; Integrative approach to pain; Traditional medicine of the Balkans and Europe; Safety when choosing or using complementary medicine methods.</p> <p><i>Practical Classes</i></p> <p>The modern approach enables understanding and mastering of the problem of disease occurrence, influence of external and internal factors, practical learning of some diagnostic and therapeutic procedures. Basics of</p>

acupuncture channels, main acupuncture points, determination of food intolerance, detection of weak points of the organism. Introduction to real cases. Discussion. Case study. Internet presentations. Visit to the field (wellness and spa centers, integrative medicine practices).

Interactive, problem-oriented teaching will solve problems related to the application of integrative medicine.

Literature

1. Kligler Benjamin, Lee Roberta: Integrative Medicine principles for practice, Program in Integrative Medicine, University of Arizona. McGraw-Hill Companies, NY, Chicago, London, Madrid, Milan, Sydney, Toronto, Singapur, New Delhi, 2004.
2. Leonard A. Wisneski , Lucy Anderson: The Scientific Basis of Integrative Medicine, 2nd edit, © 2009 by Taylor and Francis Group, LLC, CRC Press is an imprint of Taylor & Francis Group, an Informa business, ISBN 978-1-4200-8290-6
3. Bruce Pomeranz, Gabriel Stux. SCIENTIFIC BASES OF ACUPUNCTURE. Springer-Verlage, 1989 ISBN 978-3-540-19335-7
4. Yoshiaki Omura: A Pratica do Teste do Anel Bidigital-BDORT, Associacio Medica Brasileira de Acupuntura, Sao Paulo 2000, Brasil
5. Aaron E Katz: Dr. Katz's Guide to Prostate Health- From Conventional to Holistic Therapies, Freedom Press, Ca, 2006, ISBN 1-893910-37-7
6. Jane Lyttleton: Treatment of Infertility with Chineseac Medicine, Churchill Livingstone 2004, ISBN 0443 06640X
7. Atlas of Therapeutic Motion For Treatment and Health- A Guide to Traditional Chinese Massage and Exercise Therapy, Foreign Languages Press, Beijing, 1989 , ISBN: 0-8351-2306-5
8. Maya Tiwari: Ayurveda A life of Balance, Inner Traditions India HomeOffice, Rochester, Vermont, USA, 1995, ISBN 0-89281-676-7
9. Mones Abu-Asab, Hakima Amri, Marc Micozzi: AVICENNA'S MEDICINE, A New Translation of the 11th Century Canon with practical Applications for Integrative Health Care. Healing Arts Press, Rochester, Vermont, Toronto, Canada, 2013 ISBN 978-1-59477-432-4
10. Dr. William Shaw: Biological Treatments for Autism&PDD, The latest Research On Causes and Biomedical Therapies for Autism and PDD. 3rd edition, 2008 ISBN0-9661238-1-6.

Number of active teaching: 30

Lectures: 15 **Exercises:** 15

Methods of teaching
interactive lectures, group exercises

Grading (maximum 100 points)

Pre-Exam commitments	Points	Final Exam	Points
Lectures	5	Written Exam	65
Practical classes	30		

Biologics and Immunotherapy

Study programes: pharmacy, pharmacy - medical biochemistry

Name of subject: **Biologics and immunotherapy**

Subjects status: elective

ECTS: 3

Requirement: Immunology

Subjects objective:

To provide basic knowledge about biologics, their development, pharmacoeconomic aspects, legislative, pharmacokinetic / pharmacodynamic characteristics as well as pharmacotherapeutic application. Understanding the difference between a biologics and a low molecular weight drug, as well as the difference between a biologics and its generic equivalent - biosimilar. Providing basic knowledge about the role of biological drugs and immunotherapy in the treatment of various diseases, such as cancer, autoimmune diseases and chronic inflammatory diseases. The aim of the course is to enable the understanding of the different immunotherapeutic approaches currently in use.

This course is designed with a special focus on the mechanism of action and therapeutic aspect of biologics as well as the most important immune signaling pathways in the cell as the site of action of biologics.			
Subjects outcome:			
Upon completion of course students will be familiar with the concepts related to rational use of biologics and basic concepts of immunotherapy. Students will be introduced to the modern immunotherapeutic strategies for the treatment of cancer, autoimmune diseases, chronic inflammatory and other diseases. Students will developed the ability to perceive the advantages and limitations of the use of biologics and immunotherapy with special focus on the future trends in the development of immunotherapy.			
Subjects content:			
<i>Lectures</i>			
Types and functions of major immune cells. Functions of key molecules that play important roles in the immune system. Involvement of the immune system in some diseases. Possible treatments of some diseases through control of the immune system. Definition of biologics, mechanism of action, differences between classical drugs and biologics, classification of biologics. Biologics used in various cancers, rheumatoid arthritis (RA), ankylosing spondylitis, Crohn's disease, ulcerative colitis, psoriasis, asthma.			
<i>Practical Classes</i>			
Working on case studies and concrete examples. Problem based learning and problem solving. The role of pharmacists in the application of biological drugs and immunotherapy in human medicine. Demonstration of the ability to identify, think critically and address current issues related to biological drugs / immunotherapy used in modern medicine			
Literature:			
1. Naing A. Hajjar J. Immunotherapy, Springer International Publishing, 2018.			
2. Lopci E. Fanti S. Atlas of Response to Immunotherapy, Springer 2020.			
3. Dong H. Markovic S. The Basics of Cancer Immunotherapy, Springer International Publishing, 2018			
4. Singh, A. B. Allergy and allergen immunotherapy : new mechanisms and strategies, Apple Academic Press Inc 2017.			
5. Ganellin C. Jefferis R. Roberts S. Introduction to biological and small molecule drug research and development, Elsevier, 2013.			
Number of active teaching: 30			
Lectures: 15	Exercises: 15		
Methods of teaching:			
interactive lectures, practical classes, analysis and problem solving.			
Grading (maximum 100 points)			
Pre-Exam commitments	Points	Final Exam	Points
Lectures	5		60
Practical classes	35		

Information Systems in Pharmacy

Study programmes:	pharmacy, pharmacy - medical biochemistry
Name of subject:	Information Systems in Pharmacy
Subjects status:	elective
ECTS:	3
Requirement:	none
Subjects objective:	The objective of this course is to provide students with the basic knowledge in the area of application of computer science in pharmaceutical science, practice and studying. Learning the theory and practice of information processes (collecting, transferring, storage and processing the data), and the importance of content, development and application of information technology in pharmaceutical practice.
Subjects outcome:	

After passing the exam, the student is qualified to apply the knowledge of basic software tools, multimedia and internet, in real situations in the pharmaceutical practice. Student is competent for collecting, storage and processing the data in pharmaceutical practice, analysis of feedback information and understanding of information systems in healthcare system (pharmaceutical science, practice and education).

Content of the course:

Theoretical classes

Multidisciplinary basis of informatics use of information technology in healthcare systems. Data protection in healthcare systems. Specific software used in pharmacy practice. Healthcare information system, types and reach. Laboratory information system, hospital information system. Medical data. Medical documentation, electronic data record (e-health card, e-prescription). Integrated healthcare system of Republic of Serbia – IZIS; Project „My doctor“. Nomenclature and classification systems in healthcare system: international classification of disease, injuries and cause of death; Anatomical Therapeutic Chemical classification of drugs (ATC classification); JKL classification; EAN standards. Drug information sources (Evidence based medicine); software for prevention and detection of drug-drug interactions. Telemedicine and telepharmacy; pharmaceutical sciences in virtual world. Biometrics. E-learning. Safety standards in pharmaceutical data informatics.

Practical classes

Internet. HTML. Windows. Word. Excell. Power-point. The specific software used in pharmacy and laboratory practice.

Literature:

1. Anderson PO, McGuinness SM, Bourne PE. Pharmacy Informatics. CRC Press, Boca Raton, London, New York, 2010
2. Rule book for the form and content of drug prescription, ways of issuing and drug prescribing ("*Official gazette RS*", number 74/2018, 87/2018, 47/2019)

Number of active teaching: 30

Lectures: 15

Exercises: 15

Methods of teaching:

interactive lectures, practical exercises, practical work on computer.

Grading (maximum 100 points)

Pre-Exam commitments	Points	Final Exam	Points
Lectures	5	Exam	65
Practical classes	30		

OTC Therapy

Study programmes:	pharmacy
Name of subject:	OTC therapy
Subjects status:	elective
ECTS:	3
Requirement:	none
Subjects objective:	To provide knowledge about the therapy of the most common minor ailments - medical conditions that can be treated through the concept of self-care and self-medication, which do not require laboratory diagnosis and usually do not require a visit to the medical doctor. To give the student a generalist knowledge to the basic cause(s) and occurrence of each condition covered, to be able to recognize the signs/symptoms of the condition as well as a clear distinction at what point it is necessary to refer the patient to a medical doctor. To provide knowledge about OTC drugs, basic mechanism of action, indications, contraindications, side effects and interactions. This course will help you gain a better understanding of how non-prescription and self-care products can be used safely and effectively.
Subjects outcome:	Upon completion of this course, students will be familiar with the concept of self-care and self-medication and the most common minor ailments. Student understands the importance of selecting the adequate OTC drug, practices efficient and safe use of OTC drugs. The student is able to clearly recognize which medical conditions require referral to the medical doctor, is able to recognize the symptoms and signs of these medical conditions and to

provide information and advice to the patient about the dose and appropriate use of OTC product, mechanism of action, side effects, possible interactions, contraindications, as well as over-the-counter medicine precautions.			
Subjects content:			
<i>Lectures</i>			
Epidemiology, etiology, pathophysiology, signs and symptoms of the most common medical conditions that can be treated through the concept of self-care. Drugs used in the treatment of respiratory diseases (sore throat, cough, allergic rhinitis, flu, colds), gastrointestinal tract problems (mouth ulcers, heartburn, motion sickness, nausea, vomiting, indigestion, constipation, diarrhea, haemorrhoids), skin conditions (eczema, dermatitis, acne, alopecia, psoriasis, sun protection, viral and bacterial skin infections, parasitic skin diseases), women's health (cystitis, dysmenorrhoea, premenstrual syndrome, menorrhagia, vaginal thrush, emergency hormonal contraception, common symptoms in pregnancy), men's health (lower urinary tract symptoms, erectile dysfunction and hair loss), painful conditions, insomnia, eye and ear diseases.			
<i>Practical Classes</i>			
Working on case studies and pharmacy practice examples. Critical thinking and analysis, problem based learning, scientific research, self-directed learning and efficient use of modern technology in professional practice. The role of pharmacists in promoting safe and effective self-care. Work aimed at mastering the techniques of active communication with patients in order to provide adequate healthcare information and advice.			
Literature:			
1. Blenkinsopp A. Duerden M. Blenkinsopp J. Symptoms in the Pharmacy A Guide to the Management of Common Illness, John Wiley & Sons Ltd 2018			
Number of active teaching: 30			
Lectures: 15	Exercises: 15		
Methods of teaching:			
interactive lectures, practical classes, analysis and problem solving.			
Grading (maximum 100 points)			
Pre-Exam commitments	Points	Final Exam	Points
Lectures	5		60
Practical classes	35		

Computational Chemistry for Pharmacists

Study programmes:	pharmacy, pharmacy - medical biochemistry
Name of subject:	Computational Chemistry for Pharmacists
Subjects status:	elective
ECTS:	3
Requirement:	Pharmaceutical Organic Chemistry I
Subjects objective:	Introduction to theoretical principles and methods used in computational chemistry with procedures and applications in drug design and prediction of their activities and toxicity. Practical sessions will prepare students to use software for structure generation and analysis, and prediction of their activities.
Subjects outcome:	After passing the exam the student: <ul style="list-style-type: none"> will have the understanding of the theoretical basis and knowledge of key terms used in computational chemistry relevant applied in pharmaceutical sciences. will have an understanding of the computer aided drug design principles. will be able to utilize information from molecular structure data banks and selected computational chemistry software. will be able to predict relevant molecular properties and activities by following provided instructions.
Subjects content:	
<i>Lectures</i>	

<p>Various representations of small molecules. Graphical representations of biomolecules. Molecular structures databanks. Basis of molecular modelling. Molecular mechanics. Conformational analysis. Molecular dynamics. Molecular similarity. Molecular properties prediction. Molecular docking. Molecular mechanism of drug action prediction. Toxicity prediction based on off-target interactions. Methods for ADME predictions.</p> <p><i>Practical classes</i></p> <p>Use of the chemical drawing software. Three-dimensional structure generation and optimization of a drug molecule. Molecular dynamics of a molecular system. Searching of molecular structure data banks. Molecular docking. Use of web servers for ADME prediction. Group discussions. E-portfolio preparation.</p>			
<p>Literature:</p> <p>1. Hinchliffe A. Molecular Modelling for Beginners, Wiley, 2004.</p>			
<p>Number of active teaching: 30</p>			
<p>Lectures: 15</p>		<p>Exercises: 15</p>	
<p>Methods of teaching:</p> <p>lectures, practical classes, demonstrations, exercises.</p>			
<p>Grading (maximum 100 points)</p>			
<p>Pre-Exam commitments</p>		<p>Final Exam</p>	
<p>Points</p>		<p>Points</p>	
<p>Lectures</p>		<p>Exam</p>	
<p>Practical classes</p>			
<p>Colloquim</p>			

Marketing in Pharmacy

<p>Study programme:</p>	<p>pharmacy, pharmacy - medical biochemistry</p>
<p>Subject Title:</p>	<p>Marketing in Pharmacy</p>
<p>Course status:</p>	<p>compulsory</p>
<p>ECST Value:</p>	<p>3</p>
<p>Prerequisite:</p>	<p>none</p>
<p>Course objectives:</p> <p>The objective of this course is for the student to: learn the basic principles of pharmaceutical marketing; be familiar with modern methods of marketing strategies; be familiar with all activities and processes within the marketing function, communication processes that take place in marketing activities; development of marketing manager competencies; recognizing the specificity of marketing in pharmacy.</p>	
<p>Course outcome:</p> <p>Training students to independently apply the principles of pharmaceutical marketing, planning, organizing, managing and controlling marketing activities in pharmacy, market research, and mastering analytical methods for assessing market conditions (SWOT and portfolio analysis); understanding the specificity of marketing in the pharmaceutical industry and the notion of added value in pharmaceutical strategic management.</p>	
<p>Course content:</p> <p><i>Theory</i></p> <p>General principles of marketing and strategic marketing. Planning, organizing, managing and controlling marketing activities. Marketing mix. Enlightened marketing by Kotler. Market research methods (APIC - analysis, positioning, implementation, control). Market segmentation. Client needs analysis. Consumer Relationship Marketing (CRM). Marketing of pharmaceuticals. Categorization of products in the pharmaceutical market. Product portfolio. Post-marketing drug monitoring. Marketing of services. Good service cycle. Customer Satisfaction Measurement (CSM). Communication in marketing. Promotional activities in pharmacies. Public health and social marketing. Digital Marketing. Regulation and ethics in advertising and marketing of pharmaceutical products and services.</p> <p><i>Practice</i></p> <p>Practical examples of theoretical units are studied, analyzed and discussed within the exercises. Workshop examples of marketing strategies and methods in selected therapeutic drug groups for selected markets. Market research methods: APIC (analysis, positioning, implementation, measurement), strengths, weaknesses, chances and threats (SWOT), Boston Consulting Group (BSG) matrix, AIDA concept (attention, interest, desire, action). Position analysis of specific products and services compared to competing products / services (benchmarking).</p>	

Digital marketing channel analysis. Pharmaceutical Marketing Code (IFPMA). Design and defense of seminar paper.			
Literature:			
1. Kotler Ph. Marketing management. Data status, Belgrade, 2006.			
2. Bateson E.G., Hoffman D. „Services Marketing“; Edition 4, Data status, Belgrade, 2013.			
Number of active teaching: 30			
Lectures: 15	Exercises: 15		
Applicable teaching methods:			
Lectures, case analysis, discussions, e-learning.			
Grading Scheme (max. 100 points)			
Pre-exam requirements	Points	Final exam	Points
Lectures	5	Exam	50
Practical classes	15		
Colloquim	20		
Seminar	10		

Pharmacotherapy of Skin Diseases

Study program: pharmacy
Name of subject: Pharmacotherapy of Skin Diseases
Subjects status: elective
ECTS: 3
Requirement: Pharmacology
Subjects objective:
To enable students to understand the basic concepts in dermatology, the basic principles of treatment of the most common skin diseases, as well as to enable understanding of the pathophysiology of skin diseases and the role of drugs in achieving the desired therapeutic outcomes. To provide knowledge for understanding the mechanism of action, indications, dosage, side effects, drug interactions, therapeutic monitoring, duration of therapy with local and systemic drugs in dermatology. To enable the student to understand the existing challenges and limitations in the treatment of skin diseases such as the occurrence of adverse drug reactions, the impact of pharmacogenomics or inadequate adherence to the therapeutic outcome. An additional goal of the course is to develop an understanding of the role of pharmacists in the prevention of skin diseases, as well as in the therapy of susceptible populations.
Subjects outcome:
After passing the exam, the student recognizes diverse skin diseases, participates in their prevention and understands the basics of treatment of the most common skin diseases. The student applies knowledge of skin anatomy / physiology and selects appropriate therapy based on skin biology; communicates with the patient and health professionals about the risks and benefits of systemic or local therapy. The student is able to anticipate and avoid potential drug-drug interactions, including complementary drugs.
Subjects content:
<i>Lectures</i>
Basic anatomy and physiology of the skin. Bacterial, viral and fungal infections of the skin. Skin ulcerations. Atopic and contact dermatitis. Psoriasis. Acne vulgaris (acne). Hair loss. Rosacea. Pigmentary disorders. Topical and systemic drugs in dermatology.
<i>Practical classes</i>
Working on case studies and concrete examples. Problem based learning and problem solving. Role of pharmacist in identification of clinical features, differential diagnosis and management of common skin disorders.
Literature:
1. Bosiljka M. Lalević-Vasić, Ljiljana M. Medenica, Miloš M. Nikolić. Dermatologija sa propedeutikom, Medicinski fakultet Beograd, 2019.
2. Đorđe Karadaglić, Dermatologija, Vojnoizdavački zavod Beograd, 2016.

Number of active teaching: 30			
Lectures: 15	Exercises: 15		
Methods of teaching: interactive lectures, practical classes, analysis and problem solving.			
Grading (maximum 100 points)			
Pre-Exam commitments	Points	Final Exam	Points
Lectures	5	Written exam	60
Practical classes	35		

Pharmacotherapy of Special Populations

Study programmes: pharmacy	
Name of subject: Pharmacotherapy of Special Populations	
Subjects status: elective	
ECTS:	3
Requirement: Pharmacology	
Subjects objective: The course aims to acquire basic knowledge about the specifics of drug use within different population groups, as well as the impact of population group characteristics on the safety and efficacy of pharmacotherapy. To enable understanding of the benefits and risks of drug use in the treatment of infants, children, adolescents, pregnant women, geriatric populations, and different ethnic groups with a focus on the pharmacokinetic, pharmacodynamic, and physiological/pathological characteristics of these populations. Introducing students to various tools designed to ensure safe and effective therapy for different population groups.	
Subjects outcome: After passing the exam, the student can understand the importance of population characteristics and the importance of adapting the pharmacotherapeutic approach from the aspect of promoting efficient and safe use of drugs. The student can understand the specifics of pharmacotherapy of the most common diseases of different population groups. The student can contribute to the emergence of positive therapeutic outcomes within different population groups.	
Subjects content: <i>Lectures</i> Epidemiology, etiology, pathophysiology, signs, symptoms, and tests relevant to the pharmacotherapy of common disorders/diseases of different population groups. Use of drugs in the treatment of the most common diseases of various population groups, including infants, children, adolescents, the elderly, pregnant and lactating women, patients with kidney and liver diseases, ethnic groups. <i>Practical Classes</i> Working on case studies and concrete examples. Critical thinking and analysis, problem solving, scientific inquiry, self-directed learning and the effective use of modern technology for professional practice. Role of pharmacist in management of common disorders/diseases in special groups.	
Literature: 1. H. P. Rang, J. M. Ritter, R. J. Flower, G. Henderson. Pharmacology, 8 th edition. Data Status 2019. 2. Joseph DiPiro, Gary Yee, L. Michael Posey, Stuart T. Haines, Thomas D. Nolin, Vicki Ellingrod Pharmacotherapy: A Pathophysiologic Approach, Eleventh Edition 11th Edition New York; Toronto: McGraw-Hill Medical. 2020.	
Number of active teaching: 30	
Lectures: 15	Exercises: 15
Methods of teaching: interactive lectures, practical classes, analysis and problem solving.	

Grading (maximum 100 points)			
Pre-Exam commitments	Points	Final Exam	Points
Lectures	5		60
Practical classes	35		

Scientific Research

Study programmes:	pharmacy, pharmacy – medical biochemistry		
Name of subject:	Scientific Research		
Subjects status:	elective		
ECTS:	3		
Requirement:	none		
Subjects objective:	To get students acquainted with the basic principles of scientific research, as well as their training in scientific research.		
Subjects outcome:	Mastering the necessary knowledge that will equip the student for scientific research work. It should provide students with training in the preparation of diploma work as well as other scientific papers in the field of pharmacy. Introduction to electronic search engines, databases and scientific journals.		
Subjects content:	<p><i>Lectures:</i> History and philosophy of science, Importance of scientific work, Education and choice of scientist, Choosing a topic for scientific work, Research methodology, Collecting, arranging and studying literature, Reviewing literature and creating a scientific hypothesis, Planning and performing experiments, Processing and presenting data, Types of conclusion, Processing of research results, Methods of citing literature, Preparation of manuscripts for scientific work for the press, Application, preparation and defense of the diploma work, Writing other types of publications, Evaluation of scientific work, Development of scientific projects</p> <p><i>Practical Classes:</i> Techniques for collecting, arranging and studying literature. Browse selected electronic databases. Processing research results. Writing a scholarly paper. Citation of literature (Vancouver and Harvard style), Analysis of primary publications in the field of pharmacy, Index Medicus (abbreviations of Journal titles), Analysis of domestic and foreign scientific meetings (Seminar, Symposium, Conference, Congress), SCI, Scindeks, WOS, High IF Journals, Monographs</p>		
Literature:	1. Electronic databases		
Number of active teaching:	30		
Lectures:	15	Exercises:	15
Methods of teaching:	Lectures, practical classes, seminars		
Grading (maximum 100 points)			
Pre-Exam commitments	Points	Final Exam	Points
Lectures	5	Written exam	60
Practical classes	25		
Seminar	10		

Organization of Healthcare Activities

Study programme:	pharmacy, pharmacy - medical biochemistry
Name of subject:	Organization of Healthcare Activities
Subject status:	elective
ECST Value:	4
Prerequisite:	none
Subject Objective:	

The objective of the course is to acquaint the student with the basics of organization of healthcare institutions and the healthcare sector. Understanding the legal framework within which the healthcare system of the Republic of Serbia functions.

To acquaint the student with the most important regulations in the Republic of Serbia governing: healthcare activity; pharmaceutical healthcare; testing, production, marketing, pharmacovigilance, quality control and supervision of medicines and medical devices; rights, obligations, tasks and goals in the field of healthcare; health insurance rights and obligations; patient rights; organization of environmental law, work of chambers of healthcare professionals.

Subject outcomes:

After passing the exam, the student will be able to explain the basic elements of the healthcare system of the Republic of Serbia; state and explain the regulations governing healthcare and healthcare institutions in the RS at the primary, secondary and tertiary levels; analyze the public healthcare service network, explain the principles, system and types of health insurance; state the basic procedures for testing and marketing, manufacturing, pharmacovigilance, advertising, quality control and supervision of medicines and medical devices. After passing the exam, the student will be able to join the current healthcare system of the Republic of Serbia by applying professional knowledge in the implementation of pharmaceutical healthcare in compliance with the applicable legal regulations.

Subject content:

Theory

Healthcare system, functions, development and goals. Medical technology. Healthcare policy; Organization of healthcare system and institution. Network of healthcare institutions in the Republic of Serbia; Primary, secondary and tertiary healthcare; Pharmaceutical healthcare, (public and hospital pharmacy; galenical laboratory), pharmacy (private practice, health institution); Types of health insurance; Protection of patients' rights; Regulations in the field of medicines and dietary supplements; regulations in the field of medical devices; Production and marketing of medicines; production and trafficking of narcotics. Medication policy; Essential medication lists. Environmental legislation; Nature, environment protection; Waste management; Quality control of healthcare institutions. Healthcare accreditation. Healthcare Chambers.

Practice

Analysis of healthcare legislation in the Republic of Serbia; Pharmacopolitics, Healthcare policy; Healthcare accreditation; Conditions for opening a pharmacy; Supervision of the quality of work of healthcare institutions; Network plan for healthcare institutions in RS; Analysis of the healthcare system in Serbia and abroad; E-prescription; E-healthcare; The national electronic healthcare records system My Doctor; Pharmaceutical waste; Medical waste; Practical examples in the field of environmental protection.

Literature:

1. The Law on Chambers for Health Workers
2. The Law on Medicines and Medical Devices
3. Public Health Law
4. Health Insurance Act
5. The Patient Rights Act
6. The regulation on the form and content of a prescription, the method of dispensing and prescribing medicines
7. The regulation on closer conditions for issuing, renewing or revoking a license to members of the Chambers for Healthcare Workers
8. The regulation on the list of medicines prescribed and charged with compulsory health insurance funds
9. The regulation on the manner of disposal of medicines, excipients and medical devices
10. The regulation on closer conditions for performing healthcare activities in healthcare institutions and other forms of health care service
11. The regulation on quality control of professional work of healthcare institutions, private practice, healthcare professionals and health associates

Number of active teaching: 30

Lectures: 15

Exercises: 15

Methods of teaching:

interactive lectures, practical classes, analysis and problem solving.

Grading (maximum 100 points)

Pre-Exam commitments	Points	Final Exam	Points
Lectures	5	Written exam	50

Practical classes	15		
Colloquium	20		
Seminar	10		

Addiction and Drug Abuse

Study programs: pharmacy, pharmacy - medical biochemistry			
Name of subject: Adiction and Drug Abuse			
Subjects status: elective			
ECTS: 4			
Requirement: Pharmacology, Neuropharmacology			
Subject objective: Acquisition, adoption, analysis, synthesis and application of knowledge of xenobiotics that cause dependence, divided into categories.			
Subject outcome: Upon completion of the course, students will be able to: deal with the problem of treatment of toxic addictive substances, determine the correct sample for toxicological analysis, including sample preparation; interpret toxicology report and suggest antidote or other appropriate therapy.			
Subject content: <i>Lectures</i> Social aspects of addiciton; historical overview of misuse of addictive drugs, legislation and national action plans for prevention of abuse of addicitbe drugs. Chemistry and function of the CNS, toxicodynamics and toxicokinetics of addictive drugs, dependency theory, tolerance. <i>Practical classes</i> Alcohol and other volatile compounds. Heroin and other opiates. Cocaine, crack, amphetamines. Nicotine and caffeine. CNS depressants. Hallucinogens. Cannabis and cannabinoids. Anabolic steroids. Analysis of the mechanisms of toxicity, toxicokinetics, tolerance and dependence. First aid and treatment.			
Literature: 1. Thomas A. Gossel, J. Bricker Douglas: Principles of Clinical Toxicology, 3 rd ed., Raven Press, New York, 1994. 2. Pedro Ruiz, C. Strain Eric G. Langrod John: The Substance Abuse Handbook, Williams & Wilkins, New York, 2007. 3. Darryl S Inaba, William E Cohen, Elizabeth von Radics, Ellen K Cholewa: Uppers, Downers, All Arounders: Physical and Mental Effects of Psychoactive Drugs, 8th ed, CNS Publications, Inc, 2014			
Number of active teaching:			Other classes:
Lectures: 30	Exercises: 30	Other forms of teaching:	
Students research work:			
Methods of teaching:			
Grading (maximum 100 points)			
Pre-Exam commitments	Points	Final Exam	Points
Lectures	5	Written exam	50
Practical classes	30		
Colloquium	15		

Digital Pharmacy

Study programmes: pharmacy, pharmacy – medical biochemistry
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Name of subject: Digital pharmacy			
Subjects status: elective			
ECTS: 4			
Requirement: none			
Subjects objective: To provide basic knowledge about digital health and digital pharmacy, to provide an understanding of the meaning, development, and application of digital drugs and digital therapeutics, to familiarise students with the basic principles of using various digital technologies and tools in therapy and therapy monitoring.			
Subjects outcome: Upon completion of this course, the student will be familiar with the application and importance of the application of digital technologies and tools in therapy and pharmaceutical practice. The student is familiar with the concept of digital therapy and is familiar with the approved preparations and medical devices in this category as well as with the most current research in the field of digital pharmacy. The student understands the importance of artificial intelligence for data processing, is familiar with the concepts of artificial and augmented reality and examples of application in pharmacy. The student is familiarised with the importance and challenges of digitalization as well as with the importance of educating pharmacists on this topic, the student is ready to follow current trends and get involved in the process of the digital transformation of the pharmaceutical profession.			
Subjects content: <i>Lectures</i> The concept, development, and application of digital therapies. Digital drugs. Digital therapeutics. Telemedicine and mHealth. Systems, applications, and sensors in therapy-Wearables. Application of artificial intelligence, pharmabots, avatars, virtual and augmented reality in pharmacy and pharmaceutical practice. Trends in the further development of digital therapy and digital technologies in healthcare. Advantages, challenges, and ethical aspects of digitalization in pharmacy. <i>Practical Classes</i> Examples of digital therapies. Approved digital drugs, systems, sensors, software in therapy. Examples of the use of a mobile phone as a platform for monitoring general health, therapy, and improving adherence. Analysis of advantages and challenges of the application of digital technologies in therapy and pharmaceutical practice. Virtual pharmacy vs. real.			
Literature: 1. "Pharmaceutical care in digital revolution-inside towards circular innovation" Claudia Rijcken.. ISBN: 978-0-12-817638-2. Izdavač Academic Press Publication, Elsevier, 2019.			
Number of active teaching: 30			
Lectures: 15	Exercises: 15		
Methods of teaching: interactive lectures, practical classes, analysis and problem solving.			
Grading (maximum 100 points)			
Pre-Exam commitments	Points	Final Exam	Points
Lectures	5	Written exam	50
Practical classes	15		
Colloquium	30		

Pharmacogenomics and Personalized Medicine

Study programmes: pharmacy, pharmacy – medical biochemistry	
Name of subject: Pharmacogenomics and Personalized Medicine	
Subjects status: elective	
ECTS: 4	

Requirement:	none		
Subjects objective:	Program provides pharmacists with an understanding of how genetic factors influence drug metabolism, response, and adverse effects. To provide knowledge and ability to apply genetic information to clinical practice. To give the student a generalist knowledge about personalized medicine as a a method of disease prevention and treatment considering individual variations in genes, environment, and lifestyle. Students will become familiar with the most widely used genomic laboratory techniques and interpretation of pharmacogenomics data used in personalizing drug therapy		
Subjects outcome:	After passing the exam, the student recognizes the relationship between an individual’s genetic make-up, their health, and their response to medications. Student knows how to make use of genomic information in order to develop the most effective use of medications, including minimizing adverse events. Student applies knowledge of personal medicine and is capable of providing an individualized approach to each patient, based on his/her personal genetic profile.		
Subjects content:	<p><i>Lectures</i></p> <p>Fundamentals of pharmacogenomics. Impact of pharmacogenomics on drug clinical pharmacology. Interpretation of pharmacogenomic test results. Interpretation of pharmacogenomic literature and use of evidence-based guidelines. Case-based scenarios of clinically-actionable pharmacogenomic examples in the areas of drug-induced hypersensitivity reactions, pain, neurology, psychiatry, cardiology, and oncology. Clinical implementation of pharmacogenomics in different healthcare settings. Genetic predictors of disease. Applying genetic principles to guide therapeutic decisions</p> <p><i>Practical Classes</i></p> <p>Working on case studies and concrete examples. Critical thinking and analysis, problem solving, scientific inquiry, self-directed learning and the effective use of modern technology for professional practice. Role of pharmacist in Pharmacogenomics and personalized medicine.</p>		
Literature:	<ol style="list-style-type: none"> 1. Rang H. P. Ritter J. M. Flower R. J. Henderson G. Pharmacology 8th edition, Data status 2019. 2. Francis Lam Y. W. Scott S. A. Pharmacogenomic: Challenges and opportunities in therapeutic implementation, Elsevier, 2019. 3. Ginsburg G.S. Willard H. Essentials of Genomic and personalized medicine. Academic press, 2009. 		
Number of active teaching:	30		
Lectures:	15		
Exercises:	15		
Methods of teaching:	interactive lectures, practical classes, analysis and problem solving.		
Grading (maximum 100 points)			
Pre-Exam commitments	Points	Final Exam	Points
Lectures	5		60
Practical classes	35		

Medical Devices

Study programmes:	pharmacy, pharmacy – medical biochemistry
Name of subject:	Medical Devices
Subjects status:	elective
ECTS:	4
Requirement:	none
Subjects objective:	

Introduction to the definition, types and classification of medical devices, legal regulations for medical devices, conditions for production and trade of medical devices, conducting clinical trials, the process of registration of medical devices, vigilance and monitoring of medical devices on the market, technical assessment and conformity assessment of medical devices with basic requirements, advertising and labeling of medical devices.			
Subjects outcome:			
Upon completion of the course, the student is expected to be able to identify which products fall into the category of medical devices, how to classify medical devices, what conditions should be met for the production and trade of medical devices, how the processes of medical devices registration, clinical trials, advertising, reporting of adverse reactions and monitoring of medical devices on the market are implemented, how the technical assessment and conformity assessment of medical devices is conducted, as well as how the medical device is labeled.			
Subjects content:			
<i>Lectures</i>			
Definition, types and classes of medical devices. Basic characteristics of general, in vitro diagnostic and active implantable medical devices. Laws and regulations in the field of medical devices: national and European regulations. Requirements for the production of medical devices. Structure of the technical document. Conditions for wholesale and retail trade of medical devices. Registration of medical devices. Conducting clinical trials for medical devices, biocompatibility testing, biological tests for biocompatibility assessment. Reporting adverse reactions to medical devices (vigilance). Monitoring of medical devices (post-marketing monitoring and market surveillance). Medical device quality requirements and technical assessment. Conformity assessment and mark of conformity (CE mark). The process of approving promotional material and advertising a medical device. Data necessary for proper labeling of the medical device.			
<i>Practical Classes</i>			
Introduction to the characteristics and requirements for medical devices sold in pharmacies. Classification of a medical device - a case study. Assessment of the adequacy of medical device labeling - a case study. Laboratory exercises - technical assessment (quality control) of medical devices, checking the functionality of the medical device.			
Literature:			
1. Law on medical devices ("Official gazete of the Republic of Serbia" No 105/2017)			
2. Council Directive 90/385/EEC on Active Implantable Medical Devices (AIMDD) (1990)			
3. Council Directive 93/42/EEC on Medical Devices (MDD) (1993)			
4. Council Directive 98/79/EC on in vitro Diagnostic Medical Devices (IVDMD) (1998)			
5. Regulation (EU) 2017/745 of the European Parliament and of the Council of 5 April 2017 on medical devices			
6. Regulation (EU) 2017/746 of the European Parliament and of the Council of 5 April 2017 on in vitro diagnostic medical devices			
7. Gad SC, McCord MG. Safety Evaluation in the Development of Medical Devices and Combination Products. New York: Informa Healthcare; 2008.			
Number of active teaching: 30			
Lectures: 15	Exercises: 15		
Methods of teaching:			
Lectures, practical work, case studies.			
Grading (maximum 100 points)			
Pre-Exam commitments	Points	Final Exam	Points
Lectures	5	Written exam	70
Practical classes	25		

Pharmacoepidemiology with Pharmacoeconomics

Study programme:	Pharmacy, Pharmacy - Medical Biochemistry
Course title:	Pharmacoepidemiology with Pharmacoeconomics
Course status:	elective

ECST Value:	4
Prerequisite:	Pharmacology
Course goals and outcomes:	
The objective of the course is to provide students with knowledge in the field of pharmacoepidemiology, to enable them to critically evaluate information in this field, to acquaint them with research methods and the application of their results in practice, and to introduce the student with the basic principles of the application of economic methods in healthcare and pharmacy, the tasks of pharmacoeconomics, the methodology of pharmacoeconomic research, the ways of conducting these researches and their application in practice.	
Course outcome:	
Upon passing the exam, the students will be able to critically evaluate pharmacoepidemiological problems, use databases related to medication use and side effects of drugs, conduct such research independently, and apply their results in practice, understand the importance of a statistical approach in monitoring drug consumption and the importance of reforms in ways of prescribing and dispensing medicines based on the results of pharmacoepidemiological studies. Furthermore, students acquire theoretical and practical knowledge of the basic principles of pharmacoeconomics, methods and studies for evaluating the pharmacoeconomic feasibility of a therapeutic strategy; collecting data on the costs and outcomes of patient treatment; they acquire basic knowledge in the field of healthcare economics and quality of life, as well as healthcare technology, they acquire basic knowledge in a rational approach to the use of medicines.	
Course content:	
<i>Theory</i>	
Principles and application of epidemiological methods in pharmacy (collection, processing and analysis of data related to the use of drugs and medical devices (rational prescribing, frequency of prescribing and treatment outcome). Methods for detecting adverse and beneficial effects of drugs, including spontaneous reporting, ad hoc epidemiological studies and database usage. Study design. Cross-section studies, observational studies (cohort studies and case-control studies) and clinical studies. Drug utilization studies. Bias. Health, economic and humanist outcomes of drug use. The methodology and calculation of drug usage; The concept of the daily-defined doses (DDD) and Anatomical -Therapeutic -Chemical (ATC) classification of drugs; World Health Organization drugs usage indicators. Introduction to pharmacoeconomics. Health economics. Types of costs. Cost of treatment. Basic principles and methods of pharmacoeconomic methods of collecting and analyzing drug consumption data - economic burden of disease, cost minimization analysis, cost/effectiveness analysis, cost / benefit analysis, cost / usefulness analysis. Pharmacoeconomic calculations in healthcare systems. Diagnostically related groups. Drug price strategy. Effectiveness of drugs. Healthcare outcomes. ECHO model. Health-related quality of life. Concept and assessment of healthcare technologies.	
<i>Practice</i>	
Use of pharmacoepidemiological databases. Analysis of pharmacoepidemiological studies. Reporting side effects of the drug. Identification of clinical practice problems requiring pharmacoepidemiological research; analysis of several examples of pharmacoepidemiological studies; expressing consumption of drugs at defined daily doses (DDD), finding defined daily doses for the drugs that are most in use; to analyze practical examples of case-control studies; to analyze practical examples of cohort studies; analysis of a case study of a quality of prescribing drugs that used WHO indicators;	
Practical classes consist of exercises that follow relevant topics covered in theoretical instruction: calculation of treatment costs, application of cost minimization analysis, application of cost-effectiveness analysis, application of cost- benefit analysis, application of cost- usefulness analysis; Application of calculating the impact of treatment on quality of life. Concept and instrument analysis: QUALY- quality-adjusted years of life; DALY - Disability adjusted years of life, SF 36 - Health questionnaire.	
Literature:	
1. Rang H. P. Ritter J. M. Flower R. J. Henderson G. Pharmacology 8th edition, Data status 2019. 2. Renée J. G. Arnold. „,Pharmacoeconomics from theory to practice” CRC Press 2010. 3. Bootman JL, Townsend RJ, McGhan WF. „Principles of Pharmacoeconomics“ 3rd Ed. Cincinnati Harvey Whitney Books Company; 2005.	
Number of active teaching: 30	
Lectures: 15	Exercises: 15
Applicable teaching methods:	
lectures, case study analysis, discussions, e-learning.	

Grading Scheme (max. 100 points)			
Pre-exam requirements	Points	Final exam	Points
Lectures	5	Written exam	50
Practice	15		
Colloquium	20		
Seminar	10		