University of Belgrade Faculty of Pharmacy	Integrated academic studies of PHARMACY	

Study programme: Pharmacy

Course title: Introduction to Pharmacy

Teachers: Krajnović M. Dušanka, Lakić M. Dragana, Mirić M. Milica

Course status: Mandatory

Semester: I	**Year of studies: I**
ECTS points: 1	**Course code: F107**

Requirements: none

Course aims:

Understanding of the significance and role of pharmacy profession in the healthcare system, role of medicinal products in the society, the importance of the facultes of pharmacy in education of pharmacists, and importance and diversity of the future profession. Gathering of basic knowledge on development of pharmacy profession and scope of the pharmaceutical practice, and social responsibility of pharmacists in the health protection, prevention and treatment of illness. Basics of the communication skills.

Course outcomes:

Student is aware of the historical and cultural foundations for the development of Pharmacy (both scientific and professional); understands the professional and the social role of the pharmaceutical practice; understanding the purpose and the necessity for the continuous professional self-development; applies various communication skills in the Pharmacy and in the general society.

Course contents:

Lectures

Professional development of Pharmacy. Development of Pharmacy as a scientific discipline. The most significant discoveries for the development of Pharmacy. Short review of the medicinal product development through time. Professional orientation in Pharmacy. Motives for choosing pharmacist profession. Concept of health and illness. Behavioral aspects of pharmaceutical care. Behavior of ill person. Health, economic and social aspect of the pharmaceutical care. Communication with colleagues and beneficiaries of health services. Methods and types of communication. Rules of good communication.

Recommended literature:

1. Krajnović D. Nerecenzirana skripta za predmet Uvod u farmaciju, 2012.
2. Tasić LJ, Parojčić D, Bogavac-Stanojević N, Ilić K, Jović S, Kocić-Pešić V. Promocija zdravlja i prevencija bolesti žena u farmaceutskoj praksi. Beograd: Univerzitet u Beogradu - Farmaceutski fakultet; 2007.
3. Tasić LJ, Krajnović D, Jocić D, Jović S. Komunikacija u farmaceutskoj praksi. Beograd: Univerzitet u Beogradu - Farmaceutski fakultet; 2011.
4. Smith MC, Wertheimer AI. Social and Behavioural Aspects of Pharmaceutical Care. New York: Pharmaceutical Press; 1996.
5. Anderson S. Making Medicines - A brief History of pharmacy and pharmaceuticals. 1st ed. New York: Pharmaceutical Press; 2005.

The total of active learning classes

Lectures: 15	**Exercises:** 0

Teaching methods: lectures, discussions

Grading system: descriptive

Exam prerequisites	Points	Final exam	Points
Active participation in lectures	30	Practical	
Exercises		Written	70
Colloquia		Oral	
Seminars			

University of Belgrade Faculty of Pharmacy	Integrated academic studies PHARMACY	

Study programme: Pharmacy

Course title: Biology and Human Genetics

Teachers: Biljana M. Potparević, Lada P. Živković

Course status: Mandatory

Semester: I	**Study year: I**
ECTS: 5	**Course code: F101**

Course prerequisites: /

Course aims:

General aim:

To learn the basics of cell biology and the importance of genetic events during cell function.

Specific aims:

- Basic knowledge about prokaryotic and eukaryotic cell characteristics.
- Basic knowledge about eukaryotic cell organization through to more detailed studies of cytoplasmic organelles and various cell types in the human body.
- Understanding the structure of genetic material and its function.
- Introduction to the elementary principles of inheritance in humans, gene and chromosome mutations and mechanisms of DNA repair.
- Introduction to human developmental biology, processes of cell differentiation and the genetic mechanisms underlying malignant transformation

Course outcomes: After completing the course the students are expected to be able to:

- Be proficient in the use of optical microscopes.
- Describe and explain the structure and function of cells as elementary units of biological structures.
- Understand the organization of basic processes in the cytoplasm and the cell nucleus.
- Describe and explain the transfer of genetic information from DNA - RNA - protein.
- Understand and explain mechanisms of mutations and the relationship between the terms genotype and phenotype.
- Apply the knowledge gained in this course to other courses at the Faculty of Pharmacy.

Course contents:

- *Lectures* The concept and importance of this course for pharmacy students.
- Methodological approaches to cell biology and genetics.
- The evolution of the cell.
- The chemical composition of the cell.
- The organization of eukaryotic cells.
- Genetic material and its functions.
- The cell cycle and its gene regulation
- Gametogenesis, fertilization and developmental biology.
- Gene and chromosomal mutations.
- Mechanisms of DNA repair.
- Oncogenetics.

Practical classes

- The optical microscope and techniques of microscopy.

- The size and shape of the nucleus and embryological origin of cells.
- The plasma membrane.
- Cytoplasmatic organelles.
- The nucleus at interphase and chromatin.
- Transcription and translation.
- Cell division: Mitosis and meiosis.
- Gene mutations and chromosomal aberrations.

Recommended literature:

1. B. Potparević, L. Živković (2014); Manual in Biology and Human genetics, Colorgafx, Beograd.
2. Humana Genetika, R. Papović, LJ. Luković, I. Novaković, M. Stanić, V. Bunjevački, S. Cvjetićanin, O. Stojković, Medicinski fakultet, Beograd, (2010)
3. N. Đelić, Z. Stanimirović (2005) Principles of Genetics, Elit-Medica, Beograd.
4. Alberts, Johnson, Lewis, Morgan, Raff, Roberts, Walter (2015) Molecular biology of the cell; 6th Ed, New York.
5. R.L. Nussbaum, R.R. Mc Innes, H.F. Willard (2001); Genetics in medicine; Sixth edition, New York.

The total of active learning classes

Lectures: 45	**Practical classes: 30**

Teaching methods: The course takes place in one semester and employs the following teaching methods: Lectures and practical classes

Grading system:

Pre-exam obligations	**Points**	**Exam**	**Points**
Class Participation	2	Practical exam	/
Practical classes	8	Written exam	70
Tests (colloquia)	20	Oral exam	optional
Seminar work	/		

University of Belgrade Faculty of Pharmacy	Integrated academic studies PHARMACY	

Study programme: Pharmacy

Course title: Human functional morphology

Teachers: Popović Dejana

Course status: Mandatory

Semester: I	**Study year: I**
ECTS: 5	**Course code: F102**

Course prerequisites: Byology with human genetics

Course aims: To adopt elementary medical terminology and to acquire the basic knowledge about macroscopic (anatomical) and microscopic (hystological) structure of the human body and its interaction with function

Course outcomes: To empower the student for the acquisition of additional knowledges in the domain of the organ system function in conditions of health and disease, considering the complexity of the human body structure and its interaction with the function

Course contents:

Anatomy

Introduction in anatomy, topographical regions of the human body and basic anatomical terminology. Functional morphology of the organ systems: locomotor system (osteology, arthrology and myology), trunk (walls and thoracal cavity), cardiovascular system, lymphatic system, respiratory system, abdomen (walls and abdominal cavity), digestive system, pelvis (walls and pelvic cavity), urinary and reproductive system, central and peripheral nervous system, sensory organs, endocrine system.

Hystology

Introduction in hystology, basic microscopic methods. Cell - basic characteristics of structural and functional organization of the cell. Tissue types (epithelium, connective tissue, muscle and nervous tissue). Blood and hematopoietic tissue. Lymphopoietic organs. Cardiovascular system. Respiratory system. Digestive system. Urinary and reproductive system. Central and peripheral nervous system. Sensory organs. Endocrine system. Skin.

Practical work

Interactive functional anatomy and analysis of hystological preparationos

Recommended literature:

1. Moore KL, Dalley AF, Agur AMR. Clinically Oriented Anatomy. 6th ed. Baltimore: Lippincott Williams & Wilkins; 2009.
2. Drake RL, Vogl AW, Mitchel AVM. Grays anatomy for students. 3rd ed. London: Elsevier; 2014.
3. Ellis H, Mahadevan V. Clinical anatomy: Applied Anatomy for Students and Junior Doctors. 12th ed. Wiley-Blackwell; 2010.
4. Bradbury S. Hewer's Textbook of Histology for Medical Students. 9 th. ed. London: Elsevier; 1973.
5. Ovalle W, Nahirney P. Netter's Essential Histology with Student Consult Access. London: Elsevier; 2013.

The total of active learning classes

Lectures: 45	**Practical work: 30**

Teaching methods: The teaching is performed during I semester through theoretical lectures and practical instructions with anatomical and histological preparations analysis

Grading system:

Pre-commitment:	Points	Exam	Points
Active participation in lectures	3	Practical exam	
Practical works	12	Written exam	70
Tests (colloquia)	15		

University of Belgrade Faculty of Pharmacy	Integrated academic studies PHARMACY	

Study programme: Pharmacy

Course title: General and inorganic chemistry

Teachers: Čakar M. Mira, Popović V. Gordana, Tanasković B. Slađana

Course status: Mandatory

Semester: I	**Study year: I**
ECTS: 5	**Course code: F1O3**

Course prerequisites: none

Course aims:

Acquiring knowledge of chemistry necesarry for understanding the structure and properties of simple and complex biopharmaceutical important compounds, as well as the mechanism of chemical processes in which they included. Acquiring practical and calculate knowledge necesarry for successful work on other chemical and pharmaceutical subjects, as well as in the pharmaceutical practice.

Course outcomes:

After successful completion of this course, a student will be able to:

- application of acquired knowledge for the evaluation of chemical properties of compounds
- predict and analyse chemical reactions
- planning and organizing the safe laboratory working
- develope skills in analytical thinking in problem solving

Course contents:

Lectures

Chemical bonding: chemical bonding theories and types; hybridization. Intermolecular interactions: the types of interactions; states of matter. Solutions: units of concentration; colligative properties of the solutions; ionic strength; ion activities. Rates of chemical reactions. Catalysts and inhibitors. Chemical eqilibrium and eqilibrium constants. Eqilibrium and pH in the solutions of acids, bases and salts. Buffers: composition; pH; capacity. Eqilibria in heterogeneous systems: solubility; solubility product constant; solubility - solubility product constant relationship; precipitation and dissolution. Oxidation-reduction reactions. Electrochemical cells and reduction potential. Prediction strength of oxidation and reduction characteristics and direction of redox reactions. Coordination compounds: bonds in complexes; eqilibria in aqueous solutions; isomerism; nomenclature. Stoichiometric calculations. Periodic properties of elements and inorganic compounds. Chemical characteristics of elements and inorganic compounds significant for biosystems, ecosystems and pharmacy.

Practical classes

Chemical labaratory, function and eqipment; safety in chemical labaratory and basic laboratory techniques. Solutions: properties; preparing a solution with specific quantitative composition. Calculation and measuring of pH in aqueous solutions of electrolyte. Buffers: selection and preparation. Investigation of reactivity of elements and inorganic compounds with biopharmaceutical importance.

Recommended literature:

1. Whitten KW, Davis RE, Peck ML. General Chemistry. 9th ed. Saunders college publishing; 2010.
2. Kotz J, Treichel P. Chemistry and chemical reactivity. 8th ed. Saunders college publishing; 2012.
3. Čakar M, Popović G. Opšta hemija I. Šesto izdanje. Beograd: Farmaceutski fakultet; 2010.
4. Dragojević M, Popović M, Stević S, Šćepanović V. Opšta hemija, I deo. Beograd: Tehnološko-metalurški fakultet; 2003.
5. Filipović I, Lipanović S. Opća i anorganska hemija. IX izdanje. Zagreb: Školska knjiga; 1995.

The total of active learning classes			
Lectures: 60		**Practical classes:** 30	
Teaching methods: Lectures, practical work, discussion, problem solving.			
Grading system:			
Pre-exam obligations	**Points**	**Exam**	**Points**
Class Participation	5	Practical exam	
Practical classes	5	Written exam	50
Tests (colloquia)	40	Oral exam	
Seminar work			

University of Belgrade Faculty of Pharmacy	Integrated academic studies PHARMACY	

Study programme: Pharmacy

Course title: Organic chemistry 1

Teachers: Zorana N. Tokić-Vujošević

Course status: Mandatory

Semester: I	**Study year: I**
ECTS: 5	**Course code: F1O6**

Course prerequisites: /

Course aims:

- Acquire knowledge about building chemical bonds, types of hybridization and electronic effects in organic compounds
- Learning about the basic classes of organic compounds (systematic naming, structure, and reactivity)
- Learning of the mechanisms of ionic and radical reactions characteristic for organic compounds

Course outcomes:

Acquire knowledge about the structure and reactivity of organic molecules

Understanding of the mechanisms of organic reactions

Acquisition of a logical framework for linking the structure and function of organic molecules

Course contents:

Lectures :

A review of general chemistry (chemical bonds, hybridization of orbitals, structure and isomerism of organic molecules. Electronic effects (inductive and resonance and their influence on the polarization of molecules and reactivity).Reactive species (nucleophiles and electrophiles) and the basic types of chemical reactions in organic molecules.

Alkanes, cycloalkanes, radical reactions (mechanism).Unsaturated hydrocarbons (alkenes, alkynes, electrophilic additions); conjugated alkadiene (1,2 - and 1,4-additions).

Aromatic compounds (structure-reactivity, aromatic substitution mechanism). Some important class of aromatic compounds; Alkyl-, alkenyl-, and aryl halides (structure-reactivity relatioship, possible mechanisms for substitution reactions: S_N1 and S_N2 reaction). Alcohols (structure-reactivity relatioship, amphoteric properties).Phenols and quinones (reactivity, factors affecting the acidity of phenol).Ethers; Thioalcohols and thioethers. The carbonyl compounds: Mechanism of nucleophilic addition to aldehydes and ketones (reaction and protective groups). α, β-unsaturated carbonyl compounds (structure-reactivity). Carboxylic Acids and Their Derivatives (the mechanism of nucleophilic acyl substitution). Factors which affect the acidity of the carboxyl group in the aliphatic and aromatic acids with various substituents. Reactivity of Carboxylic Acid Derivatives. α-Carbon chemistry: keto-enol equilibrium; the enolate ion in formation of C-C bond. α-Halogenation of enols and enolates. Aldol reactions; Claisen condensations; Alkylation of the alpha position; Conjugate addition reactions. Synthesis strategies: 1,3-dicarbonili as starting compounds in the synthesis of various carbonyl compounds Amines (nomenclature, properties and preparation); the reaction of amines with various electrophiles;basicity of aliphatic and aromatic amine. Synthesis strategies (aryl diazonium salts as precursors in the synthesis of aromatic compounds)

Recommended literature:

1. K.Peter C. Vollhardt and Neil E. Shore Organic Chemistry: Structure and function, 5th edition (2007), Freeman Custom Publishing
2. Paul M. Dewick Essentials of Organic Chemistry: For Students of Pharmacy, Medicinal Chemistry and Biological Chemistry, Ed. 2006, John Wiley & Sons
3. David R. Klein Organic Chemistry, 1st Edition (2011), John Wiley & Sons

The total of active learning classes:

Lectures: 60	**Practical classes: 0**

Teaching methods: lectures , consultations , exercise on selected examples			
Grading system:			
Pre-exam obligations	**Points**	**Exam**	**Points**
Class Participation	5	Practical exam	-
Practical classes	-	Written exam	50
Tests (colloquia)	45	Oral exam	-
Seminar work	-		

University of Belgrade Faculty of Pharmacy	Integrated academic studies PHARMACY	

Study programme: Pharmacy

Course title: Physics

Teachers: Neli Kristina D. Todorović-Vasović

Course status: Mandatory

Semester: I	**Study year: I**
ECTS: 3	**Course code: F104**

Course prerequisites: no

Course aims: Familiarisation with basic principles of physics required for understanding physical systems. Connecting the physical and biophysical systems. Connection of modern developments in physics with newly discovered phenomena in science. Identification of the basic theoretical and practical knowledge in physics necessary to easier adoption of the content of courses in pharmacy

Course outcomes:

Students will have the possibility to understand the content of chemical and biological courses, as well as the ability to detect connections between physics and other sciences.

Course contents:

Lectures

The basic physical laws of mechanics, thermodynamics, electrodynamics and atomic and subatomic physics

Practical classes

Basic physical measurements. Processing of Measurement data. Use of computer animation . Spectral analysis. Spectrometer and the spectroscope. Gamma radiation. NMR. Absorption spectrophotometry. Reflectance spectrophotometry. Determination of the relative density of liquids with a pycnometer. Determination of EMF and the internal resistance of the electric circuit . Relative density of solids. Areometers. The gas laws. Equations of fluid dynamics. Photoelectric effect.

Recommended literature:

1. Young HD , Freedman RA, Ford AL. Sears and Zemansky`s University Physics. 12-th ed. San Francisco: Pearson Addison-Wesley; 2007.

2. Тодоровић-Васовић НК, Јесенко Роквић А. Практикум за експерименталне вежбе из физике. Фармацеутски факултет; 2012.

3. Тодоровић-Васовић НК, Поглавља из физике [internet]. Универзитет у Београду, Фармацеутски факултет, Катедра за физику и математику, 2012. http:/ / supa.pharmacy.bg.ac.rs/ courses/48/ posts.

4. Вучић В , Ивановић Д, Физика I, двадесетдруго издање, Београд: Научна Књига; 1990.

5. Станковић Д , Осмокровић П. Практикум лабораторијских вежби из физике, Завод за физику техничких факултета Универзитета у Београду; 2004.

The total of active learning classes

Lectures: 30	**Practical classes: 15**

Teaching methods: Lectures with animations. Interactive teaching. Tasks. The consultation.

Grading system:

Pre-exam obligations	Points	Exam	Points
Class Participation		Practical exam	
Practical classes	12	Written exam	70
Tests (colloquia)	9	Oral exam	

Seminar work	9	

University of Belgrade Faculty of Pharmacy	Integrated academic studies PHARMACY	

Study programme: PHARMACY

Course title: Mathematics

Teachers: Stana Nikčević, Dragana Ranković

Course status: Mandatory

Semester: I semester	**Study year: I**
ECTS: 4	**Course code: F105**

Course prerequisites: No requirements

Course aims: To provide elementary mathematical knowledge about linear algebra, integral and differential calculus, differential equations, and applied mathematics.

Course outcomes: : A student will be able to comprehend subject related to physical, chemical, and pharmaceutical sciences.

Course contents:

Lectures

Linear algebra. Matrices. Determinants. Systems of linear equations (Cramer's formulas and Gauss algorithm). Vector calculus. Functions. The concept of a function. Limits. Asymptotes. Continuity, definitions and properties of elementary functions.

Differential calculus. Derivative. Basic theorem of differential calculus (Rolle's, Lagrange's and Taylor's theorems). Applications. Partial derivative of the function depending of several variables (method of least squares).

Integral calculus. Indefinite integral. Techniques of integration: method of substitution, integration by parts. Integration of rational, trigonometric and some irrational functions. Definite integral. Newton-Leibnitz theorem. Applications of definite integral (computing lengths, areas, volumes). Improper integrals. Approximating the value of the definite integral (midpoint and trapezoid rules).

Differential equations. First-order differential equations (separated variables. homogenous, linear, Bernouli's, total differential). Second-order differential equations (equations that can be reduced to first order, linear equations – particularly with constant coefficients). Applications in physics, chemistry and pharmacy.

Optimization methods. Examples of optimization problems (optimization of production plan, transport, etc.). Linear programming.

Exercises

Examples and exercises related to the lectures content.

Recommended literature:

1. Robert A. Adams „Calculus" (Addison Wesley)
2. Jovan D. Kečkić, Stana Ž. Nikčević „Matematika jednogodišnji kurs" (Kečkić)

The total of active learning classes

Lectures: 30	**Exercises: 30**

Teaching methods: The course is in one semestar using lectures, exercises, tutorials and 4 homeworks.

Grading system:

Pre-exam obligations	Points	Exam	Points
Class Participation is obligatory	/	Written exam (2nd part)	30
Practical classes is obligatory	/	Oral exam	40
Colloquia (1st part of the written exam)	30		

University of Belgrade Faculty of Pharmacy	Integrated academic studies PHARMACY	

Study programme: pharmacy

Course title: Practicum in organic chemistry

Teachers: Zorana N. Tokić-Vujošević

Course status: Elective

Semester: I	**Study year: I**
ECTS: 2	**Course code: F1i2**

Course prerequisites: /

Course aims:

- mastering and improving basic knowledge of organic chemistry through exercise on selected examples of organic chemical reactions
- facilitating the preparation of exam in Organic chemistry 1
- facilitating the understanding and acquiring of knowledge of medicinal, pharmaceutical and biological chemistry

Course outcomes:

Systematization of the most important concepts in organic chemistry in order to establish the fundamental basis for mastering professional and applicative courses
Understanding and application of mechanisms of organic reactions to problems in medicinal chemistry and biochemistry.

Course contents:

Lectures : student-presented seminars in certain fields of organic chemistry

Practical classes :

functional groups, and systematic and trivial nomenclature organic compounds

formal charge of organic molecules

the polarity of organic molecules and electronic effects (inductive and resonance)

the impact of the resonant and inductive effects on the reactivity of functional groups

reactive particles (nucleophiles and electrophiles)

Basic types of organic reactions (ionic- radical, Electrophilic-nucleophilic, the addition-substitution-elimination)

nucleophilic substitution S_N1 and S_N2 mechanism (examples biosynthesis of terpenes and glutathione as biogenic nucleophile)

The nucleophilic addition: reaction of carbonyl groups with nitrogen nucleophiles, alcohols and thiols

electrophilic addition: reactivity of alkenes and conjugated diene (the chemistry of polymers)

electrophilic substitution
free-radical reactions
aromaticity and electrophilic aromatic substitution

phenols and quinones (oxidation-reduction reactions)
carboxylic acids and their derivatives
amines

the effect of resonance and inductive effects on acidity and basicity of organic compounds)

Protection of functional groups and the hydrolytic reactions in unblocking them

The elimination reactions (dehydration, decarboxylation, desamination)

Recommended literature:

1. K.Peter C. Vollhardt and Organic Chemistry: Structure and function, 5th edition (2007), Freeman Custom Publishing
2. Neil E. Shore: Study Guide and Solutions Manual for Organic Chemistry Structure and Function, (2006)
3. David R. Klein Organic Chemistry, 1st Edition (2011), John Wiley & Sons

The total of active learning classes: 30			
Lectures: 0		**Practical classes: 30**	
Teaching methods: exercise on selected examples of reactions (substitutions, additions ...) and mini tests to check the knowledge acquired			
Grading system:			
Pre-exam obligations	**Points**	**Exam**	**Points**
Class Participation	-	Practical exam	-
Practical classes	-	Written exam	40
Tests (colloquia)	30	Oral exam	-
Seminar work	30		

University of Belgrade Faculty of Pharmacy	Integrated academic studies PHARMACY	

Study programme: Pharmacy

Course title: Introduction to Laboratory Work

Teachers: Kapetanović P. Vera, Jelikić-Stankov D. Milena, Karljiković-Rajić D. Katarina, Ražić S. Slavica, Uskoković-Marković M. Snežana, Odović V. Jadranka

Course status: Elective

Semester: I	**Study year: I**
ECTS: 2	**Course code: F1I1**

Course prerequisites: None

Course objectives: Course is designed to introduce students to techniques used in analytical laboratories. Students become familiar with the correct use of basic laboratory glassware, equipment as well as basic operations, necessary for the work on the qualitative and quantitative chemical analysis.

Course outcomes: The student has gained the necessary experimental experience for independent laboratory work for qualitative and quantitative chemical analysis important to professional courses. The student is able to use basic laboratory glassware and equipment and understand selected techniques used in analytical laboratory.

Course contents:

Lectures

Practical classes

Precautions and safety in the laboratory. Chemical clasification. Distilled and deionized water. Washing and maintenance of laboratory glassware and working area. Methods of performance of chemical reactions. Carry out wet and dry reactions in semimicroqualitative chemical analysis. Carring out color–reactions. Flame tests. Carrying out the reaction in a fume hood. Using a water bath, centrifuge (separation of the precipitate and solution), an ultrasonic bath (dissolution of insoluble compounds). Straining and filtering techniques. Magnetic stirrer. Weighing on the technical and analytical balances. Drying laboratory dishes to constatnt mass. Quantitative transfer of solutions for analysis. Volume measurement for quantitative analysis. Burette, volume reading. Preparation of the primary and secondary standards. Preparation of a series of standard solutions - dilution. Preparation of solutions of specific pH values. Examples of titrations.

Recommended literature:

1. Laboratory work, Department of Analytical Chemistry.
2. Skoog DA, West DM, Holler FJ. Fundaments of Analytical Chemistry. 7th ed. Philadelphia: Saunders College Publishing; 1996.
3. Christian GD, Dasgupta PK, Schug KA. Analytical Chemistry. 7th ed. New York: John Wiley & Sons, INC; 2013.
4. Vogel AI. Qualitative Inorganic Analysis. 7th ed. London: Longman; 1996.

The total of active learning classes

Lectures: 0	**Practical classes:** 30

Teaching methods: Laboratory practice, work in small groups, interactive teaching

Grading system:

Pre-exam obligations	Points	Exam	Points
Class Participation		Practical exam	30
Practical classes	30	Written exam	0
Tests (colloquia)	40	Oral exam	0
Seminar work			

University of Belgrade Faculty of Pharmacy	Integrated academic studies PHARMACY	

Study programme: Pharmacy

Course title: Organic chemistry 2

Teachers: Vladimir Savic

Course status: Mandatory

Semester: II	**Study year: I**
ECTS: 7	**Course code: F1O10**

Course prerequisites: none

Course aims:

Theoretical classes: understanding of stereochemical properties of organic compounds; acquiring knowledge of general properties of heterocyclic compounds; acquiring basic knowledge of chemistry of biomolecules (carbohydrates, peptides, nucleic acids, lipids).
Laboratory classes: learning about experimental technique applied in the synthesis and purification of organic compounds; building potential to select scientific information, create presentation and orally describe scientific results; developing skill to use knowledge in solving organic chemistry problems.

Course outcomes:

Theoretical classes: knowledge of stereochemical properties of organic compounds and chemical reactions; understanding of structural and chemical properties of heterocyclic compounds and biomolecules.
Laboratory classes: acquired skill in experimental techniques used in synthesis and purification of organic compounds; ability to select analyse and present scientific information.

Course contents:

Lectures

Stereochemistry: stereoisomers, symmetry, chirality, nomenclature, enantiomers, optical activity, configuration, compound with more than one chiral atom, racemates, synthesis and separation of racemates , conformations of acyclic compounds, stereochemistry of cyclic compounds, conformations of 6-membered rings, biphenyls-structure and properties, stereoselective/stereospecific reactions, asymmetric synthesis. Heterocyclic compounds: nomenclature, general properties, aromaticity, heteroatom and their effect on reactivity, acidity, basicity; 5-membered rings with one, two or more heteroatoms - structure, properties, derivatives; 6-membered heterocyclic compounds with one, two or more heteroatoms - structure, properties, derivatives, polycyclic heterocyclic compounds. Carbohydrates: nomenclature, classification, reactions; extension and shortening of the C-chain; cyclic structures; mutarotation, anomeric effect; derivatives: glycosides, esters, ethers; disaccharides, polysaccharides; peptides, peptide bond, synthesis of polypeptides; primary and secondary structures; sequence determination. Nucleic acids: structure and properties of nucleoside and nucleotide; synthesis and properties of nucleic acids. Lipides: structure and properties

Practical classes

Six experiments, stereochemistry and one seminar combined with the organic chemistry problem solving session.

Recommended literature:

1. Organic Chemistry**,** K.P.C. Vollhardt, N. E. Schore, 2010.
2. Stereochemistry of organic compounds, E.L. Eliel, S. H. Wilen, 1994.
3. Heterocyclic chemistry, J.A. Joule, K. Mills, 2010.

The total of active learning classes 105

Lectures: 60	**Practical classes:** 45

Teaching methods: lectures, laboratory work, tutorials

Grading system:

Pre-exam obligations	Points	Exam	Points
Class Participation	2	Practical exam	
Practical classes	28	Written exam	70
Tests (colloquia)		Oral exam	
Seminar work			

University of Belgrade Faculty of Pharmacy	Integrated academic studies PHARMACY	

Study programme: Pharmacy

Course title: Physical Chemistry

Teachers: Aleksić M. Mara, Kuntić S. Vesna, Blagojević M. Slavica

Course status: Mandatory

Semester: II	**Study year: I**
ECTS points: 5	**Course code: F1011**

Course prerequisites: none

Course aims: Acquisition of fundamental knowledge in selected fields of physical chemistry which is necessary for understanding physicochemical processes significant for education of a pharmacist and pharmacist - medical biochemist. The aim is to enable student to implement acquisitioned knowledge in studying other courses that require understanding of the physicochemical principles.

Course outcomes: Acquisition of knowledge related to thermodynamic parameters, solid and liquid state of matter, solutions and phase transitions, surface phenomena, colloidal dispersions, chemical kinetics, and basics of radiochemistry. The knowledge and understanding of physicochemical processes significant for pharmacy and biochemistry, enables student to follow the lectures at senior courses successfully.

Course contents:

Lectures Chemical thermodynamics: laws of thermodynamics, state functions, thermochemistry, process spontaneity, chemical potential, homogenous system equilibrium. Liquid state of matter: vapour pressure, capillarity, viscosity, surface tension, methods for viscosity and surface tension measurement. Solid state of matter: crystal and amorphous state. Solutions: solid and gas phase dissolution in liquid phase, colligative properties, osmosis and determination of osmotic pressure, liquid mixtures - miscible, partially miscible and immiscible liquids. Phase equilibrium and phase transformation: Gibbs` phase rule, thermal analysis. Phase boundary phenomena: adsorption at liquid and solid surfaces, adsorption isotherms. Principles of chromatography (elution mechanism, plate theory), physicochemical principles of chromatographic separation (adsorption, partition and ion exchange processes), methods for mixture component separation. Basic concept of colloidal chemistry: colloidal system, colloidal particle structure, kinetic, optical and electrical properties of colloids, stability and coagulation. Chemical kinetics: complex chemical reaction mechanism (parallel, consecutive, equilibrium reactions), rate and order of reactions, determination of reaction order methods. Catalysis: catalyst properties, homogeneous and heterogeneous catalysis, mechanism of catalysts action. Basic principles of radiochemistry: natural and artificial radioactivity, ionizing radiation, radiation doses.

Practical training: Chemical thermodynamics: determination of thermodynamic parameters, heat of reaction determination. Liquid state of matter: viscosity coefficient and surface tension determination. Chemical kinetics: determination of kinetic parameters. Phase boundary phenomena: determination of Gibbs` adsorption isotherm, the use of adsorption and partition chromatography for mixture components separation.

Recommended literature:

1. Malešev D. Odabrana poglavlja fizičke hemije. Beograd: published by Malešev D.; 2003.

2. Kuntić V, Aleksić M, Pejić N, Blagojević S. Praktikum iz fizičke hemije. Beograd: Farmaceutski fakultet, Univerzitet u Beogradu; 2010.

3. Kuntić V, Aleksić M, Pavun L, Pejić N. Zbirka zadataka iz fizičke hemije. Beograd: published by Pavun L.; 2003.

4. Medenica M, Malešev D. Eksperimentalna fizička hemija. Beograd: published by Medenica M.; 2002.

5. Atkins PW. Physical Chemistry. Oxford: Oxford University Press; 2002.

The total of active learning classes

Lectures: 45	**Practical classes: 15**

Teaching methods: Lectures, consultation, practical laboratory training.			
Grading system:			
Exam prerequisites	**Points**	**Final Exam**	**Points**
Active participation in lectures	5	Practical	
Practical training	15	Written	40
Colloquia	40	Oral	
Seminar work			

University of Belgrade Faculty of Pharmacy	Integrated academic studies of PHARMACY	

Study programme: Pharmacy

Course title: Physiology 1

Teachers: Plećaš-Solarović A. Bosiljka, Pešić R. Vesna, Nedeljković S. Miodrag

Course status: Mandatory

Semester: II	**Year of studies: I**
ECTS points: 5	**Course code:**

Requirements: Human functional morphology

Course aims:

Provision of important knowledge from physiology of cell, tissue, organ systems and human body as whole, relevant to pharmaceutical practice. Provision of theoretical basis relevant for other courses (pathophysiology, pharmacology, medical biochemistry, pharmacognosy, pharmacotherapy, clinical pharmacy, pharmacotherapy, toxicology, bromatology).

Course outcomes:

After finishing this course student will be trained to:

- properly use medical terminology
- be familiar with function of individual organs, understand integrated function of organs and control mechanisms related to them.
- understand interconnections of regulatory systems, which is important for organism adaptation to inner and outer environmental changes in everyday basis.

Course contents:

Theoretical lectures

Introduction to physiology. General physiology and physiology of the cell. Physiology of nervous system. Neurons and neuroglial cells; synaptic transmission, neurotransmitters, reflexes, functional organization of nervous system; neurobiology of sleep; Sensory function of nervous system; Motor function of nervous system; autonomic nervous system; metabolism of the brain; protective apparatus of central nervous system. Physiology of the blood. Blood cells; erythrocytes, leukocytes and platelets; hemostasis; water in organism: content, distribution and origin of water in the body. Physiology of the cardiovascular system. Heart: conduction system; electrical and mechanical changes in heart beat; the parameters of cardiac function; work and metabolism of the heart muscle; coronary circulation. Circulation: arterial, venous and capillary circulation; lymph and lymphatic system; regulation of cardiovascular function. Physiology of the respiratory system. Respiratory pathways. Mechanics of breathing. Transport and exchange gases. Regulation of breathing.

Practical classes

Membrane potentials and synaptic transmission. Reflexes: patellar and pupil reflex. Mechanism of genesis and characteristics of skeletal muscle contraction. Erythrocytes: determination of hemoglobin concentration, erythrocyte count and erythrocyte osmotic fragility. Leukocytes: determining the blood levels. The buffering capacity of the blood plasma. Coagulation of the blood. Determination of heart rate and arterial blood pressure. Auscultation of heart sounds. Control of cardiovascular function. Lung volumes and vital capacity of the lung (spirometry). Control of breathing.

Recommended literature:

1. Plećaš B. Skripta za predavanja „FIZIOLOGIJA - PREDAVANJA 2011/2012“. Drugo ispravljeno i dopunjeno izdanje. Beograd; 2011.
2. Pešić V, Nedeljković M. Priručnik za praktičnu nastavu. Beograd: Autorsko izdanje; 2007.
3. Koeppen BM, Stanton BA. Berne & Levy PHYSIOLOGY. 6th ed. Philadelhia: Mosby, Elsevier; 2010.
4. McCorry LK. Essentials of Human Physiology for Pharmacy. 2nd edition. Boca Raton: CRC PRESS, Taylor & Francis Group; 2009.
5. Barret KE, Barman SM, Boitano S, Brooks H. Ganong's Review of Medical Physiology. 23th ed. New York: McGraw Hill Lange; 2009.

The total of active learning classes

Lectures: 45	**Practical classes: 30**

Teaching methods:

Classes are performed in one semester using the following methods:

- theoretical lectures (lectures, PP presentations, interactive teaching)
- practical lectures combined with computer animations and simulations of physiological processes, interactive teaching (checking students' knowledge)
- consultations

Grading system:

Exam prerequisites	Points	Final exam	Points
Active participation in lectures	0-2	Practical	
Practical classes	18	Written	70
Colloquia	10	Oral	
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Integrated academic studies of PHARMACY	

Study program: Pharmacy

Course title: Analytical Chemistry 1

Teachers: Kapetanović P. Vera, Jelikić-Stankov D. Milena, Karljiković-Rajić D. Katarina, Ražić S. Slavica, Uskoković-Marković M. Snežana, Odović V. Jadranka

Course status: Mandatory

Semester: II	**Year of studies: I**
ECTS points: 4	**Course code: F1O9**

Prerequisite for attending course: none

Course objectives:

This course will provide students with a background in qualitative chemical analysis performing students for solving analytical problems important for professional courses:

- Basic knowledge about heterogeneous equilibria
- Sample preparation and ion identification using selected reagents
- Identification of unknown substances
- Using chromatographic and extraction techniques for ions separation and identification.

Course outcomes:

Student become skilled to:

- Apply obtained knowledge about heterogeneous systems and evaluated the conditions of precipitation and dissolution
- Evaluate and apply appropriate sample preparation procedure
- Identify ions present in an unknown substance
- Apply separation techniques in separation, purification and analyte preconcentration

Course contents:

Lectures:

Basic principles of qualitative chemical analysis. Chemical equilibria of heterogeneous systems. Conditions of precipitation/dissolution - the influence of common ion, foreign ion, pH value, and complexation. Fraction separation/precipitation of hydroxide and sulphide. Analytical principles of sample preparation (dissolving substances) for qualitative chemical analysis of cations and anions. Analytical principles of ion separation: separation, purification and preconcentration. Applying chromatography techniques in separation and identification of inorganic ions with special atention to the partition, ion exchange, and ion chromatography. Theoretical principles and implementation of extraction methods in separation and identification of inorganic ions with special atention to the liquid-liquid extraction, solid phase extraction (SPE) and cloud point extraction (CPE). Selected examples of application separation techniques in ion analysis important in pharmacy.

Practical training:

Identification reactions of anions and cations (group, selective, specific). Identification of unknown substances with special application to conversion poorly soluble substances by preparation of soda extract. Application of chromatographic and extracting techniques in ion separation and identification. Application of paper chromatography for separation of IV and V analytical group's cations. Ion separation by solid phase extraction (SPE). Metal ion separation by chelating complex compounds using liquid-liquid chromatography.

Recommended literature:

1. Kapetanović V, Jelikić-Stankov M. Analitička hemija I uvod u semimikrokvalitativnu analizu, Beograd: Univerzitet u Beogradu; 1998.

2. Jelikić Stankov M, Kapetanović V, Karljiković-Rajić K, Aleksić M, Ražić S, Uskoković-Marković S, Odović J. Semimikrokvalitativna hemijska analiza, Praktikum za studente farmacije. Beograd: Farmaceutski fakultet;2012**.**

3. Dean JR. Extraction Techniques in Analytical Sciences. Chichester: John Wiley & Sons; 2009.

4. Vogel AI. Qualitative Inorganic Analysis. 7th ed. London: Longman; 1996.

5. Miller JM. Chromatography, Concepts and Contrasts. 2nd ed. New York: John Wiley & Sons; 2005.

The total of active learning classes

Lectures: 30	**Practical training:** 30

Teaching methods: lectures, laboratory practice, work in groups, consultations, interactive teaching

Grading system:

Exam prerequisites	**Points**	**Final exam**	**Points**

Active participation in lectures	6	Practical	
Practical training	16	Written	50
Colloquia	28	Oral	
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Integrated academic studies PHARMACY	

Study programme: Pharmacy

Course title: Botany

Teachers: Jančič B. Radiša, Lakušić S. Branislava, Slavkovska N. Violeta

Course status: Mandatory

Semester: II	**Study year: I**
ECTS: 6	**Course code: F1O12**

Course prerequisites: none

Course aims:

Acquiring knowledge about the basics of morphology, anatomy, physiology and ecology of pharmaceutically important plants. Localization of primary and secondary metabolites and their biological roles. Introduction to the classification systems as information systems. Identification of selected groups of medicinal plants.

Course outcomes:

Capacitating students to: explain the morphological and anatomical characteristics of plant organs important for pharmacy; describe and explain the basic physiological processes of plants; correctly name and classify selected taxa; predict the properties of taxa based on their systematic affiliation; access the requested information about the plants of interest to pharmacy; recognize groups of medicinal plants.

Course contents:

Lectures

Specific characteristics of the plant cell: the cell wall, plastids, vacuoles; organization of plant body: unicellular organisms, colonies, multicellular organisms; tissues: meristem, permanent; secretory tissue; organography: vegetative, reproductive organs, metamorphosis; structure of plant organs: root, stem (primary and secondary) and leaf; basic concepts of plant physiology: photosynthesis, respiration, mineral nutrition, metabolic products; taxonomy, nomenclature and description rules , taxon and ways to create a group, the system of classification of plants, natural, phylogenetic and special systems; Review of biosystematic groups of plants (Plantae) at the level of the division: Cyanophyta (Cyanobacteria), Chlorophyta, Phaeophyta, Bryophyta, Equisetophyta, Pteridophyta, Pinophyta, Magnoliophyta, ending with selected species important to pharmacy; Morphology of vegetative and reproductive organs and systematics of Pinophyta (gymnosperms): Gnetopsida, Ginkgopsida, Cycadopsida, Pinopsida; Morphology of vegetative and reproductive organs of Magnoliophyta (Angiosperms); Magnoliopsida and Liliopsida - selected taxa important for pharmacy; kingdom of Fungi - selected taxa important for pharmacy; basics of the plant ecology; botany and biotechnology - tissue culture, transgenic plants.

Practical classes

Microscopy: plant cells, tissues and organs; macroscopy: morphology of vegetative and reproductive organs; selected species important for pharmacy from Bryophyta, Equisetophyta, Pteridophyta, Pinophyta, Magnoliophyta; procedures for determination of vascular plants with botanical literature and database.

Recommended literature:

1. Jančić R. Botanika farmaceutika. Beograd: Službeni list; 2004 - 2012

2. Lakušić B, Slavkovska V, Stojanović D. Priručnik za vežbe iz botanike za studente Farmaceutskog fakulteta. Beograd: univertitet u Beogradu - Farmaceutski fakultet; 2005.

3. Jančić R, Stojanović D. Ekonomska botanika. Beograd: Zavod za izdavanje udžbenika; 2008.

4. Jančić R. Rečnik botaničkih morfoloških pojmova. Beograd: SANU; 2010.

5. Applequist W. The indetification of medicinal plants. Missouri, St. Louis: Missouri Botanical Garden Press; 2006.

The total of active learning classes

Lectures: 45	**Practical classes:** 45

Teaching methods:

Theoretical and practical classes.			
Grading system:			
Pre-exam obligations	**Points**	**Exam**	**Points**
Class Participation	0-3	Practical exam	
Practical classes	14-27	Written exam	18-35
Tests (colloquia)		Oral exam	18-35
Seminar work			

University of Belgrade Faculty of Pharmacy	Integrated academic studies PHARMACY	

Study programme: pharmacy

Course title: English Language in Pharmacy Practice

Teachers: Leontina Kerničan

Course status: elective

Semester: II	**Study year: I**
ECTS: 3	**Course code: F1I3**

Course prerequisites: /

Course aims:

To

- Introduct to pharmaceutical professional terminology
- develop abilities in oral and written communication on the main professional issues
- develop abilities to understand written information from various pharmaceutical disciplines

Course outcomes:

Student will be able to:

- apply the knowledge in active oral and written communication
- express oppinion regarding some issues from pharmaceutical profession
- understand less comprehensive professional literature

Course contents:

Lectures (practical classes included)

Introduction to general concepts of pharmaceutical profession. Chemistry, periodical system, measuring units. Laboratory equipment (glassware and devices) and laboratory analyses. Cell, tissue, human body. Description and classification of drugs. Use and dispending of drugs. Health and disease. Communication with patient. Textual analysis and composition. Exercises of verbal communication. Discussions on pharmaceutical profession, general aims in pharmacists' job and drugs (based on provided reading materials). Lexical exercises in applying professional terminology. Definition and reformulation. Exercises of text review.

Recommended literature:

1. Kerničan-Varga L., English Language in Pharmacy Practice, Zbirka tekstova sa vežbanjima i stručnim rečnikom (treće dopunjeno izdanje), Grafopan Beograd, 2011.

2. Mićić S., Nazivi bolesti i poremećaja u engleskom jeziku, Beogradska knjiga, Beograd, 2004.

3. Arneri-Georgiev J., More Medical Words You Need, Savremena administracija a.d., Beograd, 2002.

4. Bijas Z., Englesko-hrvatsko-engleski rečnik, Nakladni zavod Globus, Zagreb, 2001.

5. Medić M., Medicinski rečnik, Latinsko-srpsko-latinski rečnik, Elit-Medica, Beograd, 1998.

The total of active learning classes

Lectures: 30	**Practical classes: /**

Teaching methods:

Interactive lessons, working in group, rol playing, individual tasks.

Grading system:

Pre-exam obligations	Points	Exam	Points
Class Participation	5-10	Practical exam	
Practical classes		Written exam	15-30
Tests (colloquia)		Oral exam	15-30
Seminar work	15-30		

University of Belgrade Faculty of Pharmacy	Integrated academic studies PHARMACY	

Study programme: Pharmacy

Course title: Foreign Language for Pharmacy - French

Teachers: Mirić M. Milica

Course status: Elective

Semester: II	**Study year: I**
ECTS: 3	**Course code: F1I3F**

Course prerequisites:

Course aims:

This course aims to introduce the basic pharmacy terminology to students, to develop their communicative competence in the pharmacy profession as well as their comprehension of scientific papers and professional publications in French and to enable an effective application of acquired skills.

Course outcomes:

Upon completion of this course, the students are expected to be able to effectively use basic pharmacy terminology in the professional setting, to apply the knowledge of LSP in the understanding of basic scientific and professional literature and to express their opinion on selected pharmaceutical topics.

Course contents:

Lectures

Introduction to basic terminology in different professional fields. Topics: Pharmacy studies and profession; Body parts, cell, tissue and organ systems; Chemistry: perodic table, laboratory glassware; Health and disease; Medicines: dosage forms, classes, prescription, patient information leaflet, drug dispensing. Use of pharmacy terminology. Communication with patients. Discussions on professional topics based on the contents presented through the course. Analyzing texts.

Practical classes

Recommended literature:

1. Mirić M. French Language for Pharmacy, study materials.

2. Thieulle J, Van Eibergen J. Le langage médical : A l'usage des futurs professionnels de la santé. Collection: REUSSIR DEAS. Paris: Editions Lamarre; 2010.

3. Mourlhon - Dallies F, Tolas J. Santé - médécine.com. Paris: CLE International; 2004.

4. Garnier M, Delamare V, Delamare J, Delamare T. Dictionnaire illustré des termes de médecine. 29e édition, Paris: Maloine; 2006.

5. Jovanović A S. Savremeni francusko-srpski rečnik sa gramatikom, Beograd: Prosveta; 2005.

The total of active learning classes

Lectures: 30	**Practical classes:**

Teaching methods:

Interactive lectures, group work, individual tasks.

Grading system:

Pre-exam obligations	Points	Exam	Points
Class Participation	0-2	Practical exam	
Practical classes		Written exam	15-30
Tests (colloquia)	0-18	Oral exam	

Seminar work		
Other	0-50	

University of Belgrade Faculty of Pharmacy	Integrated academic studies of PHARMACY	

Study programme: Pharmacy

Course title: Application of Information Technology in Pharmacy

Teachers: Ranković D. Dragana, Lakić M. Dragana, Tadić B. Ivana

Course status: elective

Semester: II	**Year of studies: I**
ECTS points: 3	**Course code: F1I4**

Requirements: none

Course aims:

Gathering new skills and knowledge in the field of information technology for the future professional development. Application of the contemporary information technology methods in the processes of learning and teaching. Introduction to the information technology systems in the pharmaceutical profession and the healthcare system.

Course outcomes:

Knowledge and understanding of information technologies. Student will be able: to use MS Word and Excel for the purposes of learning and the future professional work, to search through the web pages in order to find studying materials, as well as to use the possibilities of on-line learning. Usage of the pharmaceutical and healthcare information systems.

Course contents:

Lectures

Operative system and its purpose, Windows working environment, folders and files, basic elements of windows and manipulation, saving of files.

MS Word. Cursors and selection of text, font formatting, search and replacement of text, paragraph formatting, bullets and numbering, creation of tables, conversion of text to table, processing of multiple pages text, column formatting, working with different styles.

MS Excel. Basic elements of the window, data entry and table formatting, insertion and copying of formulas, absolute and relative cell addresses, charting of graphs, various types of graphs, using multiple sheets and files.

Internet-intranet networks. Searching tools. Sourcing of the learning material. On-line learning. Information systems and information technologies. Information systems in pharmacy – design, architecture and structure. Methods and software for the pharmaceutical and healthcare system. Standards and norms in the pharmaceutical information technology.

Recommended literature:

1. On-line materials
2. Millares M. Applied Therapeutics - Applied Drug Information: Strategies for Information Management. Vancouver Washington; 1998.

The total of active learning classes

Lectures: 10	**Practical classes:** 20

Teaching methods:

lectures, discussions

Grading system:

Exam prerequisites	Points	Final exam	Points
Active participation in lectures	5	Practical	
Practical classes	5	Written	70
Colloquia		Oral	
Seminars			
Other activities	20		

University of Belgrade Faculty of Pharmacy	Integrated academic studies of PHARMACY	

Study programme: Pharmacy

Course title: Physiology 2

Teachers: Plećaš-Solarović A. Bosiljka, Pešić R. Vesna, Nedeljković S. Miodrag

Course status: mandatory

Semester: III	**Year of studies: II**
ECTS points: 5	**Course code: F2O1**

Requirements: Physiology 1

Course aims:

Provision of important knowledge from physiology of cell, tissue, organ systems and human body as whole, relevant to pharmaceutical practice. Provision of theoretical basis relevant for other courses (pathophysiology, pharmacology, medical biochemistry, pharmacognosy, pharmacotherapy, clinical pharmacy, pharmacotherapy, toxicology, bromatology).

Course outcomes:

After finishing this course student will be trained to:

- properly use medical terminology
- be familiar with function of individual organs, understand integrated function of organs and control mechanisms related to them.
- understand interconnections of regulatory systems, which is important for organism adaptation to inner and outer environmental changes in everyday basis.

Course contents:

Theoretical lectures

Physiology of the digestive system. Motility and secretory function and their regulation. Processes in the oral cavity, pharynx and esophagus. Stomach. Small intestine. Exocrine pancreas. Bile: composition, role, formation and regulation of secretion. Colon. Digestion and absorption: carbohydrates, proteins, and lipids; Absorption of water, electrolytes and vitamins. Liver. Quantitative metabolism. Body temperature: regulation and disorders. Physiology of the urinary system. Functional anatomy of the kidney; juxtaglomerular device; blood flow through the kidneys. The formation of urine: glomerular filtration, tubular reabsorption and secretion; concentrating urine. The composition of urine. Micturition reflex. Maintenance of acid-base balance. H^+ concentration in the body fluids. The role of chemical buffer, the respiratory system and the kidneys in the H^+ homeostasis. Basic H^+ homeostasis disorders. Maintaining the balance of electrolytes and water in the body. Physiology of the endocrine system. General characteristics of hormones. Thyroid gland. Hormonal regulation of calcium and phosphate homeostasis: parathyroid hormone, calcitonin and vitamin D hormone. Endocrine pancreas. Adrenal gland: hormones of the cortex and medulla. Pituitary gland: hormones of the anterior and posterior lobes. Hypothalamus. Gonads. Physiology of the skin.

Practical classes

Digestive enzymes (ptyalin, pepsin, trypsin) and bile: characteristics, roles. Renal physiology: processes responsible for the formation of urine. General physiology of the endocrine system, endocrine pancreas and blood glucose determination.

Recommended literature:

1. Plećaš B. Skripta za predavanja „FIZIOLOGIJA - PREDAVANJA 2011/2012“. Drugo ispravljeno i dopunjeno izdanje, Beograd; 2011.
2. Pešić V, Nedeljković M. Priručnik za praktičnu nastavu. Beograd: Autorsko izdanje; 2007.
3. Koeppen BM, Stanton BA. Berne & Levy PHYSIOLOGY. 6th ed. Philadelhia: Mosby, Elsevier; 2010.
4. McCorry LK. Essentials of Human Physiology for Pharmacy. 2nd edition. Boca Raton: CRC PRESS, Taylor & Francis Group; 2009.
5. Barret KE, Barman SM, Boitano S, Brooks H. Ganong's Review of Medical Physiology. 23th ed. New York: McGraw Hill Lange; 2009.

The total of active learning classes

Lectures: 45	**Practical classes: 15**

Teaching methods: Teaching methods:

Classes are performed in one semester using the following methods:

- theoretical lectures (lectures, PP presentations, interactive teaching)
- practical lectures combined with computer animations and simulations of physiological processes, interactive teaching (checking students' knowledge)
- consultations

Grading system:

Exam prerequisites	Points	Final exam	Points
Active participation in lectures	0-2	Practical	
Practical classes	18	Written	70
Colloquia	10	Oral	
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Integrated academic studies PHARMACY	

Study programme: Pharmacy

Course title: Immunology

Teachers: Arsenović Ranin M. Nevena, Stojić-Vukanić M. Zorica

Course status: Mandatory

Semester: III	**Study year: II**
ECTS: 5	**Course code: F204**

Course prerequisites: No

Course aims: To provide knowledge about:

- the components of the innate and adaptive immunity, the development and functions of immune responses.
- main features of immunity to different types of pathogenic mikroorganisms
- disorders of the immune system functions: hypersensitivity reactions, autoimmune diseases and immunodeficiencies
- immunity to tumors and transplantation immunology
- principles underlying some of the most commonly used laboratory methods in immunology

Course outcomes: After completing the course the students are exprected to:

- know the effector mechanisms of innate and adaptive immunity in defense against infection
- know the pathogenesis and clinical manifestations of selected immunologic diseases as well as the novel therapies for these diseases
- know general principles of transplantation immunology and immunity to tumors
- know principles of the most commonly used immunoassays for qualitative and/or quantitative analysis of antigen and antibody

Course contents:

Lectures

Innate immunity: recognition of microbes and damaged cells by the innate immune system, components of the innate immune system. Properties of antigens recognized by T and B lymphocytes. Structure and function of major histocompatibility comples (MHC) molecules. Capture, processing and presentation of protein antigens. The structure of the T and B cell receptors for antigen. Development of immune repertoires. Activation of T lymphocytes. Differentiation and functions of CD4+ and CD8+ effector T cells. B cell activation and antibody production. Effector mechanisms of humoral immunity: neutralization of microbes and microbial toxins. Immunologic tolerance. The factors that contribute to the development of autoimmunity and general features of autoimmune disorders. Immunity to tumors. Transplantation immunology. Hypersensitivity reactions: mechanisms and classification. Congenital i acquired immunodeficiencies (AIDS).

Practical classes

Immunization, the production of polyclonal and monoclonal antibodies. Precipitation reactions. Agglutination reactions. Complement fixation and total haemolytic complement activity test. Immunoassays with radioactive probes. Enzyme immunoassays. Fluorescently labeled probes (immunofluorescence and flow cytometry). Immunohistochemistry. Isolation of immune cells. Assessment of humoral and cell-mediated immunity *in vitro* and *in vivo*. Laboratory tests that are performed before transplantation to reduce the risk for immunologic rejection of allografts. Detection of immune complexes in tissues and body fluids. Molecular biology techniques in immunology.

Recommended literature:

Abbas AK, Lichtman AH, Pillai S. Basic immunology – functions and disorders of the immune system. 4th ed. Philadelphia: Elsevier Saunders; 2014.

Abbas AK, Lichtman A, Pillai S. Cellular and molecular immunology. 8th ed. Philadelphia: Elsevier Saunders; 2015.

Kindt TJ, Goldsby RA, Osborne BA. Kuby Immunology. 6th ed. New York: W.H. Freeman and Company; 2007.

Murphy K. Janeway's Immunobiology. 8th ed. New York: Garland Science,Taylor & Francis Group, LLC; 2012.			
The total of active learning classes			
Lectures: 30		**Practical classes: 30**	
Teaching methods: teaching, laboratory work			
Grading system:			
Pre-exam obligations	**Points**	**Exam**	**Points**
Class Participation		Practical exam	
Practical classes	5	Written exam	65
Tests (colloquia)	30	Oral exam	
Seminar work			

University of Belgrade Faculty of Pharmacy	Integrated academic studies PHARMACY	

Study programme: Pharmacy

Course title: Instrumental Methods

Teachers: Mirjana Medenica, Nataša Pejić

Course status: Mandatory

Semester: III	**Study year: II**
ECTS: 6	**Course code: F203**

Course prerequisites: Physical Chemistry

Course aims: Introduction to theoretical principles, various types of apparatus and procedures of different instrumental methods that will be discussed and used in other courses during the pharmaceutical studies as well as in a pharmaceutical laboratory. Introduction to some chosen methods during the individual practical training.

Course outcomes: Student is qualified (both theoretically and practically) to choose the appropriate instrumental method to complete the required task in accordance with the specificity of the pharmaceutical profession. Student is able to solve the problems with basic instruments and apparatus using the supplied manuals.

Course contents:

Lectures

Principles and types of instrumental methods. Signals and detection. Instruments for measurements. Spectroscopic methods. Electromagnetic radiation, photocells, qualitative and quantitative aspects of spectrometry and applications. Instrumental methods based on rotation and refraction of radiation. Absorption and emission of electromagnetic radiation. Lambert-Beer law. Atomic absorption and atomic emission (flame photometry) spectrometry. Molecular spectrometry, interactions of electromagnetic radiation with molecules, absorption of UV, VIS and IR radiation, methods of molecular absorption and emission spectrometry (UV–VIS and IR spectrometry, fluorimetry. Methods based on light scattering (turbidimetry and nephelometry). Mass spectrometry. Electrochemical methods. Electrolytes, conductivity of electrolytes, Kohlrausch's laws, conductance measurements, dissociation degree and dissociation constant, electrophoretic effect, conductometry and conductometric titrations. Electrochemical (galvanic) cell, mechanism of generating the electrode, membrane and diffusion potential, Nernst equation of potentials of electrodes, types of electrodes, ion-selective electrodes, pH metry and pX metry. Potentiometry and potentiometric titrations. Electrolytic cell, coulometry, Karl–Fisher titration. Polarization and depolarization of electrodes, polarography. Instrumental separation methods. Separation techniques: physical-chemical principles of separation (adsorption, partition, ionic exchange, charge and velocity). Classification of instrumental separation methods. Gas and liquid chromatography; theoretical principles, types, important factors in separation in gas and liquid chromatography, apparatus and applications. Electrophoresis; theoretical principles, types and apparatus.

Practical classes

Experiments in laboratory: Polarimetry. Refractometry. Atomic absoprtion spectroscopy and flame photometry. UV-VIS spectrometry and fluorimetry. Nephelometry and turbidimetry. Conductometry and conductometric titrations. Potentiometry and potentiometric titrations in different chemical systems. pH metry and pX metry. Coulometry. Karl–Fisher titration. Polarography. Some selected separation techniques (gas and liquid chromatography). Electrophoresis.

Recommended literature:

1. Medenica M, Malešev D. Eksperimentalna fizička hemija. Beograd: published by Medenica M.; 2002.
2. Skoog D, Holler FJ, Niemen TA. Principles of Instrumental Analysis (4th ed.). Philadelphia: Sounders College Publishing; 1998.
3. Antić Jovanović A, Molekulska spektroskopija – spektrohemijski aspekt. Univerzitet u Beogradu, Fakultet za fizićku hemiju; 2002.
4. Rouessac F, Rouessac A. Chemical Analysis Modern Instrumentation Methods and Techniques. USA: John Wiley & Sons, Ltd.; 2007.
5. Kuntić V, Aleksić M, Pavun L, Pejić N. Zbirka zadataka iz fizičke hemije. Beograd: published by Pavun L; 2003.

The total of active learning classes

Lectures: 45	**Practical classes: 45**

Teaching methods: Lectures, practical training in laboratory, consultations, researching.			
Grading system:			
Pre-exam obligations	**Points**	**Exam**	**Points**
Class Participation		Practical exam	
Practical classes	30	Written exam	70
Tests (colloquia)		Oral exam	
Seminar work			

University of Belgrade Faculty of Pharmacy	Integrated academic studies of PHARMACY	

Study program: Pharmacy

Course title: Pharmaceutical Chemistry 1

Teachers: Erić M. Slavica, Brborić S. Jasmina, Marković D. Bojan

Course status: Mandatory

Semester: III	**Year of studies: II**
ECTS points: 5	**Course code: F2O6**

Prerequisite for attending course: Organic Chemistry 1, Organic Chemistry 2

Course aims: for student to acquire basic knowledge in pharmaceutical and medicinal chemistry, which then will be used in mastering courses Pharmaceutical Chemistry 2 and 3, as well as Pharmacology and Pharmacokinetics.

Course outcomes: Student is expected to obtain knowledge about physicochemical properties of pharmacologically active molecules, about reactivity of their functional groups, about chemical and metabolic stability of medicines, to understand target and mechanisms of drug effects on molecular level, to analyze relationships of chemical structure, properties and effects of medicines.

Course contents:

Lectures:

Introduction to pharmaceutical-medicinal chemistry, functional groups that are important to medicinal chemistry, nomenclature of medicines, physicochemical properties of pharmacologically active compounds: ionization, lipophilicity and solubility of medicines; molecular-chemical bases of drug effects: targets of drug effects, structure-activity relationship analysis, chemical stability of medicinal compounds (oxidation, hydrolysis and other instability reactions with examples), chemical aspects of drug biotransformation of medicines, I and II phase metabolism reactions with examples; bioisosteres in medicinal chemistry; prodrug: properties, division and application with examples.

Practical training:

Data bases review, experimental determination of physicochemical parameters: lipophilicity, solubility, drug ionization; application of computational methods in drug structure-effect relationship analysis; calculation of molecular descriptors of pharmacologically active compounds, introduction to basic principles of molecular modeling of drugs; functional groups review, examples of chemical stability and drug biotransformation.

Recommended literature:

1. Patrick GL. Introduction to Medicinal Chemistry. 4th ed. Oxford: University Press; 2009.
2. Lemke TL. Review of Organic Functional Groups. Introduction to Medicinal Organic Chemistry. 5th ed. Philadelphia: Lippincott Williams & Wilkins; 2012.
3. Cairns D. Essentials of Pharmaceutical Chemistry. 3rd ed. London, Chicago: Pharmaceutical Press; 2008.
4. Foye's Principles of Medicinal Chemistry. 7th ed. Williams DA, Lemke TL, editors. Baltimore: Lippincott Williams & Wilkins; 2013.
5. Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry. 12th ed. Beale JM, Block JH, editors. Philadelphia: Lippincott Williams & Wilkins; 2011.

The total of active learning classes

Lectures: 45	**Practical training:** 30

Teaching methods: oral lectures, interactive teaching, experimental training, computational training

Grading system:

Exam prerequisites	Points	Final exam	Points
Active participation in lectures		Practical	
Practical training	30	Written	70
Colloquia		Oral	
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Integrated academic studies of PHARMACY	

Study program: Pharmacy

Course title: Analytical Chemistry 2

Teachers: Kapetanović P. Vera, Jelikić-Stankov D. Milena, Karljiković-Rajić D. Katarina, Ražić S. Slavica, Uskoković-Marković M. Snežana, Odović V. Jadranka

Course status: mandatory

Semester: III	**Year of studies: II**
ECTS points: 5	**Course code: F2O2**

Prerequisite for attending course: none

Course objectives:

This course provides an introduction to the fundamental principles of quantitative chemical analysis in order to enable student for solving analytical problems:

- Theoretical and practical approach to quantitative chemical analysis
- Methods of classic quantitative chemical analysis
- Basic principles of calculations in gravimetric and volumetric analysis
- Analytical applications of selected instrumental methods in inorganic ion analysis
- Processing, evaluation, and interpretation of results and validation of analytical methods.

Course outcomes:

Student will be able to:

- Assessment the equilibrium constants
- Calculate titration curves
- Select the appropriate indicator for titration
- Select the method for determination of specific ion
- Carry out all phases of quantitative chemical analysis
- Calculate, evaluate and discuss obtained results

Course contents:

Lectures:

Introduction to quantitative chemical analysis. Gravimetric analysis. Introduction to volumetric analysis. Acid-base titration of monoprotic and polyprotic systems. Importance of distribution diagrams. Acid-base titration in non-aqueous media - examples important for professional courses. Oxido-reduction titrations - methods of cerimetry, permanganometry, iodometry. Theoretical principles of Karl-Fischer and Winkler methods. Precipitation titrations. Halide determination by classical methods and methods based on adsorption indicators. Complexometric titrations. Theoretical principles of water hardness determination. Selection of analytical methods and data processing. Application of selected instrumental methods in inorganic ions analysis. Examples of photometric titration based on helate complexes and potentiometric determination of halide mixtures. Basic statistics and parameters of analytical method validation.

Practical training:

Basic procedures in quantitative chemical analysis. Selected example of gravimetric analysis. Examples of acid-base titrations. Acetic and phosphoric acid determination. Determination of carbonates content of volumetric sodium hydroxide solution. Examples of oxido-reduction titrations. Determination of hydrogen peroxide, iron, arsenic/copper. Examples of precipitation titration. Chloride determination by Mohr and Volhardt methods. Examples of complexometric titrations. Magnesium and calcium determination. Processing results - applying a statistical test of significance. Introduction to analytical instrumental techniques: potentiometric titration of phosphoric acid, photometric determination of copper by titration with EDTA, photometric titration of copper and bismuth mixture.

Recommended literature:

1. Skoog DA, West DM, Holler FJ. Fundaments of Analytical Chemistry. 7th ed. Philadelphia: Saunders College Publishing; 1996.

2. Christian GD, Dasgupta PK, Schug KA. Analytical Chemistry. 7th ed. New York: John Wiley & Sons, INC; 2013.

3. . Jelikić Stankov M, Kapetanović V, Karljiković-Rajić K, Aleksić M, Ražić S, Uskoković-Marković S, Odović J. Kvantitativna hemijska analiza, Praktikum i zbirka zadataka za studente farmacije. Beograd: Farmaceutski fakultet; 2013.

4. Savić J, Savić M. Osnovi analitičke hemije Klasične metode. Sarajevo: Svjetlost; 1989. **5.** Thomas M. Analytical Chemistry by Open Learning: Ultraviolet and Visible Spectroscopy. New York: John Wiley & Sons; 1996.			
The total of active learning classes			
Lectures: 45		**Practical training:** 45	
Teaching methods: lectures, laboratory practice, work in groups, consultations, interactive teaching			
Grading system:			
Exam prerequisites	**Points**	**Final exam**	**Points**
Active participation in lectures	6	Practical	
Practical training	24	Written	40
Colloquia	30	Oral	
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Integrated academic studies PHARMACY	

Study programme: Pharmacy

Course title: General Biochemistry

Teachers: Spasojević-Kalimanovska V. Vesna, Jelić-Ivanović D. Zorana, Bogavac-Stanojević B. Nataša, Kotur-Stevuljević M. Jelena

Course status: Mandatory

Semester: III	**Study year: II**
ECTS: 6	**Course code: F205**

Course prerequisites: Organic Chemistry 2

Course aims:

To obtain knowledge on: basic catabolic, anabolic and common metabolic pathways in the cell, as well as their regulations.

Course outcomes:

After a successfully finished course, it is expected that the student is able to describe and analyze major catabolic, anabolic and common metabolic pathways.

Course contents:

Lectures

Structure - function relationships of biomolecules. Enzyme structure and mechanism of action, enzyme kinetics, types of enzyme inhibition. Basic principles of bioenergetics. Catabolism and anabolism of carbohydrates, lipids and nitrogen containing compounds, regulation of catabolic and anabolic pathways. Protein and nucleic acids biosynthesis. Cell signaling.

Practical classes

Workshops

• Enzyme: general characteristics, interrelationship of structure and function and enzyme classification. Saturation kinetics of enzymes and significance of Michaelis Menten constant determination. Impact of different inhibitors on enzyme reaction. Mechanisms of regulations of enzyme activity.

• Catabolism of carbohydrates: chemistry and thermodynamics, regulation of glycolysis, glycogenolysis and citric acid cycle. Importance of particular catabolic products for anabolic pathways. Respiratory chain and oxidative phosphorylation.

• Eicosanoids and cholesterol: structure, biosynthesis and regulation. Role of lipoproteins in cholesterol transport in the body.

• Protein and nucleic acids biosynthesis: central dogma of protein synthesis. Nucleic acids structure and function. DNA-histone interaction and organization of eukaryotic genetic material in chromosomes. Replication, transcription and translation in prokaryotes and eukaryotes.

Recommended literature:

1. Spasić S, Jelić-Ivanović Z, Spasojević-Kalimanovska V, Opšta biohemija, Beograd, 2003.

2. Devlin TM. Textbook of Biochemistry with Clinical Correlations. John Wiley & Sons, New York, 2011.

The total of active learning classes

Lectures: 45	**Practical classes:** 15

Teaching methods:

Lectures, practical classes – interactive classes, workshops, disscussions, problem solving, seminars.

Grading system:

Pre-exam obligations	Points	Exam	Points
Class Participation	2	Practical exam	
Practical classes		Written exam	70

Tests (colloquia)	10	Oral exam	
Seminar work	18		

University of Belgrade Faculty of Pharmacy	Integrated academic studies PHARMACY	

Study programme: Pharmacy

Course title: Pharmacology 1

Teachers: Ugrešić D. Nenad, Stepanović-Petrović M. Radica, Savić M. Miroslav, Novaković N. Aleksandra, Tomić A. Maja

Course status: Mandatory

Semester: IV	**Study year: II**
ECTS: 4	**Course code: F207**

Course prerequisites: Physiology 2

Course aims:

To provide the student with:

- **knowledge about the mechanisms of drug action**
- **information necessary for understanding the various effects of drugs**
- **comprehension about the therapeutic and adverse effects of distinct drug groups**
- **knowledge about the principles of the therapeutic drug use.**

Course outcomes:

Upon completion of this course, students will be able to:

- **identify the mechanisms of various actions of distinct drug groups**
- **link the therapeutic and adverse effects of distinct drug groups with their different pharmacological effects**
- **build up the personal critical attitude towards a drug.**

Course contents:

Lectures

General principles of pharmacology. Drug development. Receptor/cellular/molecular level of the mechanism of drug action. Drug targets. Receptors. Affinity. Efficacy. Agonists, inverse agonists, antagonists. Competitive, non-competitive and irreversible antagonism. Mechanisms of signal transduction. G proteins. Second messengers. Ion channels. Enzymes. Transporters. Drug interactions. Drug safety. Principles of hemotherapy. Antibacterial drugs. Resistance to antimicrobial drugs. Antimicrobial drugs that inhibit the synthesis or action of folates. Beta lactam antibiotics. Antimicrobial drugs that inhibit the synthesis of bacterial proteins. Antimicrobial drugs with inhibitory effects on topoisomerases. Antituberculotics. Antimycotics. Antivirotics. Antiprotozoal drugs. Anthelminthics. Cytostatic drugs. Immunopharmacology (inflammation/autacoids). Eicosanoids. Nonsteroidal antiinflammatory drugs. Histamine and antihistamines. Immunomodulators.

Practical classes

Computer simulations and learning though discussion of the results of experimental research: Development of novel drug. Routes of drug administration. Dose-effect curve. Antagonism. Antibacterial drugs. Cytostatic drugs. Influence of drugs on inflammation.

Recommended literature:

1. Rang HP, Ritter JM, Flower RJ, Henderson G. Rang and Dale's Pharmacology. 8th edition. London: Elsevier Churchill Levingstone, 2015.
2. Katzung BG, ed. Basic & Clinical Pharmacology. 12th edition. New York: :Lange Medical Books, Mcgraw-Hill Medical Publishing Division; 2012.
3. Brunton LL, Chabner BA, Knollmann BC, eds. Goodman and Gilman's the Pharmacological Basis of Therapeutics. 12th edition. New York: Mcgraw-Hill; 2011.

The total of active learning classes

Lectures: 30	**Practical classes: 15**

Teaching methods:

Lectures, recorded laboratory in vivo and in vitro experiments on animals, computer simulations of experiments			
Grading system:			
Pre-exam obligations	**Points**	**Exam**	**Points**
Class Participation		Practical exam	
Practical classes	5	Written exam	
Tests (colloquia)	25	Oral exam	70
Seminar work			

University of Belgrade Faculty of Pharmacy	Integrated academic studies PHARMACY	

Study program: Pharmacy

Course title: Pharmaceutical Chemistry 2

Teachers: Vladimirov M. Sote, Agbaba D. Danica, Čudina A. Olivera, Marković D. Bojan

Course status: Mandatory

Semester: IV	**Year of studies: II**
ECTS points: 8	**Course code: F2O10**

Prerequisite for attending course: Pharmaceutical Chemistry 1

Course aims: Acquisition of fundamental knowledge about chemistry of various groups of drugs. Adopted knowledge will be used in mastering medicinal, pharmaceutical-technological and pharmaceutical practice courses.

Course outcomes: Introduction to physicochemical properties of pharmacologically active molecules and reactivity of their functional groups, fundamental mechanisms of action, chemical structure-biological activity relationships, drug-drug interactions, drug-receptor interactions, chemical aspects of drug metabolism (*in vivo* and *in vitro*).

Course contents:

Lectures:

Chemotherapeutics: antibiotics (beta-lactam antibiotics: penicillin and cephalosporin classes; aminoglycosides; macrolides; tetracyclines; chloramphenicol; lincosamides; polypeptide and other antibiotics - chemical properties, mechanism of action, structure-activity relationship, biotransformation. Other antimicrobial drugs: sulfonamides, folate reductase inhibitors, quinolones and fluoroquinolones. Disinfecting agents, antiseptic agents, antimycotics, antiprotosoic and antiparasitic drugs; uroantiseptics, antituberculotics, antineoplastics (antimetabolites, alkilating agents); antivirotics.

Steroid hormones and hormones containing other structures. Nomenclature of steroides, stereochemistry and stereochemical modifications, biosynthesis, structure-activity relationship, biotransformation. Estrogen hormones and antiestrogens; androgen hormones, anabolics and antiandrogens; gestagen hormones, oral contraceptives; corticosteroids (mineralocorticoids and glucocorticoids); anti-inflammatory steroids; thyroxine and drug used to treat hyperthyroidism; oral hypoglycemic agents (sulfonylureas, biguanides, thiazolidinediones, etc.)

Vitamins and coenzymes: chemical properties, biological role, stability, provitamins and antivitamins. Liposolubile vitamins: vitamins A, synthetic and semisynthetic retinoides, vitamins D, E and K. Hydrosolubile vitamins: vitamins B and vitamin C.

Practical training:

Preparative method for obtaining, isolation, purification, identification and characterization of selected pharmaceutical compounds using analytical methods, separation techniques, spectroscopic methods. Determination of physicochemical constants. Case study analysis.

Recommended literature:

1.Foye's Principles of Medicinal Chemistry. 7th ed. Williams DA, Lemke TL, editors. Baltimore: Lippincott Williams & Wilkins; 2013.

2. Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry. 12th ed. Beale JM, Block JH, editors. Philadelphia: Lippincott Williams & Wilkins; 2011.

3. Владимиров С, Живанов-Стакић Д. Фармацеутска хемија. II део. Београд: Фармацеутски факултет; 2006.

4. European Pharmacopoeia. 7th ed. Strasbourg: Council of Europe; 2010.

5. Припремни материјал за вежбе

The total of active learning classes

Lectures: 45	**Practical training:** 60

Teaching methods: lectures, interactive teaching, laboratory practice

Grading system:

Exam prerequisites	Points	Final exam	Points
Active participation in lectures		Practical	
Practical training		Written	60
Colloquia	30	Oral	10

Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Integrated academic studies PHARMACY	

Study programme: Pharmacy

Course title: Pathophysiology 1

Teachers: Gordana Leposavić

Course status: Mandatory

Semester: IV	**Study year: II**
ECTS: 5	**Course code: F2O9**

Course prerequisites: Physiology 1, Physiology 2, Immunology

Course aims: To provide understanding of:

- Concepts of health and disease: etiology, pathogenesis
- Mechanisms underlying cell and tissue injury evoked by various etiological agents (ischemia, free radicals, biological agents) and mechanisms of local and whole body responses to tissue injury.
- Etiology, pathogenesis and main clinical manifestations of the most important metabolic disorders.
- Causes and mechanisms of neoplastic cell transformation; characteristics of neoplastic cells and tumour growth and cardinal alterations in the host organism.

Course outcomes: After completing the course the students are expected to:

- Be able to identify causes (etiology) and mechanisms of development (pathogenesis) of inflammation, shock, neoplasia and the most important metabolic disorders.
- Have knowledge to relate clinical manifestations of shock, neoplasia and the most important metabolic disorders with causes and mechanisms of their development.
- Understand diagnostic significance of clinical and laboratory tests and analyses used to diagnose inflammatory and metabolic disorders, shock and neoplasia.
- Comprehend pathophysiological backgrounds for action of various drug and chemicals, and strategies to prevent and/or treat inflammation, malignant diseases and metabolic disorders.

Course contents:

Lectures

- Introduction to pathophysiology: Concept of health and disease, etiology and pathogenesis.
- Cell Injury, adaptation and cell death.
- Etiopathogenesis of acute and chronic inflammation.
- Etiopathogenesis of shock
- Neoplasia: Molecular basis of malignant transformation, characteristics of neoplastic cells, biology of tumor growth,
- Alterations in body fluids and electrolytes: etiology, pathogenesis, pathophysiological and clinical consequences.
- Alterations in acid-base balance: etiology, pathogenesis, pathophysiological and clinical consequences.
- Etiopathogenesis of diabetes mellitus and acute and chronic complications
- Etiopathogenesis of atherosclerosis and clinical consequences
- Etiopathogenesis of malnutrition and obesity.

Practical classes

- Cell injury induced by ischemia and oxidative stress.
- Cell injury induced by infectious agents.
- Acute inflammation: cardinal signs, mediators and systemic changes

- Malignant cell transformation and growth. Paraneoplastic syndrome.
- Ethiopathogenesis of shock
- Alterations in body fluids and electrolytes (sodium, potassium, magnesium, calcium): Etiology, pathogenesis, pathophysiological and clinical consequences.
- Alterations in acid-base balance: etiology, pathogenesis, pathophysiological and clinical consequences.
- Etiopathogenesis of diabetes mellitus type II and its chronical complications
- Etiopathogenesis of atherosclerosis

Recommended literature:

1. Leposavić G. Patološka fiziologija za studente farmacije. Beograd: Univerzitet u Beogradu-Farmaceutski fakultet; 2012.
2. Marušić M, Kovač Z, Gamulin S. Patophysiology:Basic mechanisms of disease. Zagreb: Medicinska naklada; 2009.
3. Živančević-Simonović S. Opšta patološka fiziologija. Kragujevac: Medicinski fakultet u Kragujevcu; 2002.
4. Stošić Z i Borota P. Osnovi kliničke patofiziologije. Novi Sad: Univerzitet u Novom Sadu, Medicinski fakultet; 2012.
5. Kovač Z, Gamulin S i sur. Patofiziologija– Zadaci za problemske seminare. Zagreb: Medicinska naklada; 2006.

The total of active learning classes 60

Lectures: 30	**Practical classes: 30**

Teaching methods:

Lectures and problem-based learning

Grading system:

Pre-exam obligations	**Points**	**Exam**	**Points**
Class Participation		Practical exam	
Practical classes	20	Written exam	70
Tests (colloquia)	10	Oral exam	
Seminar work			

University of Belgrade Faculty of Pharmacy	Integrated academic studies PHARMACY	

Study programme: Pharmacy

Course title: Microbiology

Teachers: Milenković T. Marina, Antić Stanković A. Jelena

Course status: Mandatory

Semester: IV	**Study year: II**
ECTS: 6	**Course code: F209**

Course prerequisites: No

Course aims: To provide knowledge regarding classification and characteristics of pathogenic microorganisms (bacteria, viruses, protozoa, helminthes, fungi) , principles of laboratory diagnosis of infectious diseases, pathogenesis, epidemiology, treatment , prevention and control of human infections (active and passive immunization). To provide knowledge regarding mechanisms of action of antimicrobial agents and molecular mechanisms of resistance to different antimicrobial drugs.

Course outcomes: Knowing classification and characteristic (morphology, physiology, virulence factors) of pathogenic microorganisms (bacteria, viruses, protozoa, helminthes, fungi). Knowing epidemiology of infectious diseases, prevention and laboratory diagnosis. Knowing molecular mechanisms of action of antimicrobial agents (antibiotics, antiviral drugs, antifungal and antiparasitic drugs). Knowing the general principles and skills of aseptic work in microbiological laboratory.

Course contents:

Lectures

Bacteriology: Classification of bacteria. Morphology and physiology of bacterial cells. Microbial genetics. Bacterial virulence factors and pathogenesis of bacterial infection. Bacterial growth, growth curve and requirenments for growth. Methods of sterilisation and disinfection. Antimicrobial agents (mechanisms of action and resistance to antimicrobial drugs).

Gram positive and Gram negative cocci. Gram positive and Gram negative sporulating rods. Enteric Gram negative rods. Spiral bacteria. Chlamydias and mycoplasmas.

Virology: General properties of viruses. Viral structure and replication. Laboratory diagnosis of viral infections. Interferons, vaccines and antiviral drugs. Characteristics of human DNA and RNA viruses.

Medical parasitology: Biological and morphological classification of protozoa. Protozoa of intestinal and urogenital tract, blood and tissue protozoa. Medical helminthology: classification of helminthes, life cycle, the most common helminthes pathogenic for humans. Laboratory diagnosis of parasitic infections. Antiparasitic drugs.

Medical mycology: Medically important fungi (yeasts, dermatophytes). Laboratory methods in mycology. Antifungal drugs-classifications and mechanisms of action.

Practical classes

Microscopy and staining of microorganisms. Bacteriological media: preparation of different media and cultivation of bacteria. Sterilisation and disinfection. *In vitro* tests for microbial sensitivity to antibiotics and chemotherapeutics (antibiogram). Medically important Gram positive and Gram negative cocci, Gram positive non-sporulating rods, Gram positive sporulating rods and Enterobacteria. Laboratory diagnosis of viral infections. Microscopy of urogenital and blood and tissue protozoa (stained by Giemsa method).

Recommended literature:

1. Brooks GF, Carroll KC, Butel JS, Morse SA, Mietzner TA. Jawetz, Melnick & Adelberg´s Medical Microbiology, 25th ed. The McGraw-Hill Companies; 2010.

2. Levinson W. Medical Microbiology and Immunology. 12th ed. San Francisco: The McGraw-Hill Companies; 2012.

3. Ryan KJ, Ray CG. Sherris Medical Microbiology. 5th ed. Tucson: The McGraw-Hill Companies; 2010.

4. Goering RV, Dockrell HM, Yuckerman M, Roitt IM, Chiodini PL. Mim´s Medical Microbiology, 5th ed. Elsevier 2013.

5. Denyer SP, Hodges N, Gorman SP, Gilmore BF. Hugo & Russell's Pharmaceutical microbiology, 8th edition, Wiley-Blackwell

2011.			
The total of active learning classes			
Lectures: 60		**Practical classes: 30**	
Teaching methods: teaching, laboratory work			
Grading system:			
Pre-exam obligations	**Points**	**Exam**	**Points**
Class Participation		Practical exam	
Practical classes	15	Written exam	60
Tests (colloquia)	25	Oral exam	
Seminar work			

University of Belgrade Faculty of Pharmacy	Integrated academic studies of PHARMACY	

Study program: Pharmacy

Course title: Selected Chapters of Analytical Chemistry

Teachers: Kapetanović P. Vera, Jelikić-Stankov D. Milena, Karljković-Rajić D. Katarina, Ražić S. Slavica, Uskoković-Marković M. Snežana, Odović V. Jadranka

Course status: elective

Semester: IV	**Year of studies: II**
ECTS points: 2	**Course code: F2I4**

Prerequisite for attending course: none

Course objectives:

This course provides introduction students with a real sample and how to solve particularly analytical problem. Analyses of complex samples require systematic approach to the problem, and student gain first experiences in setting methodology for solving particularly analytical problems.

Course outcomes:

- Student mastered approach in real sample analysis
- Student is capable to identify, formulate, analyze and solve problems of chemical analysis, including selection of appropriate sampling technique, as well as a method/methods of sample preparation for quantitative chemical analysis
- Student gained knowledge for appropriate selection of analytical method in inorganic ion analysis, processing and discussing of results

Course contents:

Lectures:

Analysis of real samples which are important for pharmacy. Method selection for sample preparation depending on type of sample and analyte characteristics and concentrations (ultra traces, traces or macro components). Introduction to real sample digestion procedures: dry-ashing, wet-ashing, and microwave digestion. Introduction to important processes in chemical analysis: purification, preconcentration, separation, identification of sample and interference removal. Application of selected instrumental methods in inorganic ion analysis-UV/VIS spectroscopy with attention to the derivative spectrophotometry, atomic spectrometry, electroanalytical methods (potentiometry and voltammetry).

Result processing using validation of applied analytical methods.

Practical training:

Selected examples of real samples analysis of importance for pharmacy. Research data bases.

Recommended literature:

1. Skoog DA, West DM, Holler FJ. Fundaments of Analytical Chemistry. 7th ed. Philadelphia: Saunders College Publishing; 1996.

2. Christian GD. Analytical Chemistry. 6th ed. New York: John Wiley & Sons, INC; 2004.

3. Mitra S. Sample Preparation Techniques in Analytical Chemistry. New York: John Wiley & Sons; 2003.

4. Research data bases

5. Authorized script, authors-teachers and assistants on the Department of analytical chemistry

The total of active learning classes

Lectures: 15	**Practical training:** 15

Teaching methods: lectures, laboratory practice, work in groups, consultations, interactive teaching

Grading system:

Exam prerequisites	Points	Final exam	Points
Active participation in lectures	4	Practical	
Practical training	26	Written	70
Colloquia		Oral	
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Integrated academic studies PHARMACY	

Study programme: Pharmacy

Course title: Selected Chapters in General Biochemisrty

Teachers: Nataša B. Bogavac-Stanojević, Jelena M. Kotur-Stevuljević, Ninić R. Ana

Course status: elective

Semester: IV	**Study year: II**
ECTS: 2	**Course code: F2I5**

Course prerequisites: Organic chemistry 2

Course aims: That student understands metabolic interrelationships in various physiological and pathological conditions as well as their regulations. The acquisition of basic knowledge on drugs' influences on biochemical processes.

Course outcomes: After successfully mastering the course, the student is expected to describe and analyze various metabolic pathways in physiological and pathological conditions and the impacts of certain drugs on biochemical processes.

Course contents:

Lectures

Metabolic interrelationships of tissues in various physiological and pathological states. Metabolic changes in alchocolism. Catabolic and anabolic pathways in aerobic and anaerobic exercises. Mechanisms involved in switching the metabolism between the well-fed state and the starved state. Metabolic changes in cancer. Influence of drugs on biochemical processes (eg. anticoagulant therapy).

Practical classes

Comparison of anabolic and catabolic processes in starve–feed cycle. Metabolic changes in pregnancy. Carbohydrate and lipid metabolisms in aerobic and anaerobic exercises. Metabolism in alcoholism and cancer.

Recommended literature:

1. Devlin TM. Textbook of Biochemistry with Clinical Correlations. John Wiley & Sons, New York, 2011.

The total of active learning classes

Lectures: 15	**Practical classes:** 15

Teaching methods:

Oral lectures, practical classes - interactive classes, workshops, discussions, case reports and seminars.

Grading system:

Pre-exam obligations	Points	Exam	Points
Class Participation	20	Practical exam	
Practical classes		Written exam	40
Tests (colloquia)		Oral exam	
Seminar work	40		

University of Belgrade Faculty of Pharmacy	Integrated academic studies PHARMACY	

Study programme: Pharmacy

Course title: Solution chemistry

Teachers: Čakar M. Mira, Popović V. Gordana

Course status: Elective

Semester: IV	**Study year: II**
ECTS: 2	**Course code: F2I6**

Course prerequisites: General and inorganic chemistry, Organic chemistry I

Course aims:

Acquiring knowledge of dissolution of compounds (organic and inorganic), properties of solutions and their application in pharmacy, including acid-base reactions, buffer mixture, complexation reactions and solubility.

Course outcomes:

After successful completion of this course, a student will be able to:

- understand the general principles of solubility
- predict the solubility of compounds in various solvents
- make a choice of pH for the dissolution of organic acid and base in water
- make selection and prepare the buffer certain pH, ionic strength and capacity for a specific application
- application of acquired knowledge in a variety of chemical and pharmaceutical processes

Course contents:

Lectures

General principles of solubility. Dissolution of organic or inorganic substances. The properties of the solvent and dissolution mechanisms. Dissolution rate of solids in a liquid solvent. The ideal solubility. Real solutions. The coefficient of solubility. Influence of physico-chemical properties, temperature and pH on the solubility. pH of precipitation of poorly soluble acids, bases, and ampholytes. Solubility in the presence of solubilizing agents. Non-aqueous solvents. Mixtures of solvents, cosolvents. The theory of buffer actions (buffers capacity, pseudo-buffers, self-buffers, mixture of buffers). Universal buffers, Britton Robinson buffers: composition and protocol to prepare. Factors governing the choice of a buffer. Buffers for special applications. Limitations in practical application of buffers.

Practical classes

Linking theoretical knowledge of solubility with practical examples. Solving certain problems in preparing the real solution.

Recommended literature:

1. Kotz J, Treichel P. Chemistry and chemical reactivity. 8th ed. Saunders college publishing; 2012.

2. Thomas G. Chemistry for pharmacy and the life sciences. Prentice Hall, 1997.

3. Perrin DD, Dempsey B. Buffers for pH and metal ion control. Chapman and Hall, 1974.

4. Physicochemical principles of pharmacy, by Alexander T Florence and David Attwood, 4th edition, Pharmaceutical press, 2006.

The total of active learning classes

Lectures: 15	**Practical classes:** 15

Teaching methods: Lectures, practical work, discussion, problem solving, seminar/home work

Grading system:

Pre-exam obligations	Points	Exam	Points
Class Participation		Practical exam	
Practical classes	15	Written exam	70

Tests (colloquia)		Oral exam	
Seminar work	15		

University of Belgrade Faculty of Pharmacy	Integrated academic studies PHARMACY	

Study programme: Pharmacy

Course title: Basic of Molecular Genetics

Teachers: Biljana M. Potparević, Lada P. Živković

Course status: Elective

Semester: III	**Study year: II**
ECTS: 3	**Course code: F2I3**

Course prerequisites: Biology and Human Genetics

Course aims:

General aim:

- The central dogma of molecular biology.
- Mechanisms of recombination of genetic material
- Regulation of gene expression and the basic mechanisms of DNA repair.

Specific aims:

- Methods in molecular genetics

Course outcomes: After completing the course the students are expected to be able to:

- Describe and understand the structure and function of both DNA and RNA molecules in prokaryote and eukaryote.
- Understand the basis of the genetic code.
- Describe the transfer of genetic information from DNA to RNA to the primary structure of proteins.
- Understand and perform some basic methods in molecular genetics.
- Apply the knowledge gained in this course to other courses at the Faculty of Pharmacy.

Course contents:

Lectures

- The structure and biological function of nucleic acids . The central dogma of molecular biology.
- Genes and genome .
- Genome expression
- Recombination of genetic material
- Mutations of genetic material
- Repar mechanisms
- Functional genomics
- Oncogenetics.

Practical classes

- Introduction to the basic methods of molecular genetics: isolation of DNA molecules; fluorescence in situ hybridization FISH ; PCR (polymerase chain reaction) Southern blot
- RNA analysis: Nothern blot, , RT-PCR, NPA
- Array analysis.
- Research work

Recommended literature:

1. Matić G, Savić Pavićević D. Molekularna biologija 1. Beograd: NNK Internacional; 2011.

2. Brajušković G. Molekularna biologija 2. Beograd: Savremena administracija; 2012.

3. Papović R, Luković LJ, Novaković: Humana genetika. Beograd: University of Belgrade –Faculty of Medicine, 2007.

4. Malacinski GM. Essentials of molecular biology. Boston: Jones and Bartlett Publishers; 2005.

5. Craig N, Cohen-Fix O , Green R , Greider C, Storz G, Wolberger C. Molecular Biology: Principles of Genome Functions. Oxford;

2010.			
The total of active learning classes			
Lectures: 30	**Practical classes: 15**		
Teaching methods: The course takes place in one semester and employs the following teaching methods: Lectures and practical classes			
Grading system:			
Pre-exam obligations	**Points**	**Exam**	**Points**
Class Participation	2	Practical exam	/
Practical classes	8	Written exam	60
Tests (colloquia)		Oral exam	optional
Seminar work	30		

University of Belgrade Faculty of Pharmacy	Integrated Academic Studies PHARMACY	

Study programme: Pharmacy	
Name of the course: Colloid chemistry	
Lecturers: Pejić D. Nataša, Aleksić M. Mara	
Status of the course: elective	
Semester: IV	**Year of study: II**
Credit value (ECTS): 3	**Course code: F2I2**
Precaution: none	
Course goal: Expand knowledge about the properties and behavior of colloidal systems, the characteristics of natural and synthetic macromolecules, surfactants, sols, and disperse systems with the aim of better understanding the production technology of pharmaceutical medical and cosmetic products, as well as understanding of the different biochemical systems.	
Course outcome: Knowledge of colloidal systems chemistry, types, structure, properties and behavior of natural and synthetic macromolecules, the method of extraction, purification and characterization of colloids, as well as the fundamental principles of rheology and different techniques for determining the rheological properties of pharmaceutical products and biochemical samples.	
Content of the course: *Theoretical teaching* Partition and classification of dispersion and colloidal-dispersion systems. Micelle colloids (colloidal surface active agent – types, structure, properties and uses of surfactants, micelle solubilization). Stability and coagulation of colloidal systems. Separation of colloids by means methods which are used in pharmaceutical practice. Colloids and light (light scattering, turbidimetry and nephelometry: principle and application for quantitative determination, determination of critical micelle concentration and solubilization). Fundamentals of rheology - Newtonian and non-Newtonian systems (plastic, pseudoplastic, dilatant systems; thixotropic and viscoelastic systems). Determination of rheological properties of liquids (viscometers for Newtonian and non-Newtonian testing system). The application of rheological measurements in pharmacy (rheological properties of pharmaceutical and cosmetic products). Colloids in the pharmacy (gels, membranes, emulsions and suspensions). *Practical teaching* Conductometric determination of the critical micelle concentration; Turbidimetric determination of the casein concentration; Viscometric determination of the polymer average molecular weight.	
Recuired literature (available at the library and via other media) 1. Pejić N, Aleksić M. Odabrana poglavlja koloidne hemije, Beograd: Farmaceutski fakultet, Univerzitet u Begradu; 2013. 2. Đaković Lj. Koloidna hemija. Beograd: Zavod za udzbenike i nastavna sredstva; 2006. 3. Rosen M.J., Surfactants and Interfacial Phenomena, 3th ed., New Jersey: Wiley&Sons; 2004. 4. Martin A. Physical Pharmacy. New York: Williams&Wilkins; 1993. 5. Shown D.J., Introduction to Colloid and Surface Chemistry, 4th ed., Oxford: Butterworth-Heinemann; 1992	
Class number of active teaching	
Lectures: 30	Practical teaching: 15
Teaching methods: lectures, practical laboratory training, student scientific research, consultation	
Grading system:	

Exam prerequisites	Points	Final exam	Points
Activities	10	Practical exam	
Practical teaching	30	Writen exam	60

Colloquium		Oral exam	
Seminar essay			
Others			

University of Belgrade Faculty of Pharmacy	Integrated academic studies PHARMACY	

Study programme: Pharmacy

Course title: Selected topics in Physiology

Teachers: Plećaš-Solarović A. Bosiljka, Pešić R. Vesna, Nedeljković S. Miodrag

Course status: elective

Semester: IV	**Year of studies: II**
ECTS points: 3	**Course code:F2I1**

Requirements: no requirements

Course aims:

Provision of important knowledge from physiology of organ systems and human body as whole, that were not the part of the main course in Physiology: physiology of sports, ageing, memory and learning, and neurondocrine physiology.

Course outcomes:

After finishing this course student will be trained to:

- Biological and physiological basis of learning process and formation of memory, physiological basis of physical activity and ageing, role of HPA axis and behavior and
- Understand interconnection of these processes and states with functioning of an organisam as a whole entity.

Course contents:

Theoretical lectures

Physiology of learning and memory, differences of these connected processes, anatomical and physical basis of memory, types and localizations of memory. Types of learning processes. Physiology of physical activity: changes in varied physiological systems during intense physical activity. Regulation of different organ systems activity and adaptation of whole organisam on these conditions. Physiology of ageing: length of life, ageing and death, molecular and cellular basis of ageing, theories of ageing, most important physiological changes in organs and organ systems. Contemporary strategies of ageing postponement.

Practical classes

Workshops and seminars: experimental models for testing different types of memories, most common disorders of learning and memory; behavioral changes as a consequence of neuro-endocrine system disturbances; acute and chronic stress impact on functioning of neuro-endocrine system; experimental models of: depression, stress, changes in social interaction; “antiageing methods”: scopes and limitations; changes of relevant physiological parameters in athletes and their dependence on the sport activity;

Recommended literature:

1. Koeppen BM, Stanton BA. Berne & Levy PHYSIOLOGY. 6th ed. Philadelhia: Mosby, Elsevier; 2010.
2. McCorry LK. Essentials of Human Physiology for Pharmacy. 2nd ed. Boca Raton: CRC PRESS, Taylo
r & Francis Group; 2009.
3. Boron WF, Boulpaep EL. Medical Physiology: A Cellular and Molecular Approach. 2nd ed. New York: Saunders, Elsevier Science; 2009.
4. Timaris PS, editor. Physiological Basis of Aging and Geriatrics. 4th ed. New York: Informa Heal
thcare; 2007.
5. Aspinall R, editor. Biology of Aging and its Modulation. Dordrecht, Boston, London: Kluwer Academic Publishers; 2004

The total of active learning classes

Lectures: 30	**Practical classes: 15**

Teaching methods:

Classes are performed in one semester using the following methods:

- theoretical lectures (lectures, PP presentations, interactive teaching)
- practical lectures combined with computer animations and simulations of physiological processes, interactive teaching (checking students' knowledge)
- consultations

Grading system:

Exam prerequisites	Points	Final exam	Points

Active participation in lectures	5	Practical	
Practical classes	15	Written	40
Colloquia		Oral	
Seminars	20		
Other activities	20		

University of Belgrade Faculty of Pharmacy	Integrated academic studies PHARMACY	

Study programme: Pharmacy

Course title: Pharmacology 2

Teachers: Ugrešić D. Nenad, Stepanović-Petrović M. Radica, Savić M. Miroslav, Novaković N. Aleksandra, Tomić A. Maja

Course status: Mandatory

Semester: V	**Study year: III**
ECTS: 6	**Course code: F3O1**

Course prerequisites: Pharmacology 1

Course aims:

To provide the student with:

- **knowledge about the mechanisms of drug action**
- **information necessary for understanding the various effects of drugs**
- **comprehension about the therapeutic and adverse effects of distinct drug groups**
- **knowledge about the principles of the therapeutic drug use.**

Course outcomes:

Upon completion of this course, students will be able to:

- **identify the mechanisms of various actions of distinct drug groups**
- **link the therapeutic and adverse effects of distinct drug groups with their different pharmacological effects**
- **build up the personal critical attitude towards a drug.**

Course contents:

Lectures

Chemical mediators and the autonomic nervous system. Cholinergic transmission. Noradrenergic transmission. 5-hydroxytriptamine. Purines. Nitric oxide. Introduction into the pharmacology of cardiovascular system. Calcium channel blockers. Angiotensin converting enzyme inhibitors and angiotensin receptor antagonists. Diuretics. Drugs in the therapy of cardiac failure. Drugs in the therapy of ischemic heart disease. Drugs in the therapy of hypertension. Antidysrhytmic drugs. Drugs acting at hemostasis and thrombosis. Drugs acting at lipoprotein metabolism disorders. Drugs in the therapy of respiratory system diseases.

Practical classes

Computer simulations and learning though discussion of the results of experimental research: Influence of drugs at cholinergic transmission. Influence of drugs at noradrenergic transmission. Drugs that modulate the effects of 5-hydroxytriptamine, purines and nitric oxide. Influence of adrenergic and cholinergic agonists and antagonists on blood pressure and heart rhytm. Influence of drugs on the renin-angiotensin-aldosterone system. Influence of drugs on the isolated heart and blood vessels. Influence of drugs on coronary insufficiency. Influence of drugs on heart failure. Influence of drugs on coagulation. Drugs and thrombotic processes. Drugs and lipoprotein metabolism disorders. Influence of drugs on the respiratory system smooth muscles. Antitussives and expectorants.

Recommended literature:

1. Rang HP, Ritter JM, Flower RJ, Henderson G. Rang and Dale's Pharmacology. 8th edition. London: Elsevier Churchill Levingstone, 2015.
2. Katzung BG, ed. Basic & Clinical Pharmacology. 12th edition. New York: :Lange Medical Books, Mcgraw-Hill Medical Publishing Division; 2012.
3. Brunton LL, Chabner BA, Knollmann BC, eds. Goodman and Gilman's the Pharmacological Basis of Therapeutics. 12th edition. New York: Mcgraw-Hill; 2011.

The total of active learning classes

Lectures: 45	**Practical classes: 30**
Teaching methods: Lectures, recorded laboratory in vivo and in vitro experiments on animals, computer simulations of experiments	
Grading system:	

Pre-exam obligations	**Points**	**Exam**	**Points**
Class Participation		Practical exam	
Practical classes	5	Written exam	
Tests (colloquia)	25	Oral exam	70
Seminar work			

University of Belgrade Faculty of Pharmacy	Integrated academic studies PHARMACY	

Study programme: Pharmacy

Course title: Pathophysiology 2

Teachers: Gordana Leposavić

Course status: Mandatory

Semester: V	**Study year: III**
ECTS: 5	**Course code:**

Course prerequisites: Physiology 1, Physiology 2, Immunology, Pathophysiology 1

Course aims: To provide understanding of:

- Basic medical terminology.
- Causes (etiology) and cellular and molecular mechanisms of development (pathogenesis) of the most important disorders of various organs and pathophysiological basis of their clinical manifestations (symptoms and signs)

Course outcomes: After completing the course the students are expected to be able to:

- Understand and adequately use basic medical terminology in professional communications
- Understand etiology and pathogenesis of the most important functional disorders of various organs, and their typical clinical manifestations.
- Understand diagnostic significance of clinical and laboratory tests used to diagnose disorders of various organ functions
- Comprehend pathophysiological backgrounds of various drug and chemical action, and therapeutic strategies and strategies to prevent development of various organ disorders.

Course contents:

Lectures

- Etiopathogenesis of alterations in cardiovascular function: arterial hypertension, arrhythmia, myocardial ischemia, heart failure.
- Etiopathogenesis of alterations in pulmonary function: chronic obstructive pulmonary disease (COPD), bronchial astma, pneumonia, pulmonary edema.
- Etiopathogenesis of alterations in renal function: acute and chronic renal failure.
- Etiopathogenesis of alterations in the digestive system: GERB, peptic ulcer disease, vomiting, altered bowel habits (diarrhoea and constipation)
- Etiopathogenesis of cirrhosis of the liver
- Etiopathogenesis of alterations in endocrine gland function (pituitary, thyroid, adrenal glands and gonads).
- Etiopathogenesis of alterations in nervous system function: (cerebrovascular disorders, Parkinson disease, epilepsy, anxiety, schizophrenia, bipolar psychosis).
- Anemia

Practical classes

- Etiopathogenesis of cardiovascular disorders: Arterial hypertension, arrhythmia, heart failure.
- Etiopathogenesis of: COPD and bronchial asthma.
- Etiopathogenesis of acute and chronic renal failure.
- Etiopathogenesis of peptic ulcer disease
- Etiopathogenesis of alterations in endocrine gland function (hyperthireoidism and hypothireoidism, Cushing and Addison syndrome
- Etiopathogenesis of Parkinson disease, epilepsy, schizophrenia and bipolar disorders

- Etiopathogenesis of megaloblastic anf hypochromic anemia.

Recommended literature:

1. Leposavić G. Patološka fiziologija za studente farmacije. Beograd: Univerzitet u Beogradu-Farmaceutski fakultet; 2012.
2. Marušić M, Kovač Z, Gamulin S. Patophysiology:Basic mechanisms of disease. Zagreb: Medicinska naklada; 2009.
3. Đorđević-Denić G i sar. Specijlna patološka fiziologija. Beograd: Zavod za izdavanje udđbenika, 2003
4. Stošić Z i Borota P. Osnovi kliničke patofiziologije. Novi Sad: Univerzitet u Novom Sadu, Medicinski fakultet; 2012.
5. Kovač Z, Gamulin S i sur. Patofiziologija – Zadaci za problemske seminare. Zagreb: Medicinska naklada; 2006.

The total of active learning classes 60

Lectures: 30	**Practical classes: 30**

Teaching methods:

Lectures and problem-based learning

Grading system:

Pre-exam obligations	**Points**	**Exam**	**Points**
Class Participation		Practical exam	
Practical classes	20	Written exam	70
Tests (colloquia)	10	Oral exam	
Seminar work			

University of Belgrade Faculty of Pharmacy	Integrated academic studies PHARMACY	

Study programme: Pharmacy

Course title: Bromatology

Teachers: Slađana S. Šobajić, Ivan M. Stanković, Brižita I. Đorđević

Course status: Mandatory

Semester: V	**Year of studies: III**
ECTS points: 4	**Course code:**

Requirements: Organic Chemistry 1, Organic Chemistry 2, General Biochemistry

Course aims:

Introduction to the fundamental properties of macro- and micronutrients and their physiological and nutritional functions; introduction to the chemical composition of foodstuffs and their potential to fulfill nutritive and energy needs of humans; interactions of vitamins, minerals and medicines; basic information regarding nutritional additives and food contaminants; introduction to dietary products.

Course outcomes:

Upon completion of the course student is trained: to provide information on the appropriate choice of foodstuffs and foodstuffs combinations for various population groups; to be aware of the basic characteristics of the chemical composition and energy values of foodstuffs; to know basic concepts regarding food safety; to recognize the most important interactions of minerals, vitamins and medicines.

Course contents:

Lectures

Bromatology as a scientific discipline – relations to other scientific fields; definition of the food, foodstuffs and nutriments; foodstuffs types; roles of the food; factors influencing the selection of food and bioavailability of nutriments; energy values of foodstuffs; basic nutrients, chemical properties, basic functions in the organism, biological value, requirements for macronutrients, changes in nutriments due to storage and processing of foodstuffs; vitamins and minerals, recommended daily allowances, functions in the organism, factors influencing bio-usability, interactions with medicines; malnutrition caused by imbalance in nutriments intake; biologically active non-nutritive components of foodstuffs; the influence of the thermal treatment on the food nutritive value; types of the foodstuffs according to the purpose for nutrition; tools for combining of foodstuffs and planning of daily nutrition; dietary products, infant formulas, food for young children; additives in food; contamination of food.

Practical classes

Basic techniques and methods used for analysis of foodstuffs and nutriments; fundamental working principles in the laboratory of sanitary chemistry; determination of the chemical composition and energy values of nutriments and dietary products; assessment of the nutritive value of foodstuffs and dietary products.

Recommended literature:

1. Grujić R, Stanković I, Miletić I. Nauka o ishrani čoveka. Knjiga druga. Banja Luka; 2007.
2. Stanimirović S. Bromatologija. Beograd: Univerzitet u Beogradu - Farmaceutski fakultet; 1990.
3. Đorđević B, Đuričić I, Vidović B. Praktikum iz bromatologije. Beograd: Univerzitet u Beogradu - Farmaceutski fakultet; 2011.
4. HD Belitz, W Grosch. Food Chemistry. 3rd edition. Berlin: Springer; 2004.
5. Izvodi sa predavanja (handouts)

The total of active learning classes

Lectures: 45	**Practical classes:** 30

Teaching methods: lectures, practical classes

Grading system:

Exam prerequisites	Points	Final exam	Points
Active participation in lectures	0-5	Practical	
Practical classes	15	Written	36-70
Colloquia	6-10	Oral	
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Integrated academic studies of PHARMACY	

Study program: Pharmacy

Course title: Pharmaceutical Chemistry 3

Teachers: Agbaba D. Danica, Vladimirov M. Sote, Vujić B. Zorica, Nikolić M. Katarina

Course status: Mandatory

Semester: V	**Year of studies: III**
ECTS points: 8	**Course code: F3O5**

Prerequisite for attending course: Pharmaceutical Chemistry 1

Course aims:

Providing students with a solid grounding in principles and applications of medicinal and pharmaceutical chemistry and drug discovery of clinically significant drugs affecting CNS, immune system, and cardiovascular system. Adopted knowledge from this field is important for mastering courses of medicinal, pharmaceutical-technological group and courses of pharmaceutical practice.

Course outcomes:

Student is expected to obtain theoretical and practical knowledge in pharmaceutical chemistry and to analyze essential data related to physicochemical and chemical properties, mechanism of action on molecular level, biotransformation reactions, *in vivo* and *in vitro* interactions and stability of drugs in several pharmacotherapeutic groups.

Course contents:

Lectures:

Lectures include analysis and discussion of chemical structures, nomenclature, synthesis, functional groups, physicochemical properties, molecular geometry, SAR-studies, stability, significant drug-receptor/drug-enzyme interactions for following pharmacotherapeutic groups: Drugs affecting CNS, antipsychotics, anxiolytics, antidepressants, antiemetics, antimigrenics, gastroprocinetics, hypnotics, antiepileptics, general anesthetics, analeptics, cholinergics, anticholinergics, antiparkinsonics, neuromuscular blockers, central analgesics, local anesthetics; Drugs affecting the immune system: antiallergics, antiulcer drugs, nonsteroidal anti-inflammatory drugs; Drugs affecting the cardiovascular system: adrenergics (α and β receptors, biosynthesis, metabolism and stereochemistry of catecholamine, agonists/antagonists of α receptors, agonists/antagonists of β receptors, β_2-selective agonists, atiarrhythmics, Ca-channel agonists, vasodilators (coronary and periphery vasodilators); cardiac glycosides, diuretics, ACE inhibitors, AT1-antagonists, β-blockers and others. antihyperlipoproteinemics, HMG-CoA reductase inhibitors, anticoagulant drugs, thrombolytics.

Practical training:

Drug analysis of selected pharmaceutical substances: identification, related substances, and assay, according to the current European Pharmacopeia. Case studies.

Recommended literature:

1. Foye's Principles of Medicinal Chemistry. 7th ed. Williams DA, Lemke TL, editors. Baltimore: Lippincott Williams & Wilkins; 2013.
2. Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry. 12th ed. Beale JM, Block JH, editors. Philadelphia: Lippincott Williams & Wilkins; 2011.
3. Radulović D, Vladimirov S. Farmaceutska hemija I. Beograd; 2005.
4. Europeen Pharmacopoeia. 7th Edition. Strasbourg: Council of Europe; 2010.

The total of active learning classes

Lectures: 60	**Practical training:** 60

Teaching methods: oral lectures, interactive teaching, laboratory practice

Grading system:

Exam prerequisites	Points	Final exam	Points
Active participation in lectures		Practical	
Practical training	30	Written	60
Colloquia		Oral	10
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Integrated academic studies PHARMACY	

Study programme: Pharmacy

Course title: Statistics in Pharmacy

Teachers: Bogavac-Stanojevic B. Nataša, Kotur-Stevuljevic M. Jelena

Course status: Mandatory

Semester: V	**Study year: III**
ECTS: 3	**Course code: F3O6**

Course prerequisites: Mathematics

Course aims:

The aim of this course is that student acquire statistical terminology, learn how to get, organize and analyse data, to understand simple statistical methods and know how to interpret results, to use apropriate statistical tests on examples from pharmacy practice, learn how to use statistical packages.

Course outcomes:

Student will be able to choose adeqvate sample, to get apropriate data, choose exact statistical method for analysing data, perform results interpretation, to use MS Excel and other statistical packages.

Course contents:

Lectures

Statistical terminology. Opulation and sample. Variables and data. Data ordering. Graphical and tabelar data presentation. Measures of central tendency. Variation measures. Normal distribution. Standard normal distribution. Area under the curve calculation. Hypothesis testing. Error, type I and II. P value. One- and two-sided Student t test. Variance ratio tst. Analysis of variance (ANOVA). One factor ANOVA. Two factors ANOVA. Linear regreession analysis. Regression equation. Correlation analysis. Correlation coefficient. Detrmination coefficient. Standard eror of regression line deviation. Regession analysis usage for prediction. Non-parametric methods. Non-parametric t test (Mann-Whitney U test). Non-parametric analysis of variance. Non-parametric correlation. Chi-square test. Test for homogenity. Test for independence. Confidence interval for expected values.

Practical classes

Work on examples from pharmacy practice, using adequate statistical tests.

Recommended literature:

1. Sheskin DJ. Handbook of parametric and nonparametric statistical procedures. Chapman & Hall/CRC, Washington, D.C., 2000.

2. Daniel, WW. Biostatistics, A foundation for analysis in the health sciences, J. Whiley and Sons, New York, USA, 1995.

3. Script, matherial from lectures, internet pages, review papers from scientific journals

The total of active learning classes

Lectures: 30	**Practical classes: 15**

Teaching methods:

One-semestral course performed through lectures, work on examples from pharmacy practice

Grading system:

Pre-exam obligations	Points	Exam	Points
Class Participation		Practical exam	
Practical classes	15	Written exam	70
Tests (colloquia)	15	Oral exam	

Seminar work		

University of Belgrade Faculty of Pharmacy	Integrated academic studies PHARMACY	

Study programme: Pharmacy

Course title: Pharmacognosy

Teachers: Kovačević N. Nada, Petrović D. Silvana, Maksimović A. Zoran, Kundaković D. Tatjana, Drobac M. Milica

Course status: Mandatory

Semester: V, VI	**Study year: III**
ECTS: 9	**Course code: F3O7**

Course prerequisites: Botany, Organic chemistry 2, Physiology 2

Course aims:

Achievement of knowledge about pharmacologically active plant and animal metabolites (chemical and physical properties, distribution and biological activity, qualitative and quantitative analysis, principles of isolation and chemical characterization) and natural medicinal raw materials – drugs and drug preparations (morphological, anatomical characteristics, chemical constituents, manufacturing process, identification, quality control, activity and use).

Course outcomes:

Student is able to demonstrate knowledge on natural medicinal raw materials (drugs and drug preparations) that are used in the pharmaceutical industry for isolation of active constituents, and/or the development of herbal medicinal products; student is able to perform qualitative and quantitative analysis of their constituents, as well as to develop and perform extraction and separation procedures in laboratory conditions; student is able to carry out identification and quality control of drugs and drug preparations, and to demonstrate knowledge on their pharmacological activity and use; student is competent to participate in the design, organization and management of the production process, as well as in quality assurance of drugs and drug preparations.

Course contents:

Lectures

Definition of natural medicinal raw materials (drugs and drug preparations), the history of their use. Primary and secondary plant metabolism. Secondary plant metabolites: classification, chemical and physical properties, distribution and biological activity, qualitative and quantitative analysis, principles of isolation and chemical characterization. Classification of herbal drugs based on chemical composition, biosynthetic origin and pharmacological activity of their constituents. Production, quality parameters and quality control of herbal drugs and herbal drug preparations. The most significant herbal raw materials (herbal drugs) for isolation of compounds used in pharmaceutical industry. The most significant herbal drugs and herbal drug preparations used for the production of herbal medicinal and other products designed for health maintaining and promotion (biological sources; definitions; descriptions; morphological, anatomical and chemical properties; pharmacological activities and application).

Practical classes

Identification and quality control of herbal drugs and herbal drug preparations. Macroscopic and microscopic characteristics of herbal drugs. Qualitative and quantitative chemical analysis of herbal drugs and herbal drug preparations according to procedures described in modern pharmacopoeias and other relevant regulatory documents for natural medicinal raw materials.

Recommended literature:

1. Kovačević N. Principles of Pharmacognosy (In Serbian). Beograd: Srpska školska knjiga; 2002.

2. Evans WC. Trease and Evans Pharmacognosy. 16th. Ed. Edinburgh, London, New York, Philadelphia, St Louis, Sidney, Toronto: Elsevier; 2009.

3. Haensel R, Sticher O. Pharmacognosy – Phytopharmacy (In German). Heidelberg: Springer-Medizin Verlag; 2007.

4. Petrović S, Maksimović Z, Kundaković, T. Analysis of the constituents of herbal drugs. Handbook for lectures and practical classes of Pharmacognosy (in Serbian). Beograd: Unverzitet u Beogradu - Farmaceutski fakultet; 2013.

5. Petrović S, Maksimović Z, Kundaković, T. Chemical analysis of herbal drugs and constituents. Workbook (in Serbian). Beograd: Unverzitet u Beogradu - Farmaceutski fakultet; 2013.

The total of active learning classes

Lectures: 75		**Practical classes:** 60	
Teaching methods: Interactive lectures, practical classes			
Grading system:			
Pre-exam obligations	**Points**	**Exam**	**Points**
Class participation	5	Practical exam	
Practical classes	10	Written exam	65
Tests (colloquia)	20	Oral exam	
Seminar work			

University of Belgrade Faculty of Pharmacy	Integrated academic studies PHARMACY	

Study programme: Pharmacy

Course title: Pharmacology 3

Teachers: Ugrešić D. Nenad, Stepanović-Petrović M. Radica, Savić M. Miroslav, Novaković N. Aleksandra, Tomić A. Maja

Course status: Mandatory

Semester: VI	**Study year: III**
ECTS: 5	**Course code: F3O8**

Course prerequisites: Pharmacology 2

Course aims:

To provide the student with:

- **knowledge about the mechanisms of drug action**
- **information necessary for understanding the various effects of drugs**
- **comprehension about the therapeutic and adverse effects of distinct drug groups**
- **knowledge about the principles of the therapeutic drug use.**

Course outcomes:

Upon completion of this course, students will be able to:

- **identify the mechanisms of various actions of distinct drug groups**
- **link the therapeutic and adverse effects of distinct drug groups with their different pharmacological effects**
- **build up the personal critical attitude towards a drug.**

Course contents:

Lectures

Introduction into the central nervous system pharmacology. Chemical transmission and drug actions on the central nervous system. Aminoacid transmitters. Other transmitters and modulators. Depressors of the central nervous system. Anxiolytic and hypnotic drugs. Antipsychotics. Antidepressants. Stimulants and psychotomimetics. Dependence and addiction. Analgesics. Antiepileptic drugs. Drugs in the therapy of neurodegenerative diseases. Drugs in anesthesiology. General anesthetics. Myorelaxants. Local anesthetics. Pharmacology of the endocrine system. Drugs acting at the hypothalamus, pituitary and adrenal glands. Drugs acting at the thyroid. Insulin, diabetes mellitus and antidiabetics. Drugs acting at the reproductive system. Drugs acting at the gastrointestinal system. Ophthalmologic drugs. Dermatological drugs

Practical classes

Computer simulations and learning though discussion of the results of experimental research: Pharmacology of the central nerovus system. Behavioral pharmacology. Analgesics. Convulsants and anticonvulsants. Anesthetics and myorelaxants. Actions of drugs on the hyperglycemia and hypoglycemia. Effects of drugs on the smooth muscles of the gastrointestinal system. Effects of drugs on the uterus.

Recommended literature:

1. Rang HP, Ritter JM, Flower RJ, Henderson G. Rang and Dale's Pharmacology. 8th edition. London: Elsevier Churchill Levingstone, 2015.
2. Katzung BG, ed. Basic & Clinical Pharmacology. 12th edition. New York: :Lange Medical Books, Mcgraw-Hill Medical Publishing Division; 2012.
3. Brunton LL, Chabner BA, Knollmann BC, eds. Goodman and Gilman's the Pharmacological Basis of Therapeutics. 12th edition. New York: Mcgraw-Hill; 2011.

The total of active learning classes

Lectures: 45	**Practical classes: 15**

Teaching methods:

Lectures, recorded laboratory in vivo and in vitro experiments on animals, computer simulations of experiments			
Grading system:			
Pre-exam obligations	**Points**	**Exam**	**Points**
Class Participation		Practical exam	
Practical classes	5	Written exam	
Tests (colloquia)	25	Oral exam	70
Seminar work			

University of Belgrade Faculty of Pharmacy	Integrated academic studies PHARMACY	

Study programme: PHARMACY

Course title: Medical biochemistry

Teachers: Aleksandra Topić, Dusko Mirković

Course status: Mandatory

Semester: VI	**Study year: III**
ECTS: 7	**Course code: F3O4**

Course prerequisites: General biochemistry

Course aims: Introduction to the role of medical biochemistry in pharmacy (in clinical studies, in monitoring of therapy, drug interference with biochemical markers, detection of adverse drug effects); introduction to the metabolism of carbohydrates, proteins, lipids, water and electrolytes, as well as their disorders; introduction to the main biochemical markers: determination and clinical significance in diagnostics.

Course outcomes: Understanding the characteristics of biomarkers and their application in the implementation of rational pharmacotherapy; understanding of the role of the biochemical laboratory in diagnostics, monitoring and treatment of disease; understanding the composition of biological specimens in a healthy population, and in populations with specific physiological states and certain diseases. Capability to provide relevant information in relation to the interpretation of the results obtained by analyzing biological specimens.

Course contents:

Lectures

Metabolism and basic principles of regulation the metabolism of carbohydrates, proteins, lipids, iron, water and electrolytes (sodium, potassium, chloride, calcium, magnesium, and phosphate). Laboratory in diagnostics and monitoring of diabetes mellitus, and other disorders of carbohydrate metabolism. The characteristics and the clinical significance of the most important plasma proteins. Disorders of lipid metabolism**,** diagnostics of dyslipidemia and risk factors for atherosclerosis. Metabolism of water, electrolyte and acid-base balance. Laboratory in diagnostics of metabolic disorders of calcium, phosphate and magnesium. The parameters for testing iron status. The metabolism of haemoglobin and characteristics of haemoglobinopathies. The use of biochemical tests for examination of renal function, liver and gastrointestinal tract. Clinical significance of main enzymes. Tumour markers. Laboratory diagnostics of the most common endocrine disorders.

Practical classes

Laboratory exercises. Introduction to the characteristics of the biological specimens; sources of preanalytical and analytical errors. Quantitative determination of the following biochemical parameters in the appropriate biological samples (serum, urine or whole blood): glucose, total protein, haemoglobin, bilirubin, urea, creatinine, uric acid, and determining the activity of the enzyme. Chemical examination of urine and urine sediment. Workshops and seminars. Students in small groups will elaborate specific themes, resolve problems and cases from practice and present their work.

Recommended literature:

1. Murray RK, Granner DK, Mayes PA, Rodwell VW. Harper's Illustrated Biochemistry, Mc Graw-Hill Companies; 29th ed (2006).

2. Marshall WJ, Lapsley M, and Bangert SK. Clinical Chemistry, Mosby; 6th ed (2008).

3. Burtis CA, Ashwood ER, Bruns DE. Tietz Textbook of Clinical Chemistry and Molecular Diagnostics; Elsevier; 5th ed (2012).

4. Bishop ML, Fody EP, Schoeff LE. Clinical Chemistry: Principles, Techniques, and Correlations. Lippincott Williams & Wilkins.; 6th ed (2010).

The total of active learning classes

Lectures: 60	**Practical classes:** 45

Teaching methods: Lectures, interactive teaching, laboratory work, discussions and case studies, use of the Internet and the library.

Grading system:			
Pre-exam obligations	**Points**	**Exam**	**Points**
Class Participation		Practical exam	
Practical classes	15-30	Written exam	36-70
Tests (colloquia)		Oral exam	
Seminar work			

University of Belgrade Faculty of Pharmacy	Integrated academic studies PHARMACY	

Study programme: Pharmacy

Course title: Pharmaceutical Technology 1

Teachers: Vuleta M. Gordana, Milić R. Jela, Primorac M. Marija, Savić D. Snežana, Vasiljević D. Dragana

Course status: Mandatory

Semester: VI	**Study year: III**
ECTS: 10	**Course code: F3O9**

Course prerequisites: Phisical Chemistry, Introduction to Pharmacy

Course aims:

Introducing students with basic principles of formulation, technological procedures and pharmaceutical technological testing of various dosage forms (powders for oral and external use; granules; solutiions, suspensions and emulsions for oral and external use; ear and nasal preparations; oromucosal preparations; ointments, gels, creams, pastes, medicated plasters) and homeopatic preparations; training for the drug compounding and pharmaceutical technological testing; training for use of professional literature and reporting on the selection of the most suitable dosage form, its properties, storage and application.

Course outcomes:

A student has knowledge on: types, properties, preparation procedures, pharmaceutical technological testing and pharmacopoeia requirements for various dosage forms and homeopathic preparations; he/she knows the types, properties and functions of excipients in dosage forms formulation and preparation/manufacturing. A student is able to individually propose and prepare appropriate dosage form. Student is familiar with Good Pharmacy Practice and The Rulebook on the methods of prescribing and dispensing of drugs.

Course contents:

Lectures

Definition, meaning and general terms in Pharmaceutical Technology. Types and functions of excipients in formulation of dosage forms. Types, properties, preparation and pharmaceutical technological testing of various dosage forms and homeopatic preparations. Reological behaviour of pharmaceutical preparations. Extraction and methods of extraction. Extracts and tinctures.

Practical classes

Requirements for premises and organisation of activities in pharmacy. Pharmacopoeias, handbooks and drug codexes. Introduction to regulations on preparation, storage and dispensing of drugs. Recipe and its parts. Dosage regimen and check of dosage regimen. Types, properties, preparation and pharmaceutical technological tests of various dosage forms and homeopatic preparations. Pharmaceutical calculations. Significance of Good Pharmacy Practice.

Recommended literature:

1. Vuleta G, Milić J, Primorac M, Savić S. Farmaceutska tehnologija I. (udžbenik). Beograd: Univerzitet u Beogradu - Farmaceutski fakultet; 2012.
2. Vasiljević D, Krajišnik D, Grbić S, Đekić Lj. Farmaceutska tehnologija I. (praktikum), izmenjeno i dopunjeno izdanje, Beograd: Univerzitet u Beogradu - Farmaceutski fakultet; 2012.
3. Remington: The Science and Practice of Pharmacy. 22nd ed., London: Pharmaceutical Press; 2012.
4. Aulton M, Taylor K. The Design and Manufacture of Medicines. 4th ed., Edinburgh, Churchill Livingstone; 2013.
5. Allen L, Ansel H. Ansel's Pharmaceutical Dosage Forms and Drug Delivery Systems. 10th ed., Philadelphia, Walters Kluwer; 2014.

The total of active learning classes

Lectures: 45	**Practical classes:** 105

Teaching methods:

Theoretical classes, interactive classes, practical classes, problem based learning

Grading system:			
Pre-exam obligations	**Points**	**Exam**	**Points**
Class Participation	0 or 3	Practical exam	-
Practical classes	2 - 4	Written exam	26 - 50
Tests (colloquia)	27 - 43	Oral exam	-
Seminar work	-		

University of Belgrade Faculty of Pharmacy	Integrated academic studies of PHARMACY	

Study programme: Pharmacy

Course title: Bromatology Practicum

Teachers: Slađana S. Šobajić, Ivan M. Stanković, Brižita I. Đorđević

Course status: elective

Semester: VI	**Year of studies: III**
ECTS points: 2	**Course code: F3I1**

Requirements: Bromatology

Course aims:

Introduction to the requirements of the national regulations, control requirements and the methods used for the assessment of the quality and safety of foodstuffs and dietary products. Introduction to the specificity of working with food as an analytical matrix.

Course outcomes:

Upon completion of practical classes, the student is trained to apply the basic analytical methods for the assessment of quality and safety of certain categories of foodstuffs, and to compare them with the requirements of the respective national legal regulations.

Course contents:

Practical classes

Methods for determination of the foodstuffs quality – analysis of selected carbohydrates and proteins, analysis and identification of fats and oils; methods used for determination of the biologically nonnutritive food ingredients; methods for determination of the food additives and chemical contaminants of food and drinking water; methods for determination of the naturally harmful food ingredients (histamine, allergens).

Recommended literature:

1. Đorđević B, Đuričić I, Vidović B. Praktikum iz bromatologije. Beograd: Univerzitet u Beogradu-Farmaceutski fakultet; 2011.
2. Trajković J, Mirić M, Baras J, Šiler S. Analiza životnih namirnica. Beograd: Univerzitet u Beogradu-Tehnološko-metalurški fakultet; 1983.
3. Nielson S. Food analysis. Third Edition. New York: Kluwer Academic, Plenum Publishers; 2003.

The total of active learning classes

Lectures: 0	**Practical classes:** 30

Teaching methods: laboratory practical classes

Grading system:

Exam prerequisites	Points	Final exam	Points
Active participation in lectures		Practical	
Practical classes	70	Written	30
Colloquia		Oral	
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Integrated academic studies PHARMACY	

Study programme: Pharmacy

Course title: Practicum in Pharmacognosy

Teachers: Kovačević N. Nada, Petrović D. Silvana, Maksimović A. Zoran, Kundaković D. Tatjana, Drobac M. Milica

Course status: Elective

Semester: VI	**Study year: III**
ECTS: 2	**Course code: F3I2**

Course prerequisites: none

Course aims:

Training of students for independent application of procedures of herbal medicinal raw materials quality control (herbal drugs and herbal drug preparations) in specific assignments, for analysis and presentation of obtained results.

Course outcomes:

Student is capable to perform independently quality control of herbal raw material, solve specific assignment, prepare a protocol and written report, and present obtained results.

Course contents:

Lectures

Practical classes

Defining the specific professional/scientific problem, selection of the adequate approach and analytical methods to problem solving, review and usage of avaliable professional and scientific literature related to the assigned problem, individual/team work in problem solving.

Identification of herbal raw material; quality control of herbal raw material according to procedures described in pharmacopoeias; solving of specific assignment related to herbal raw material analysis; review of relevant literature; preparation of a protocol and a written report on conducted analysis; discussion of experimental results, in comparison to pharmacopoeial requirements, or the other relevant literature; writing the seminar, report and/or abstract for submission of student's scientific work and presentation of obtained results.

Recommended literature:

1. Petrović S, Maksimović Z, Kundaković, T. Analysis of the constituents of herbal drugs. Handbook for lectures and practical classes of Pharmacognosy (in Serbian). Beograd: Unverzitet u Beogradu - Farmaceutski fakultet; 2013.

2. Petrović S, Maksimović Z, Kundaković, T. Chemical analysis of herbal drugs and constituents. Workbook (in Serbian). Beograd: Unverzitet u Beogradu - Farmaceutski fakultet; 2013.

3. Ph. Eur. 7. Strasbourg: The Council of Europe; 2011.

The total of active learning classes

Lectures: 0	**Practical classes:** 30

Teaching methods:

Introductory lecture, practical work, literature review, preparation of seminar, report and/or abstract for submission of student scientific work and results presentation.

Grading system:

Pre-exam obligations	Points	Exam	Points
Class participation		Practical exam	
Practical classes	30-70	Written exam	21-30
Tests (colloquia)		Oral exam	

Seminar work		

University of Belgrade Faculty of Pharmacy	Integrated academic studies PHARMACY	

Study programme: Pharmacy

Course title: Selected Topics in Microbiology

Teachers: Antic Stankovic A. Jelena, Milenkovic T. Marina

Course status: elective

Semester: VI	**Study year: III**
ECTS: 2	**Course code: F3I3**

Course prerequisites: Microbiology

Course aims: Acquiring knowledge about microbial contaminants that are in the pharmaceutical industry, the acquisition of knowledge about methods of prevention and monitoring of microbial contamination, the acquisition of knowledge about the application of microorganisms in the pharmaceutical industry (production of antibiotics, vitamins, amino acids and enzymes), methods recombinant technology and acquiring knowledge about the application of microorganisms as biological vectors in vaccine production.

Course outcomes: After completing the course Selected topics in microbiology student will posses knowledge about the characteristics microorganisms which are significant contaminants in the pharmaceutical industry, they know the principles and methods of monitoring and control microbial contamination and will have knowledge about the application of microorganisms in the pharmaceutical industry, production of vaccines and biological assays.

Course contents:

Lectures

Introduction to Pharmaceutical Microbiology. Microbial ecology: microorganisms from the air, water and raw materials.

The physiological microflora and its role in the contamination of pharmaceutical products. Hygiene standards in the pharmaceutical industry. Hygiene standards in health care institutions.

Disinfectants and antiseptics. The sterile pharmaceutical products. Methods for isolation and identification of microorganisms (classical and rapid tests). Evaluation of antimicrobial agents in laboratory conditions.

Resistance to antibiotics, the origin and mechanisms. Pharmaceutical biotechnology. The use of microorganisms in

production of antibiotics, hormones and vitamins. Vaccines. The use of microorganisms in recombinant DNA technology.

Practical classes

Microbiological testing of pharmaceutical products (sterility and microbiological purity). Sample preparation.

Seeding of samples on nutrient media. Reading results. Interpretation of results. Report writing.

Recommended literature:

1. Black J.G. Microbiology, Principless and Explorations. 7th Edition. Asia: John Wiley&Sons; 2008.

2. European Pharmacopoeia 8th edition; 2014.

3. Glayer AN, Nikaido H. Microbial Biotechnology. Second Edition. San Francisco: Cambridge University; 2007.

4. Hugo WB, Rusell AD. Pharmaceutical Microbiology. Seventh edition. San Francisco: Blackwell Publishing; 2004.

5. Tatora GJ, Funke BR, Case CL. Microbiology an Introduction. Eight Edition. San Francisco: Pearson Benjamin Cummings; 2004.

The total of active learning classes

Lectures: 15	**Practical classes: 15**

Teaching methods: teaching, laboratory work

Grading system:

Pre-exam obligations	Points	Exam	Points
Class Participation	5	Practical exam	

Practical classes	20	Written exam	50
Tests (colloquia)	25	Oral exam	
Seminar work			

University of Belgrade Faculty of Pharmacy	Integrated academic studies PHARMACY	

Study programme: Pharmacy

Course title: Medical Therminology

Teachers: Gordana Leposavić, Milica Mirić

Course status: Elective

Semester: VI	**Study year: III**
ECTS: 2	**Course code: F3I4**

Course prerequisites: Pathophysiology 1

Course aims:

- To provide knowledge on medical terminology necessary for communication with health professional in oral and written form, and entire understanding of information containing medical terminology provided by other health professional
- To provide more comprehensive understanding of the most important pathophysiological disorders, their clinical manifestations, diagnostic procedures and therapeutic strategies related to these disorders.

Course outcomes: Following the course the students are expected to:

- be able to competently use medical terminology in professional communications
- improve knowledge of human macroanatomy and microanatomy, basic pathophysiology and clinical manifestations of the most common diseases and disorders and diagnostic procedures and therapeutic strategies related to these diseses and disorders.

Course contents:

Lectures

- Basics information on structure and types of medical terminology: roots, suffixes and prefixes, eponyms, the most important abbreviations/acronyms; synonyms and antonyms.
- Terminology used to describe anatomical positions and relations.
- Terminology used to describe the most important pathoanatomical, pathohistological, laboratory and clinical phenomena and diagnostic and therapeutic procedure related to the most common diseases of cardiovascular and respiratory system, digestive apparatus, liver, pancreas, kidney, urinary tract, nervous system (causing motor, sensitive and sensory disorders) and locomotor apparatus.

Practical classes

Are designed to demonstrate practical use of medical terminology related to pathoanatomy, pathophysiology, laboratory and clinical manifestations, diagnostic and therapic procedures related to the most common diseases of cardiovascular and respiratory system, digestive apparatus, liver, pancreas, kidney, urinary tract, nervous system (causing motor, sensitive and sensory disorders) and locomotor apparatus through presentation of various clinical cases.

Recommended literature:

1. Leposavić G. Patološka fiziologija za studente farmacije. Beograd: Univerzitet u Beogradu-Farmaceutski fakultet; 2012.
2. Marušić M, Kovač Z, Gamulin S. Patophysiology:Basic mechanisms of disease. Zagreb: Medicinska naklada; 2009.
3. Enrlich A, Schroeder CL. Medical Terminology for Health Professions. VII edition. New York: Delmare Learning; 2011.
4. Jones BD. Comprenhensive Medical Terminology. IV Edition New York: Delmar; 2011.
5. Chabner DE. Medical Terminology: A Short Course. 5th Edition, Amsterdam: Elsevier Science Health Science Division; 2008.

The total of active learning classes 60

Lectures: 15	**Practical classes: 15**

Teaching methods: Interactive lectures and workshops			
Grading system:			
Pre-exam obligations	**Points**	**Exam**	**Points**
Class Participation		Practical exam	
Practical classes		Written exam	30
Tests (colloquia)		Oral exam	
Seminar work			
Workshops	70		

University of Belgrade Faculty of Pharmacy	Integrated academic studies PHARMACY	

Study programme: Pharmacy

Course title: Medicinal Plants and the Environment

Teachers: Jančič B. Radiša, Lakušić S. Branislava, Slavkovska N. Violeta

Course status: elective

Semester: VI	**Study year: III**
ECTS: 2	**Course code: F3I5**

Course prerequisites: Botany

Course aims:

Introduction to basic ecological concepts, processes and the importance of biodiversity. Resolving effects of environmental factors on the distribution of medicinal plants and the quantity and quality of their secondary metabolites (essential oils, flavonoids, alkaloids). Introduction to the impacts of exploitation of biodiversity on the environment and human health. Introduction to the basics of sustainable exploitation of wild growing medicinal flora of Serbia.

Course outcomes:

Understanding the importance of biodiversity to human health and the impact of environmental factors on medicinal plants. The student should know the potential of the natural resources of indigenous wild growing medicinal plants of Serbia and understand the importance of preserving natural resources and the environment; understand the effects of anthropogenic factors to the endangerment of individual species and biodiversity in general.

Course contents:

Lectures

Ecology, the subject of study, division and relationship to other sciences. What is ecology and what is environmental protection. Basic concepts of ecology: environment, habitat, ecosystem and vegetation. Biogeochemical processes in nature. Why is knowledge of basic ecological principles important for future pharmacists. Biodiversity: the essential and the potential significance of the various levels of biodiversity - genetic, of species, of population; biodiversity and human health. Natural resources: the diversity of native flora, native officinal and potential medicinal and aromatic species, endemic species, the state of wild populations, the causes of vulnerability. Protection of biodiversity: scientific, legal and practical, advantages and disadvantages. Sustainable use of wild plants. Monitoring.

Practical classes

Visits to institutions: Institute for Nature Conservation of Serbia; Institute of Botany and Botanical Garden "Jevremovac" Faculty of Biology, University of Belgrade; fieldwork.

Recommended literature:

1. Lakušić B , Slavkovska V, Stojanović D. Lekovite biljke i životna sredina - skripta za studente Farmaceutskog fakulteta; Univerzitet u Beogradu – Farmaceutski fakultet; 2014.
2. Jančić R , Stojanović D. Ekonomska botanika . Beograd : Zavod za izdavanje udžbenika ; 2008.
3. Jovanović S , Lakušić D. (ur .) Ugrožene biljke Srbije . Beograd : Univerzitet u Beogradu - Biološki fakultet i IP NNK Internacional ; 2006.
4. Medicinal Plant Specialist Group . International Standard for Sustainable Wild Collection of Medicinal and Aromatic Plants (ISSC-MAP) Version 1.0. Bon: Bundesamt für Naturschutz (BfN), Federal Agency for Nature Conservation; 2007.

The total of active learning classes

Lectures: 15	**Practical classes:** 15

Teaching methods:

Theoretical and practical classes.

Grading system:

Pre-exam obligations	Points	Exam	Points
Class Participation	0-10	Practical exam	
Practical classes	20	Written exam	
Tests (colloquia)		Oral exam	70
Seminar work			

University of Belgrade Faculty of Pharmacy	Integrated academic studies PHARMACY	

Study programme: Pharmacy

Course title: English Language in Academic and Professional Communication

Teachers: Leontina Kerničan

Course status: Elective

Semester: VI	**Study year: III**
ECTS: 2	**Course code: F3I6E**

Course prerequisites: /

Course aims:

To

- Develop abilities in text structural reconstruction (abstract, synthesis)
- Activate phrases and necessary patterns on professional academic level
- Master techniques in oral and written communication on academic and professional level

Course outcomes:

Student will be able to:

- Apply acquired knowledge to be professionaly involved
- Organise written patterns according to his professional requirements
- Arrange oral patterns suited to professional situation and objectives

Course contents:

Lectures

Theoretical lectures

- Abstract and synthesis – characteristics and writing style
- CV – basic characteristics, patterns, elements, writing rules
- Motivational (covering) letter – aim, characteristics and elements
- Business correspondence – elements of business letter, job applying, reply to official letter, requesting information. Oral presentation. Job interview. Official telephone communication.

Practical classes

- Text structural reconstruction leading to abstract and synthesis
- Writing CV
- Writing motivational (covering) letter
- Writing business letter based on provided writing elements
- Oral presentations on requested topic from pharmaceutical profession
- Simulation of oral professional communication (role playing)

Recommended literature:

1. Villemaire D, Villemaire L. Grammar & Writing Skills for the Health Professional. 2nd edition. Thomson Delmar Learning; 2005
2. Leki I. Academic Writing. 2nd edition. Cambridge University Press; 2007.
3. Kerničan L. English Language in Pharmacy Practice. Zbirka tekstova sa vežbanjima. Treće dopunjeno izdanje. 2011

4. Marion Field. Improving Your Written English. 3rd edition. How To Books Ltd. 2001

5. Ursache I. Get Ready for Academic Writing. Polirom, 2007

The total of active learning classes

Lectures: 15	**Practical classes: 15**

Teaching methods:

Интерактивна предавања, рад у групи, игре улога, индивидуални задаци.

Interactive lessons, working in group, role playing, individual tasks.

Grading system:

Pre-exam obligations	**Points**	**Exam**	**Points**
Class Participation	5-10	Practical exam	
Practical classes		Written exam	15-30
Tests (colloquia)		Oral exam	15-30
Seminar work	15-30		

University of Belgrade Faculty of Pharmacy	Integrated academic studies PHARMACY	

Study programme: Pharmacy

Course title: French Language in Academic and Professional Communication

Teachers: Mirić M. Milica

Course status: Elective

Semester: VI	**Study year: III**
ECTS: 2	**Course code: F3I6F**

Course prerequisites: N/A

Course aims:

This course aims to activate lanugage skills necessary for professional communication, to enable academic and professional speaking and writing techniques and to develop skills for text reconstruction.

Course outcomes:

Upon completion of this course, the students are expected to be able to effectively apply the acquired knowledge in a professional setting, to produce spoken/written discourse pertinent to their professional needs and to create domain-specific speaking practices.

Course contents:

Lectures

CV – basic features, types, elements, writing rules. Cover letter – objective, features and elements. Business correspondence – applying for a job, elements of a business letter, reply to an official letter. Job interview. Oral presentations. Abstract and synthesis – features, writing rules.

Practical classes

Writing a CV. Writing a cover letter. Writing business letters based on given elements. Simulating a job interview. Oral presentations related to pharmacy topics. Writing abstracts and sythesizing texts.

Recommended literature:

1. Mirić M. French Language for Academic and Professional Purposes, study materials.

2. Penfornis JL. Vocabulaire Progressif des affaires, 200 Exercices, Collection: Progressive. Paris: CLE International; 2004.

3. Exemples de C.V. et quelques conseils. ANPE avec le soutien du Fonds Social Européen ; available on: http://www.metiersducommerce.fr/pdf/exemples_de_cv-2.pdf.

4. Exemples de lettres de motivation. Réponses à des annonces et candidatures spontanées. ANPE avec le soutien du Fonds Social Européen ; available on: http://www.metiersducommerce.fr/pdf/exemples_de_lettres_de_motivation-2.pdf

5. Jovanović AS. Savremeni fracusko-srpski rečnik sa gramatikom. Beograd: Prosveta; 2005.

The total of active learning classes

Lectures: 15	**Practical classes: 15**

Teaching methods:

Interactive lectures, group work, simulations, individual tasks.

Grading system:

Pre-exam obligations	Points	Exam	Points
Class Participation	0-5	Practical exam	
Practical classes	0-30	Written exam	15-30
Tests (colloquia)		Oral exam	

Seminar work		
Other	0-35	

University of Belgrade Faculty of Pharmacy	Integrated academic studies PHARMACY	

Study programme: Pharmacy

Course title: Pharmacotherapy

Teachers: Ugrešić D. Nenad, Stepanović-Petrović M. Radica, Savić M. Miroslav, Novaković N. Aleksandra, Tomić A. Maja

Course status: Mandatory

Semester: VII, VIII	**Study year: IV**
ECTS: 9	**Course code: F4O3**

Course prerequisites: Pathophysiology 1, Pathophysiology 2, Pharmacology 1, Pharmacology 2, Pharmacology 3

Course aims:

To provide the student with:

- information necessary for comprehensive review of certain diseases and appropriate therapeutic options
- knowledge and skills necessary for critical assessment of signs and symptoms of certain deseases
- current evidence on efficacy and safety of treatment options in certain diseases
- knowledge necessary for critical evaluation of drugs and patient counselling regarding proper drug administration and adverse drug effects.

Course outcomes:

Upon completion of this course, students will be able to:

- understand and differentiate between the pathophysiology, clinical presentation, course, disease prognosis, pharmacological and nonpharmacological treatments of different diseases
- compare different pharmacological options for certain diseases based on their therapeutic efficacy/adverse effects potential
- present patients and healthcare workers with evidence-based information or advise about drug use.

Course contents:

Lectures

Pharmacotherapy of Cardiovascular Disorders (Arterial Hypertension, Dyslipidemias, Ischemic Heart Disease, Heart Failure, Arrhythmias, Anemias, Coagulation Disorders). Pharmacotherapy of Respiratory Disorders (Chronic Obstructive Pulmonary Disease, Bronchial Asthma, Pneumonia, Upper Respiratory Tract Infections, Allergic Rhinitis, Tuberculosis). Pharmacotherapy of Gastrointestinal System Disorders (Peptic Ulcer, Gastroesophageal Reflux, Inflammatory Bowel Disease, Nausea, Vomiting, Diarrhea and Constipation). Pharmacotherapy of Urinary Tract Disorders. Pharmacotherapy of Neurological Disorders (Epilepsy, Neurodegenerative diseases, Pain and Headaches). Pharmacotherapy of Psychiatric disorders (Affective, Psychotic and Anxiety disorders, Sleep Disorders, Psychoactive Substances Use Disorders). Pharmacotherapy of Endocrine and Metabolic Diseases (Diabetes Mellitus, Contraception and Hormone Replacement Therapy). Pharmacotherapy Musculoskeletal Disorders (Osteoporosis and Rheumatic Diseases). Pharmacotherapy of Skin Disorders. Pharmacotherapy of Infectious and Oncological Disorders (HIV, Viral Hepatitis, Fungal Infections, Breast Cancer).

Practical classes

Case study analysis (pathophysiology of disease, clinical presentation, course and disease prognosis, pharmacological and nonpharmacological treatments based on current guidelines) on the following topics: cardiovascular, respiratory, gastrointestinal, urinary, neurological, psychiatric, endocrine, metabolic, musculoskeletal, skin, infective and oncological disorders.

Recommended literature:

1. Ugrešić N, Stepanović-Petrović R, Savić M. Pharmacotherapy for Pharmacists. 1st ed. Belgrade: University of Belgrade- Faculty of Pharmacy; 2011.
2. Ugrešić N. Pharmacotherapeutic Guide 5. Belgrade: Medicines and Medical Devices Agency of Serbia; 2011.
3. DiPiro JT, Talbert RL, Yee GC, Matzke GR, Wells BG, Posey LM. Pharmacotherapy: A Pathophysiologic Approach. 8th ed. New

York: The McGraw-Hill Companies Inc.; 2011
4. Koda-Kimble and Young's Applied Therapeutics: The Clinical Use of Drugs. 10th ed. Philadelphia: Wolters Kluwer, Lippincott Willians & Wilkins, 2012.

The total of active learning classes

Lectures: 45	**Practical classes: 60**

Teaching methods:

Lectures, practical classes, case study analysis

Grading system:

Pre-exam obligations	**Points**	**Exam**	**Points**
Class Participation		Practical exam	
Practical classes	10	Written exam	60
Tests (colloquia)	30	Oral exam	student may be invited to an oral exam, based on teacher's assessment
Seminar work			

University of Belgrade Faculty of Pharmacy	Integrated academic studies PHARMACY	

Study programme: Pharmacy

Course title: Pharmacocinetics

Teachers: Miljković R. Branislava, Vezmar Kovačević D. Sandra, Vučićević M. Katarina

Course status: Mandatory

Semester: VII	**Study year: IV**
ECTS: 6	**Course code: F4O1**

Course prerequisites: Physiology 2, Pharmaceutical chemistry 1, Pathophysiology1, Pharmacology 1

Course aims: To understand pharmacokinetic (PK) processes, know types of PK data analysis, calculate PK parameters, understand, know the importance, principles and ways of conducting bioavailability (BA)/bioequivalence (BE) of drug preparations, understand PK interactions and adverse drug effects as a consequence of PK drug interactions.

Course outcomes: After completion of the course the student should acquire: knowledge about PK processes and factors that influence them, understanding the importance of drug metabolism pathways in development and therapeutic use of drugs, knowing different approaches in PK analysis of drug data, calculate PK parameters after single i.v. and per os dose, and in steady state, know factors which affect PK variability that contribute to therapeutic efficacy, know ways of conducting bioavailability (BA) and bioequivalence (BE) studies of a drug preparations, understand and predict drug interactions based on PK characteristics, know adverse drug effects as a consequence of PK drug interactions.

Course contents:

Lectures

Basic PK (PK processes: absorption, distribution, metabolism and excretion of drugs – ADME system). Design of preclinical and clinical studies. Importance of drug metabolism in development, therapeutic use of drugs. PK analysis of plasma data and calculation of PK parameters after i.v. and per os drug administration: compartment, noncompartment, population approach, PK-PD modeling, and other PK analysis. PK of steady state after i.v. and per os drug administration. PK analysis of modified release drug preparations. PK analysis and calculation of PK parameters from urine data. BA/BE studies. Factors which lead to PK variability. Pharmacokinetic drug interactions and adverse drug effects.

Practical classes

Biological materials *in vitro* and *in vivo* used in PK investigations. Investigation of drug metabolism *in vitro* and *in vivo*. PK analysis of plasma and urine data and calculations of PK parameters. Controlled in vivo PK studies. BA/BE studies. Population PK studies. Case analysis in order to calculate PK parameters after a single dose (sd), repeated dosing (SS) and i.v. and per os drug administration.

Recommended literature:

1. Pokrajac M. Farmakokinetika. 4th ed. Belgrade: University of Belgrade – Faculty of Pharmacy; 2012.

2. Pokrajac M. Farmakokinetika – Practical classes manual. 3rd ed. Belgrade: Biograf; 2008.

3. Ritchel W, Kearns G. Handbook of basic pharmacokinetics including clinical applications. 7th ed. Washington: American Pharmacists Association; 2009.

4. Jambhekar SS, Breen PJ. Basic pharmacokinetics. 2nd ed. London: Pharmaceutical Press; 2012.

The total of active learning classes

Lectures: 45	**Practical classes: 45**

Teaching methods: One semester long: interactive lectures, workshops, case study analysis, problem based learning, patient-centred learning.

Grading system:

Pre-exam obligations	Points	Exam	Points
Class Participation		Practical exam	

Practical classes	5	Written exam	70
Tests (colloquia)	25	Oral exam	Student may have to continue with an oral exam, if the professor determines that the written exam is not enough for the assessment.
Seminar work			

University of Belgrade Faculty of Pharmacy	Integrated academic studies PHARMACY	

Study programme: Pharmacy

Course title: Pharmaceutical Technology 2

Teachers: Đurić R. Zorica, Milić R. Jela, Savić D. Snežana, Vasiljević D. Dragana, Krajišnik R. Danina, Cvijić V. Sandra

Course status: Mandatory

Semester: VII	**Year of studies: IV**
ECTS points: 5	**Course code: F4O4**

Requirements: Pharmaceutical Technology 1

Course aims: Introducing students to the types, composition, characteristics, formulation, and pharmaceutical technical procedures for dosage forms for parenteral, ophthalmic, inhalation, rectal and vaginal application; providing an overview of the biopharmaceutical aspects of formulation and characterization of dosage forms for parenteral, ophthalmic, inhalation, rectal and vaginal application.

Course outcomes: A student understands the types, composition, compounding/manufacturing procedures, pharmaceutical technical procedures and pharmacopoeial requirements regarding dosage forms for parenteral, ophthalmic, inhalation, rectal and vaginal application; a student is skilled to formulate the above mentioned dosage forms, and has knowledge on types, characteristics and the role of excipients in the formulation; a student knows and understands the principles related to the influence of biopharmaceutical (physiological, drug's physicochemical, and formulation) factors on drug release from various dosage forms, and concomitant absorption process; consequently, a student is able to advise patients, and provide relevant information to other healthcare professionals.

Course contents:

Theoretical classes

Biopharmacy - general terms and definitions. Influence of physiological factors on drug absorption, depending on the route of administration. Influence of physicochemical factors on drug release from dosage form, and concomitant absorption process. Influence of formulation factors on drug release and absorption - general principles and specialities related to dosage forms for parenteral, ophthalmic, inhalation, rectal, and vaginal application.

Basic principles of the formulation of dosage forms for parenteral, ophthalmic, inhalation, rectal, and vaginal application, in order to provide adequate drug release/delivery, drug stability, therapeutic effect, and patient compliance.

The types, characteristics, composition, compounding/manufacturing procedures, quality requirements, and test procedures for dosage forms for rectal and vaginal application. The types, characteristics, composition, and compounding/manufacturing procedures of dosage forms for parenteral and ophthalmic application. Sterilisation and methods of sterilisation in the compounding/manufacturing of pharmaceuticals. Quality requirements and test procedures for parenteral and ophthalmic preparations. The types/classes of excipients for parenteral and ophthalmic preparations, and factors influencing the selection of appropriate excipients. Immunobiological preparations for active and passive immunization - pharmaceutical technical aspects. Biological drugs/biopharmaceutics - characteristics and production techniques (recombinant DNA-technology); first and second generation of biopharmaceutics – insulin examples. Radiopharmaceutical preparations - pharmaceutical technical aspects. The types, characteristics, composition, and test procedures for preparations for inhalation.

Practical classes

Selection of the adequate equipment, container/packaging, and assurance of proper conditions for compounding parenteral and eye preparations. Extemporaneous pharmaceutical compounding and test procedures related to parenteral and eye preparations (selected examples). Sterilisation, methods of sterilisation and sterilisation equipment. Preparations for inhalation - pharmaceutical technical procedures. Extemporaneous pharmaceutical compounding and test procedures for suppositories and pessaries (selected examples).

Recommended literature:

1. Đurić Z, Farmaceutska tehnologija sa biofarmacijom, I deo, Zemun: Nijansa, 2004.

2. Krajišnik D, Grbić S, Petrović J, Đekić Lj, Vasiljević D, Kovačević A, Čalija B, Farmaceutska tehnologija II,

Praktikum, izmenjeno i dopunjeno izdanje, Beograd: Farmaceutski fakultet, 2013.

3. Allen LV, Ansel HC, Ansel's Pharmaceutical Dosage Forms and Drug Delivery Systems, 10th ed. Phyladelphia: Wolters Kluwer, 2014.

4. Remington: The Science and Practice of Pharmacy, 22nd ed. Gurnee: Pharmaceutical Press, 2012.

5. Aulton ME, Taylor KMG. Aulton's Pharmaceutics: The Design and Manufacture of Medicines, 4th ed. Edinburgh: Churchill Livingstone Elsevier, 2013.

The total of active learning classes	
Lectures: 45	**Practical: 45**

Teaching methods:

Theoretical classes, interactive classes, practical classes, problem based learning, calculations

Grading system: (maximum 100 points)

Exam prerequisites	**Points**	**Final exam**	**Points**
Active participation in lectures	0-3	Practical exam	
Practical classes	3-5	Written exam	31-60
Colloquia	17-32	Oral exam	
Seminars	/		
Other activities	/		

University of Belgrade Faculty of Pharmacy	Integrated academic studies PHARMACY	

Study programme: Pharmacy

Course title: Toxycology

Teachers: Matović J. Vesna, Vujanović L. Dragana, Đukić M. Mirjana, Antonijević M. Biljana, Bulat L. Zorica, Đukić-Ćosić D. Danijela

Course status: Mandatory

Semester: VII	**Study year: IV**
ECTS: 7	**Course code: F4O2**

Course prerequisites: none

Course aims: Gaining the knowledge on different fields of toxicology (general toxicology, forensic toxicology, professional toxicology, clinic toxicology, toxicology of food, toxicology of drugs, ecotoxycology, analytic toxicology…) with the aim to improve the health and safety of living beings and the protection of their environment.

Course outcomes: Possibility of qualified work of masters of pharmacy in all fields of toxicology. This course strengthens the requirement for pharmacists to play an important role in health care systems, science and legislation.

Course contents:

Lectures

Principles of general toxicology: history and scope of toxicology, poison definition, dose-response relationship, factors determining toxicity, chemical structure-toxicity relationship, toxicokinetics, mechanisms of toxicity, target organ toxicity, basic principles of poisoning treatment and antidotes, sample preparation, qualitative and quantitative analytical methods in toxicological practice, interpretation of obtained results. The most important gaseous poisons (carbon monoxide, carbon dioxide, sulfur dioxide, nitrogen oxides, chlorine, etc.), volatile poisons (cyanides, alcohols, chlorinated carbohydrates, benzene and benzene derivates, persistent organic pollutants), mineral poisons (lead, mercury, cadmium, manganese, arsenic, fluorides, acids, alkalis, etc.) and herbal and synthetic poisons (alkaloids, heterosides, pesticides, drugs, substances of abuse, etc.). Basics of radioactivity and plastics. Drug poisoning (salicylates, barbiturates, benzodiazepines, phenothiazines, beta blockers and others). Basics of ecotoxycology and the most important pollutants of atmosphere, hydrosphere, and soil. Principles of toxicological risk assessment. Regulatory affairs in toxicology.

Practical classes

Practical training will enable students to acquire the necessary knowledge and skills relevant for laboratory work in toxicology with emphasis given to sample preparation, detection and determination methodology used in the analysis of the most important poisons through individual work, as well as through demonstrations.

Recommended literature:

1. Timbrell J. Introduction to Toxicology. 3rd ed. New York: Taylor & Francis; 2001.
2. Casarett & Doull's Toxicology: The Basic Science of Poisons. 7th ed. Klaassen CD, editor. New York: McGraw-Hill Professional; 2008.
3.Procedures for the identification and determination of investigated poisons (will be written in English).

The total of active learning classes

Lectures: 60	**Practical classes:** 45

Teaching methods: lectures, laboratory work in groups

Grading system:

Pre-exam obligations	Points	Exam	Points
Class Participation		Practical exam	
Practical classes	15	Written exam	

Tests (colloquia)	20	Oral exam	60
Seminar work			
Other activities	5		

University of Belgrade Faculty of Pharmacy	Integrated academic studies PHARMACY	

Study programme: Pharmacy

Course title: Phytotherapy

Teachers: Kovačević N. Nada, Petrović D. Silvana, Maksimović A. Zoran, Kundaković D. Tatjana

Course status: Mandatory

Semester: VII	**Study year: IV**
ECTS: 4	**Course code: F4O5**

Course prerequisites: Pharmacognosy

Course aims:

Achievement of knowledge about the position and role of phytotherapy in the system of primary helathcare and self-medication. Proper and safe use of herbal medicinal products for the treatment and prevention of diseases and health promotion.

Course outcomes:

Student is familiar with the basic principles of rational phytotherapy and herbal medicinal products - their active constituents and mechanisms of pharmacological activity. Student is able to provide relevant information on the use of herbal medicinal products, and critically evaluate selected natural product from the market.

Course contents:

Lectures

Definition of phytotherapy; rational and traditional phytotherapy. Position and role of phytotherapy in the system of primary healthcare and self-medication. Definition and types of herbal medicinal products (herbal medicines, traditional herbal medicines); familiarization with the relevant legislation. Active constituents of herbal medicinal products and the mechanisms of their activity. Safe use of herbal medicinal products: therapeutic indications, posology and methods of administration, contraindications, special warnings and precautions for use, interactions, undesirable effects; assessment of the risk/benefit ratio. Use of herbal medicinal products in functional disorders and ailments of the central nervous system, cardiovascular system, respiratory system, gastrointestinal system, urogenital system, skin and mucous membranes, bone, connective and muscular tissue, and use in metabolic disorders. Use of herbal medicinal products with immunomodulatory, adaptogenic and antioxidant activity.

Practical classes

Analysis and discussion of the composition and information provided by the patient information leaflets of herbal medicinal products available on the market. Building competency of students for counseling on proper and safe use of herbal medicinal products, by analysis of case studies. Discussion about the quality control of herbal drugs and herbal drug preparations as active constituents of herbal medicinal products.

Recommended literature:

1. Schulz V, Haensel R, Tyler VE. Rational phytotherapy. A reference guide for physicians and pharmacists. 5th ed. Berlin, Heidelberg: Springer-Verlag; 2004.

2. ESCOP Monographs. 2nd ed. supplement 2009. Exeter: The European Scientific Cooperative on Phytotherapy; Stuttgart: Georg Thieme Verlag; New York: Thieme New York; 2009.

3. ESCOP Monographs. 2nd ed. Exeter: The European Scientific Cooperative on Phytotherapy; Stuttgart: Georg Thieme Verlag; New York: Thieme New York; 2003.

4. Blumenthal M, Hall T, Goldberg A, Kunz T, Dinda K, eds. The ABC Clinical Guide to Herbs. 1st ed. Austin, Texas: American Botanical Council; New York: Thieme New York; Stuttgart: Thieme International; 2003.

5. European Medicines Agency. EMA/HMPC Community herbal monographs. http://www.ema.europa.eu.

The total of active learning classes

Lectures: 30	**Practical classes:** 30

Teaching methods:
Lectures, interactive teaching, practical classes

Grading system:

Pre-exam obligations	Points	Exam	Points
Class participation	2-5	Practical exam	
Practical classes	12-20	Written exam	31-60
Tests (colloquia)		Oral exam	
Seminar work	10-15		
Other activities			

University of Belgrade Faculty of Pharmacy	Integrated academic studies PHARMACY	

Study program: Pharmacy

Course title: Selected Chapters of Pharmaceutical Chemistry

Teachers: Vujić B. Zorica, Erić M. Slavica, Brborić S. Jasmina, Čudina A. Olivera, Marković D. Bojan

Course status: elective

Semester: VII	**Year of studies: IV**
ECTS points: 4	**Course code: F4I1**

Prerequisite for attending course: none

Course aims: Providing students with expanded knowledge in medicinal chemistry and discovery of drugs composed of novel chemical scaffold, designed as analogs of a lead compound, or interacting with new pharmacological targets mechanisms. Providing students with basic knowledge in diagnostic agents and radiopharmaceutics.

Course outcomes: Student is expected to learn principles in analysis of physicochemical properties, reactivity and stability of the studied drugs; to analyze the relationship between chemical structure and biological activity of molecules, to understand chemical interactions of drugs, drug-receptor interactions and chemical aspects of drug metabolism.

Course contents:

Course is composed of five units in the field of chemistry of new drugs used in modern pharmacotherapy: innovative drugs in antimicrobial therapy (chronological review of antibiotic development and reference to latest and safest drugs); medicinal chemistry of natural and synthetic drugs of abuse; selectivity and toxicity of antineoplastics; steroid hormones-anabolics and anticoncipiens; and diagnostics (contrast) agents. Radioisotopes and radiopharmaceutics in nuclear medicine: synthesis, properties and application in *in vivo* and *in vitro* diagnostics and in therapy.

Remark: The listed contents of the course can be changed (in order to modernize subject matter, and in accordance with interests of students and new trends in education of pharmacist), so that lecturers can amend or partly change existing contents of the course.

Recommended literature:

1.Foye's Principles of Medicinal Chemistry. 7th ed. Williams DA, Lemke TL, editors. Baltimore: Lippincott Williams & Wilkins; 2013.

2. Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry. 12th ed. Beale JM, Block JH, editors. Philadelphia: Lippincott Williams & Wilkins; 2011.

3. Burger's Medicinal Chemistry & Drug Discovery. 7th ed. Hoboken, New Jersey: John Wiley & Sons; 2010.

4. Gopal B. Saha. Fundamenals of Nuclear Pharmacy. 6th ed. Springer; 2010.

The total of active learning classes

Lectures: 45	**Practical training:** 0

Teaching methods: oral lectures, interactive teaching, seminar paper

Grading system:

Exam prerequisites	Points	Final exam	Points
Active participation in lectures	10	Practical	
Practical training		Written	40
Colloquia	50	Oral	
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Integrated academic studies PHARMACY	

Study programme: Pharmacy

Course title: Laboratory Diagnosis of Metabolic Disorders

Teachers: Kotur-Stevuljevic M. Jelena, Bogavac-Stanojevic B. Nataša, Stefanović Ž. Aleksandra

Course status: elective

Semester: VII	**Study year: IV**
ECTS: 4	**Course code: F4I2**

Course prerequisites: Pathophysiology 1 and 2

Course aims:

Broadening of students' knowledge and skills in the area of laboratory diagnostics, therapy and monitoring of the most frequent chronic diseaes: diabetes and dyslipidemia.

Course outcomes:

Students will know how to perform and analyse biochemical analysis results from the laboratory diagnostics, so as monitoring of the pharmacological and non-pharmacological therapy of diabetes and hyperlipidemia. Students will know how to perform atherosclerosis risk calculation on the lipid and non-lipid risk factor basis**.**

Course contents:

Lectures

Intergrative metabolic processes in liver, muscles, adipose tissue and brain, chormonal regulation. Metabolic processes in well-feeding state. Obesity. Biochemical aspects of starving. Metabolic disorders in different diabetes mellitus types and laboratory diagnostics and laboratory monitoring of the course and therapy of diabetes. Lipoprotein metabolism disorders and atherosclerosis. Dyslipidemia classification. Laboratory diagnostics of lipid metabolism disorders. Introduction of national and international authorities recommendations, for the laboratory diagnostics and monitoring of the diabetes, lipid status and atherosclerosis risk.

Practical classes (work)

Analytical methods for the dyagnostics and monitoring of the DM and hyperlipidemia. Characteristics and usage of the glucometers based on the biosensors operating principle. Lipid and non-lipid risk factors for atherosclerosis development through the „problem based learning“. Atherogenic risk calculation and algorithm usage in atherosclerosis and cardiovascular diseases risk prediction with clinical praxis examples. Importance of pre-analytical and analytical variations in biochemical markers determination, based on laboratory practice cases.

Recommended literature:

1. Spasic S, Jelic-Ivanovic Z, Spasojevic-Kalimanovska V. Medical Biochemistry, 2003.

2. Burtis CA, Ashwood ER, Bruns DE. Tietz Textbook of Clinical Chemistry and Molecular Diagnosis, W.B. Saunders Company, 2012.

3. Rifai N, Warnick GR, Dominiczak MH. Handbook of Lipoprotein Testing. AACC Press, 2000.

4. Kaplan LA, Pesce AJ, Kazmierczak S. Clinical Chemistry, 5th Edition - Theory, Analysis, Correlation, W.B. Saunders Company, 2010.

5. Additional literature: review articles from scientific journals, National guides for clinical practice

The total of active learning classes

Lectures: 30	**Practical classes: 15**

Teaching methods: lectures, seminars, workshops, laboratory work, e-learning, practical cases analysis, problem based learning

Grading system:			
Pre-exam obligations	**Points**	**Exam**	**Points**
Class Participation	10	Practical exam	
Practical classes	30	Written exam	40
Tests (colloquia)	10	Oral exam	
Seminar work	10		

University of Belgrade Faculty of Pharmacy	Integrated academic studies PHARMACY	

Study program: Pharmacy

Course title: Psychoactive Substances of Abuse

Teachers: Matović J. Vesna, Vujanović L. Dragana, Đukić M. Mirjana, Antonijević M. Biljana, Bulat L. Zorica, Đukić-Ćosić D. Danijela

Course status: elective

Semester: VII	**Year of studies: IV**
ECTS points: 4	**Course code: F4I3**

Prerequisite for attending course: none

Course aims:

Acquisition and implementation of knowledge on mechanism of action and toxicity of psychoactive controlled substances, a social aspect of their abuse, therapy and prevention and society strategies aiming to reduce the number of addicts.

Course outcomes:

Qualification of masters of pharmacy to be a part of multidisciplinary team (educational system, regulatory boards and commissions) dealing with and the problem of psychoactive controlled substances abuse, as a part of social and health care, focusing on the prevention of abuse and therapy.

Course contents:

Lectures:

History. Classification of psychoactive controlled substances. Addiction theories. Basic characteristics of psychoactive controlled substances. The most important psychoactive controlled substances. Alcohol. Opiate (opium, morphine, and heroine). Cocaine. Amphetamine. Cannabis (marihuana, hashish). LSD. Drugs of abuse (methadone, selective inhibitors of serine reuptake, barbiturates, benzodiazepines, anabolics, ...). New “street drugs”: synthetic cannabinoids, benzylpiperazine, GHB. Legislative. The most frequently abused psychoactive controlled substances in Serbia.

Practical training:

Practical training is integrated follow-up of lectures designed with the goal that students master the knowledge on psychoactive controlled substances. Analysis of case studies of poisoning with most important representatives of psychoactive controlled substances (practical training is conducted throughout Moodle platform for e-learning).

Recommended literature:

1. Blachford S, Krapp K. Drugs and Controlled Substances Information for Students. Blachford S., Krapp K, editors.Michigan: Gale; 2002.
2. Joseph DE. Drugs of Abuse. Wahington: U.S. Department of Justice. Drug Enforcement Administration; 2003.
3. Cole MD. The Analysis of Controlled Substances, Chichester: Wiley; 2003.
4. Emmett D, Nice G. Understanding Street Drugs. Philadelphia: Jessica Kingsley Publishers; 2006.

The total of active learning classes

Lectures: 30	**Practical training:** 15

Teaching methods: lectures, case study analysis, Moodle (e-learning platform)

Grading system:

Exam prerequisites	Points	Final exam	Points
Active participation in lectures	10	Practical	
Practical training		Written	50
Colloquia	10	Oral	
Seminars			
Other activities (Moodle)	30		

University of Belgrade Faculty of Pharmacy	Integrated academic studies of PHARMACY	

Study programme: Pharmacy

Course title: Dietetics

Teachers: Šobajić S. Slađana, Stanković M. Ivan, Đorđević I. Brižita

Course status: Mandatory

Semester: VIII	**Year of studies: IV**
ECTS points: 4	**Course code: F4O7**

Requirements: Bromatology

Course aims:

Providing information regarding the existing guidances, recommendations and other tools used to design dietary regimens; information of specific nutritive needs for certain age groups and during the course of therapy or prevention of illnesses; information on specific types of dietary products adapted to the needs of specific population groups; food and drugs interactions.

Course outcomes:

Student is capable to provide appropriate interpretation of dietary recommendations; to give general advice on the healthy nutrition of the general population as well as advices on nutrition to patients suffering from noncommunicable diseases (NCDs); to provide basic information on dietary foods and supplements, and food and drugs interactions.

Course contents:

Lectures

The role of food; principles of rational nutrition and tools for the implementation of the rational nutrition; recommendations of daily intake of nutrients – RDA and DRI values; upper tolerable level of nutrients intake; human energy requirements; methods used in nutrition and nutritional status evaluation; food biologically active ingredients; nutrition during various periods of life; nutritive needs of athletes; allergies and food intolerances; eating disorders; food fortification, functional food, dietary foods, dietary supplements; food for special medical needs – specifics of the application and formulation; interactions of food with drugs and other nutrients, medical nutrition therapy (MNT) for obesity, diabetes, hypertension and coronary heart disease.

Practical classes

Examples of calculation of energy requirements; body mass index (BMI), calculations of fractions of fat, carbohydrates and proteins in the total daily energy consumption; calculation of the energy value of foods; methods for assessment of the quality of nutrition and nutritional status; examples of usage of food composition tables; analysis of energy and nutritive value of dietary products; interpretation of information given in food labelling; seminar.

Recommended literature:

1. Mahan LK, Escott-Stump S. Krause's Food & Nutrition Therapy. 12th Edition: Elsevier Health Sciences; 2008.
2. Gibney MJ, (Editor), Lanham-New SA, (Editor), Cassidy A, Vorster HH. Introduction to Human Nutrition, 2nd Edition:Wiley-Blackwell; 2009.
3. Erdman JW. MacDonald IA, Zeisel SH. Present Knowledge in Nutrition, 10th Edition:Wiley-Blackwell; 2012
4. Handsout

The total of active learning classes

Lectures: 30	**Practical classes:** 30

Teaching methods: lectures, seminar, assignments

Grading system:

Exam prerequisites	**Points**	**Final exam**	**Points**

Active participation in lectures	0-7	Practical	
Practical classes	9-18	Written	
Colloquia		Oral	30-60
Seminars	8-15		
Other activities			

University of Belgrade Faculty of Pharmacy	Integrated academic studies PHARMACY	

Study programme: Pharmacy

Course title: Pharmaceutical Technology 3

Teachers: Primorac M. Marija, Parojčić V. Jelena, Ibrić R. Svetlana, Cvijić V. Sandra, Đuriš D. Jelena, Đekić M. Ljiljana

Course status: Mandatory

Semester: VIII	**Year of studies: IV**
ECTS points: 6	**Course code: F4O6**

Requirements: Pharmaceutical Technology 1

Course aims: Introducing students to the types, composition, characteristics, formulation, and pharmaceutical technical procedures for evaluation of solid oral dosage forms, and modified release dosage forms/drug delivery systems for different routes of administration; providing an overview of the biopharmaceutical aspects of formulation and characterization of various dosage forms/drug delivery systems.

Course outcomes: A student understands the types, composition, compounding/manufacturing procedures, pharmaceutical technical procedures and pharmacopoeial requirements regarding solid oral dosage forms; a student is skilled to formulate the above mentioned dosage forms, and has knowledge on types, characteristics and the role of excipients in the formulation of solid oral dosage forms; a student knows and understands the principles related to the influence of physiological, drug's physicochemical, and formulation factors on drug release and absorption processes after administration of solid oral dosage forms and modified release dosage forms/drug delivery systems; consequently, a student is able to advise patients, and provide relevant information to other healthcare professionals.

Course contents:

Theoretical classes

Basic principles of the formulation of solid oral dosage forms, aimed to provide adequate drug release/delivery, drug stability, therapeutic effect, and patient compliance. Biopharmaceutical aspects of drug formulation and quality control.

Solid dosage forms. Solid-state properties of powders relevant to the formulation of solid dosage forms. Hard and soft gelatin capsules: excipients, compounding/manufacturing procedures, pharmaceutical technical procedures. Pellets. Pharmaceutical excipients for solid dosage forms. Tablets (types, definition, properties, general characteristics). Tablet manufacturing processes: direct compression and various granulation techniques. Tablet coating techniques. Tablet characterization. Modified release oral dosage forms: types, characteristics, excipients, and manufacturing procedures. Drug delivery systems for different routes of administration - basic considerations.

Biopharmaceutical aspects of oral drug delivery. Biopharmaceutics Classification System (BCS). Dissolution testing of solid dosage forms (method development, application, overview of pharmacopoeial and regulatory requirements and recommendations).

Practical classes

Preparation and characterization of granules, capsules, tablets, and modified release dosage forms. Fluid bed granulation. Characterization of granules (particle size distribution, moisture content, flowability and density). Preparation of tablets on a single-punch (eccentric) tableting machine. Tablet hardness, friability and disintegration of tablets and capsules. Drug dissolution from tablets. Biopharmaceutical characterization of drugs/pharmaceutical products. Influence of media pH and surfactant concentration on the solubility of the selected model substance. Determination of partition coefficient of the model drug. Classification of drugs according to the BCS criteria.

Recommended literature:

1. Đurić Z. Farmaceutska tehnologija sa biofarmacijom. I deo. Zemun: Nijansa, 2004.

2. Krajišnik D, Grbić S, Petrović J, Đekić Lj, Vasiljević D, Kovačević A, Čalija B. Farmaceutska tehnologija II Praktikum, izmenjeno i dopunjeno izdanje. Beograd: Farmaceutski fakultet, 2013.

3. Allen LV, Ansel HC, Ansel's Pharmaceutical Dosage Forms and Drug Delivery Systems, 10th ed. Phyladelphia: Wolters Kluwer, 2014.

4. Aulton ME, Taylor KMG. Aulton's Pharmaceutics: The Design and Manufacture of Medicines, 4th ed. Edinburgh: Churchill Livingstone Elsevier, 2013.

5. Gibson M. Pharmaceutical Preformulation and Formulation, 2nd ed. New York: Informa Healthcare USA Inc., 2009.

The total of active learning classes

Lectures: 45	**Practical: 60**

Teaching methods:

Theoretical classes, interactive classes, practical classes, demonstrations, educational videos, calculations, workshops

Grading system:

Exam prerequisites	**Points**	**Final exam**	**Points**
Active participation in lectures	0-2	Practical exam	
Practical classes	2-6	Written exam	31-60
Colloquia	14-25	Oral exam	
Seminars	4-7		
Other activities			

University of Belgrade Faculty of Pharmacy	Integrated academic studies of PHARMACY	

Study programme: Pharmacy

Course title: Pharmaceutical legislation and ethics

Teachers: Krajnović M. Dušanka, Marinković D. Valentina, Tasić M. Ljiljana

Course status: Mandatory

Semester: VIII	**Year of studies: IV**
ECTS points: 3	**Course code: F4O8**

Requirements: none

Course aims:

Understanding of the national and international legal regulations in the field of pharmacy. Mastering the basics of applied ethics in pharmacy which are necessary to analyze and solve problems in the field of pharmaceutical health services, biomedical research, marketing, and industrial production. Development of the critical thinking in the process of ethical analysis of problems in specific situations of the pharmaceutical practice.

Course outcomes:

Student is aware of, and knows how to apply laws, by-laws and professional legal documents regulating all aspects of the pharmaceutical practice. The student is able to deal with ethical issues in the pharmaceutical care through application of ethical analysis; knows the difference between legal and ethical problems that pharmacists deal during the professional work.

Course contents:

Lectures

European and international legislation on medicines - basic guidelines. National health policy and regulations in fields of medicine and pharmacy (Laws on healthcare, health insurance, healthcare associations, medicines and medical devices). Medicines and Medical Devices Agency of Serbia, its purpose, assignments, structure and activities. The procedure of granting a marketing authorization for medicines or medical devices. Pharmaceutical regulations (national by-laws and professional legal documents). Professional organizations (national and international). Serbian pharmaceutical chamber. Pharmacists working license. Court of Honor. Normative ethics in pharmacy. Ethical theories (principles) that are foundation for the pharmaceutical ethics. Ethical analysis of case studies from the pharmaceutical practice ethical standards and moral values, wrong judgment and patients' rights. Errors in pharmacy - moral and legal responsibility of pharmacists. Ethics in preclinical and clinical trials. The role and importance of the ethics committee. Ethical issues in biomedical research. Ethics in advertising of medical services and pharmaceuticals. Current bioethical issues.

Lectures

Analysis and discussion of case studies (generation and critical evaluation of information and data). Problem-based learning (problem solving using the appropriate explanation of the ethical concept and the legal framework). Panel discussions, application of the law and ethics on current issues. Homework.

Recommended literature:

1. ICH regulativa i regulativa Evropske unije koje se odnose na sve aspekte leka i medicinskog sredstva.
2. Aktuelni zakoni i podzakonska akta Republike Srbije iz oblasti zdravstva i farmacije
3. Parojčić D. Razvoj etike u farmaciji od teorije do savremene prakse. Beograd: Konstisi; 2006.
4. Veatch R. Haddad A. Case Studies in pharmacy ethics. New York: Oxford University Press; 2008.
5. Gosić N. Bioetičke perspektive. Zagreb: Pergamena; 2011.

The total of active learning classes

Lectures: 30	**Practical classes:** 15

Teaching methods: lectures, seminars, workshops, calculations, case studies (homework), discussion

Grading system:

Exam prerequisites	Points	Final exam	Points
Active participation in lectures	5	Practical	
Practical classes	35	Written	50
Colloquia	10	Oral	
Seminars			

Other activities			

University of Belgrade Faculty of Pharmacy	Integrated academic studies PHARMACY	

Study programme: Pharmacy

Course title: Selected chapters in clinical pharmacokinetics

Teachers: Miljković R. Branislava, Vezmar Kovačević D. Sandra, Vučićević M. Katarina

Course status: Elective

Semester: VIII	**Study year: IV**
ECTS: 4	**Course code: F4I5**

Course prerequisites: Pharmacokinetics

Course aims:

Course outcomes: After completion of the course the student should acquire: knowledge on applying principles of clinical pharmacokinetics (PK), interpret measured plasma drug concentrations in patients, set up and modify drug regimen based on individual values of PK parameters, apply population PK models in determination optimal therapeutic regimen of drugs, understand variability of therapeutic response as a consequence of PK variability.

Course contents:

Lectures

Basic principles of clinical pharmacokinetics. PK parameters important for setting up and modifying drug regimen. Population PK models as a base in determination of optimal therapeutic drug regimen. Variability of therapeutic response as a consequence of PK variability. Initial and modified drug regimen based on the values of PK parameters. Principles of clinical PK in solving problems for specific populations of patients (patients with insufficiency of kidneys, liver, geriatric, pediatric population of patients, women, pregnancy and breastfeeding, obese patients, patients on polytherapy.

Practical classes

Applying the principles of clinical pharmacokinetics in setting up and modifying drug regimen. Average (population)/individual values of PK parameters. PK variability. Interpretation of measured plasma drug concentration in patient during standard monitoring. Calculations of PK parameters which are important for initial setting up and modified drug regimen based on values of PK parameters using PK software. Applying principles of clinical PK in solving problems for specific therapeutic groups of drugs (lithium, digoxin, aminoglycoside antibiotics, theophylline, antiepileptic drugs, immunosuppressive drugs).

Recommended literature:

1. Dhillon S, Kostrzewski A. Clinical Pharmacokinetics. 1st ed. London: Pharmaceutical Press, 2006.

2. Winter M. Basic Clinical Pharmacokinetics. 5th ed. Lippincott Williams & Wilkins, 2009.

3. Murphy J. Clinical Pharmacokinetics – pocket reference. 5th ed. Maryland: American Society of Health-System Pharmacists, 2011.

4. Applied Clinical pharmacokinetics, Bauer L.A. 2nd ed. London: McGraw-Hill Medical, 2008.

5. Rowland M, Tozer T. Clinical Pharmacokinetics and Pharmacodynamics: Concepts and Applications. 4th ed., Lippincott Williams & Wilkins, 2011.

The total of active learning classes

Lectures: 30	**Practical classes: 15**

Teaching methods: One semester long: interactive lectures, workshops, case study analysis, problem based learning, patient-centred learning.

Grading system:

Pre-exam obligations	Points	Exam	Points
Active participation in lectures	0-4	Practical exam	

Practical classes	0-6	Written exam	50
Tests (colloquia)	40	Oral exam	Student may have to continue with an oral exam, if the professor determines that the written document is not enough for the assessment.
Seminar work			

University of Belgrade Faculty of Pharmacy	Integrated academic studies PHARMACY	

Study programme: Pharmacy

Course title: Veterinary Medicines

Teachers: Parojčić V. Jelena, Vasiljević D. Dragana, Cvijić V. Sandra

Course status: Elective

Semester: VIII	**Year of studies: IV**
ECTS points: 4	**Course code: F4I6**

Requirements: Pharmaceutical Technology 1

Course aims: Introducing students to the specificities of the medicinal preparations for use in veterinary medicine, veterinary dosage forms, regulatory requirements and guidelines related to the research and development, manufacturing, marketing authorization, and quality control of veterinary drugs.

Course outcomes: Knowing the specificities of medicinal preparations for use in veterinary medicine, dosage form characteristics, and biopharmaceutical aspects of veterinary dosage forms for different species, along with the regulatory requirements and guidelines related to research and development, manufacturing, marketing authorization, and quality control of veterinary drugs; critical assessment and rational selection of the appropriate dosage form for veterinary use, depending on animal species and therapeutic aim.

Course contents:

Theoretical classes

Specificities of the medicinal preparations for use in veterinary medicine (veterinary drugs for collective treatments, routes of administration, veterinary dosage forms, taste and odour masking, dosing regiments); Biopharmaceutical aspects of veterinary drugs; Characteristics of dosage forms for veterinary use; Development and formulation of veterinary dosage forms; Extemporaneous compounding of veterinary medicines; Regulatory requirements and guidelines related to the research and development, manufacturing, marketing authorization, and quality control of veterinary drugs.

Practical classes

Overview of regulations and scientific literature related to the preparation/manufacturing, storage and handling, and prescription status of veterinary drugs; Extemporaneous compounding of veterinary drugs; Overview of dosage forms for veterinary use in different animal species.

Recommended literature:

1. Kayne CB, Jepson MH. Veterinary Pharmacy. London: Pharmaceutical Press; 2004.

2. Bishop Y. The Veterinary Formulary. 6th ed. London: Pharmaceutical Press; 2004.

3. Baggot DJ. Veterinary Dosage Forms. In: Swarbrick J, Boylan JC. Encyclopedia of Pharmaceutical Technology. 2nd ed. New York, Basel: Marcel Dekker Inc.; 2002.

4. Nacionalni registar veterinarskih lekova, ALIMS, 2014.

The total of active learning classes

Lectures: 30	**Practical: 15**

Teaching methods:

Theoretical classes, interactive classes, case studies discussion, seminar paper

Grading system:

Exam prerequisites	Points	Final exam	Points
Active participation in lectures	0-3	Practical exam	
Practical classes	0-7	Written exam	36-70

Colloquia		Oral exam	
Seminars	0-20		
Other activities			

University of Belgrade Faculty of Pharmacy	Integrated academic studies PHARMACY	

Study programme: Pharmacy

Course title: Drug Design and Synthesis

Teachers: Slavica Erić , Vladimir Savić

Course status: Elective

Semester: VIII	**Study year: IV**
ECTS: 5	**Course code: F4I7**

Course prerequisites: Pharmaceutical Chemistry 1

Course aims:

For student to gain the knowledge in the field of drug design, chemical strategies in the development and biological evaluation of pharmaceutical substances

Course outcomes:

Student is expected to: understand the mechanisms of drug action on molecular level; gain the skills in analysing quantitative and qualitative structure activity/property/selectivity relationships of pharmacologicaly active compounds, for the purpose of designing novel and optimizating current drugs; achieve the understanding of various strategies used in drug design and synthesis processes;

Course contents:

Lectures

The discovery of new drugs: serendipious discoveries, leading molecules from natural sources, selective optimization of side effects, hypothetical receptors. Rational drug design: selection and validation of targets, optimization of leading compounds, biological evaluation of pharmaceutical substances. Strategies and approaches in the chemical development of pharmaceutical substances. Physico-chemical properties of drugs. Computer-aided drug design (molecular descriptors, quantitative structure activity relationships, molecular modelling). Patents. The examples of drug design and synthesis.

Practical classes

Practical exercises, seminars.

Recommended literature:

1. Graham L. Patrick, Introduction to Medicinal Chemistry, Oxford University Press, 4th ed., 2009.

2. F.D. King, Medicinal Chemistry, Principles and Practice, The Royal Society of Chemistry, 2002.

3. John B Taylor and David J Triggle, Comprehensive Medicinal Chemistry II, Volume 3: Drug Discovery Technologies, Elsevier Ltd. 2007.

The total of active learning classes

Lectures: 30	**Practical classes: 15**

Teaching methods:

One semester course: oral lectures, interactive teaching, seminars, practical exercises;

Grading system:

Pre-exam obligations	Points	Exam	Points
Class Participation		Practical exam	
Practical classes	10	Written exam	50
Tests (colloquia)	20	Oral exam	
Seminar work	20		

University of Belgrade Faculty of Pharmacy	Integrated academic studies of PHARMACY	

Study programme: Pharmacy

Course title: Human Health Risk Assessment

Teachers: Antonijević M. Biljana, Matović J. Vesna, Vujanović L. Dragana, Bulat L. Zorica, Đukić-Ćosić D. Danijela

Course status: elective

Semester: VIII	**Year of studies: IV**
ECTS points: 4	**Course code: F4I8**

Requirements: none

Course aims:

Gaining, application, and analysis of the knowledge and skills in the area of hazard identification, assessment of the dose-response relationship, exposure assessment, risk characterization, risk evaluation methodology and risk mitigation measures.

Course outcomes:

Student is qualified to work in the area of human health risk assessment, risk mitigation measures and the appropriate legislation, thus enabling pharmacist to represent one of the specialists actively included in the health prevention and public health system.

Course contents:

Lectures

Risk assessment – definition and importance. Problem formulation. Hazard identification. Assessment of the dose-response relationship. Exposure assessment. Risk characterization. Deterministic and probabilistic methods in the risk assessment. Application of biomarkers and toxicokinetic models in the risk assessment. Interpretation of the risk – variability and uncertainty. Reference values, health based guidance values. Cumulative and aggregative approach in the risk assessment. Case studies: human health risk assessment of certain toxic substances, drugs and cosmetic ingredients. Legislation. Criteria for classification and labeling of chemicals.

Practical classes

Occupational exposure and risk evaluation. Assessment of the general population exposure, as well as certain subpopulations (the assessment of school children exposure to fluorides, cumulative risk assessment of the organophosphorus insecticides and dioxins exposure using toxicity equivalency factor, etc.). Calculation of the total risk and risk interpretation upon exposure to various substances (POPs compounds, toxic metals, medicines). Physiologically based toxicokinetic model of dermal absorption. Application of @Risk software in toxicological risk assessment. Classification and labeling.

Recommended literature:

1. Paustenbach DJ. Human and Ecological Risk Assessment. Paustenbach DJ, editor. New York: Wiley, 2002.
2. Derelanko MJ, Hollinger MA. Handbook of toxicology. 2nd ed. Derelanko MJ, Hollinger MA, editors. Boca Raton: CRC Press; 2000.
3. Casarett & Doull's Toxicology: The Basic Science of Poisons. 7th ed. Klaassen CD, editor. New York: McGraw-Hill Professional; 2008.
4. Greim H, Snyder R. Toxicology and Risk Assessment: A comprehensive Introduction. Greim H, Snyder R., editors. Weinhiem: Wiley-Interscience; 2008.

The total of active learning classes

Lectures: 30	**Practical classes:** 15

Teaching methods: lectures, case studies, workshops

Grading system:

Exam prerequisites	Points	Final exam	Points
Active participation in lectures	10	Practical	
Practical classes	20	Written	50
Colloquia	20	Oral	
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Integrated academic studies of PHARMACY	

Study programme: Pharmacy

Course title: Ecotoxicology

Teachers: Matović J. Vesna, Vujanović L. Dragana, Đukić M. Mirjana, Antonijević M. Biljana, Bulat L. Zorica;Danijela Đukić-Ćosić

Course status: elective

Semester: VIII	**Year of studies: IV**
ECTS points: 4	**Course code: F4I4**

Requirements:

Course aims: Gaining knowledge and skills and their application in the field of ecotoxicology with the special emphasis on the most important pollutants and their global effect on people and environment.

Course outcomes:

Student will gain necessary competencies to be the part of multidisciplinary team dealing with the problems of the environmental pollution, as well as with human health, especially in terms of the prevention of environmental pollution.

Course contents:

Lectures

Basic concepts of ecotoxicology as a science. Pollution of the environment and the global changes. The fate of toxicants in the environment (mobility, biodegradability, bioaccumulation, biomagnification, persistency, transfer through the biosphere). Response of the unit, population, aggregation, and ecosystem to toxic substance(s) (molecular, physiological and behavioral level). Biomonitoring and bioindicators of the environmental pollution. The most significant pollutants of the atmosphere and their global effects: global warming, acid rains, ozone layer destruction. Pollutants of the hydrosphere (oil, polychlorinated biphenyls, polycyclic aromatic hydrocarbons, etc.) and their effects on the ecosystem. Ecotoxicological risk assessment. Influences from the environment and human health;

Health Risks: air, water, food, urban environment and living conditions, ionization radiation and electromagnetic fields ...

Practical classes

Case studies and analysis of the most important environment pollutants. Eco-toxicity tests. Environmental disasters. Risk assessment: examples and exercises; Introducing the site EEU, UNEP, WHO (Environmenal health), ENHIS database

Recommended literature:

1. Newman M.C.: Fundamentals of ecotoxicology: the science of pollution. Fourth edition. CRC Press, Teylor and Frances group. 2014.

2. Walker, C. H., Sibly, R. M., Hopkin, S. P., Peakall, D. B. (2012). Principles of Ecotoxicology. CRC Press, Boca Raton, USA.3. Hoffman DJ, Rattner BA, Burton GA, Cairns J. Handbook of ecotoxicology. 2nd ed. Boca Raton: Lewis Publishers, 2003.

4. Conell D, Lam P, Richardson B, Wu R. Introduction to Ecotoxicology. Oxford: Blackwell Science, 1999.

5. Paustenbach DJ. Human and Ecological Risk Assessment. Paustenbach DJ, editor. New York: Wiley, 2002.

The total of active learning classes

Lectures: 30	**Practical classes:** 15

Teaching methods: lectures, case studies, workshops

Grading system:

Exam prerequisites	Points	Final exam	Points
Active participation in lectures	10	Practical	
Practical classes	20	Written	30
Colloquia	20	Oral	20
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Integrated academic studies PHARMACY	

Study programme: Pharmacy

Course title: Pharmacy in sports

Teachers: Stojanović S. Biljana, Malenović M. Anđelija, Dopsaj, B. Violeta, Tomić A. Maja, Đorđević I. Brižita

Course status: elective

Semester: VIII	**Study year: IV**
ECTS: 4	**Course code: F4I9**

Course prerequisites: none

Course aims: Teaching students about the role and importance of pharmacists in monitoring medicine abuse in sports. They are: being part of the team, giving advices, educating, prevention of doping, working in control laboratories, creating diatary plans, supplying with the medicines, monitoring and analysis of the medicine impact on biochemical and chematological parameters.

Course outcomes: Students becoming qualified for the application of gained knowledge in the monitoring of medicine usage in sports. Knowledge about regulatory demands in the sports field. Prevention and control of doping. Being able to educate sportsmen about usadge and abuse of medicines in sports. Monitoring effects of rational usadge of dietary supplements – the source of nutriments. Application of knowledge about impact of medicines on biological and chematological parameters.

Course contents:

Lectures

Role and importance of a pharmacist in antidoping control. Demands of national and international regulatory bodies. Methods for detection of usage of doping substances. Pharmacologically active substances and methods banned for before and after the competition. Impact of medicines on biological and chematological parameters. Impact of phisical excercise on biological and chematological parameters. Biological sample analysis – collection, storage and sample preparation, qualitative, quantitative and screening tests, methods review. Pharmacollogical activity of substances used in doping. Rational consumation of dietary suplements.

Practical classes

HPLC method application in qualitative and quantitative analysis of banned substances in dietary suplements, and their experimental determination. HPLC methods in the analysis of banned substances in biological material – screening of the biological material and detection of groups of substances used in doping, with appropriate quantitative analysis. Key parameters of method validation for qualitative and quantitative analysis. Method selection, method possibilities and analysis of the obtained results. Examples of the analysis. Problem solving. Calculation of energetic needs with the coeffitient of physical activity.

Recommended literature:

1. World Anti–Doping Code. Kanada: World Anti–Doping Agency (WADA); 2009.

2. Paul D. A Guide to the World Anti–Doping Code. Cambrige: Cambrige University Press; 2008.

3. The World Anti–Doping Code, International Standard for Laboratories. Canada: World Anti–Doping Agency (WADA); 2009.

4. The World Anti–Doping Code. Identification Criteria for Qualitative Assays, Technical Document. Montreal: World Anti–Doping Agency (WADA); 2010.

5. Viru A, Viru M. Biochemical monitoring of sport training. Champaign, IL: Human Kinetics; 2001.

6. The Antidoping in Sports Act. Belgrade: Official Gazette RS, number 101/2005; 2005.

The total of active learning classes

Lectures: 30	**Practical classes: 15**

Teaching methods:

Lectures, practical laboratory work, interactive studying and internet.

Grading system:			
Pre-exam obligations	**Points**	**Exam**	**Points**
Class Participation	**5**	Practical exam	
Practical classes	**25**	Written exam	**60**
Tests (colloquia)	**10**	Oral exam	
Seminar work			

University of Belgrade Faculty of Pharmacy	Integrated academic studies PHARMACY	

Degree program: Pharmacy

Subject: Clinical pharmacy

Lecturers: Miljković R. Branislava, Vezmar Kovačević D. Sandra, Vučićević M. Katarina

Subject status: Mandatory

Semester: IX	**Year of study: V**
Size: 6 ECTS	**Subject code: F5O1**

Prerequisites: Pharmacotherapy, Pharmacokinetics

Aim:

To acquire a knowledge about the importance of Clinical pharmacy in primary, secondary and tertiary healthcare level; To become familiar with the Pharmaceutical care concept and ways to improve the therapeutic outcomes through interactions, side effects and adherence monitoring; To understand the role of pharmacoeconomics in the evaluation of rational drug therapy.

Outcomes:

After completion of the course the student should acquire: knowledge about the concept of evidence based pharmacy/medicine; pharmacoeconomic principles in decision making; the concept of identifying, solving and preventing drug related problems, patient monitoring and counselling on medication related information, therapy evaluation to improve patient outcomes.

Course content:

Lectures

Introduction to Clinical pharmacy. Role of a pharmacist in improving patient outcomes. Clinical trials and evidence based pharmacy/medicine. Sources for drug information; critical appraisal of published research. Farmacoeconomic evaluation of rational pharmacotherapy. Pharmaceutical care concept in primary, secondary and tertiary healthcare level. Identification of drug therapy problems, development of the therapeutic plan and patient outcomes monitoring. Interpretation of the clinical laboratory investigations. Communication skills; developing a relationship between the pharmacist and the patient based upon trust. Drug interactions. Compliance, adherence and concordance. The importance of patient counselling in enhancing medication adherence. Patient safety evaluation and drug therapy. The importance of monitoring the adverse effects of medications - Pharmacovigilance.

Practical classes

Finding reliable sources of drug information. Critical appraisal of drug information. Critical appraisal of pharmacoeconomic studies. Identifying a drug therapy problem in case-studies. Development of the therapeutic plans. Monitoring of patient outcomes. Patient counselling. Evaluation of adverse effects and drug interactions, adherence monitoring. Design and implement pharmaceutical care plan to complex patient in primary, secondary and tertiary healthcare level (case studies). Improving pharmaceutical care through new modalities and optimising patient care in all levels of healthcare system.

Recommended literature:

1. Rovers JP, Currie JD. A Practical Guide to Pharmaceutical Care: A Clinical Skills Primer. 3rd ed. Washington: American Pharmaceutical Association; 2007.
2. Cipolle RJ, Strand L, Morley P. Pharmaceutical Care Practice: The Clinician's Guide. 2nd ed. New York: McGraw-Hill Medical; 2004.
3. Rickles NM, Wertheimer AI, Smith MC. Social and Behavioural Aspects of Pharmaceutical Care. 2nd ed. Boston: Jones & Bartlett Learning; 2009.
4. Sexton J, Nickless G, Green C. Pharmaceutical Care Made Easy: Essentials of Medicines Management in the Individual Patient. 1st ed. London: Pharmaceutical Press; 2006.
5. Walker R, Whittlesea C. Clinical Pharmacy and Therapeutics. 5th ed. London: Churchill Livingstone; 2012.

Number of teaching hours

Lectures: 45	Practical classes: 60

Teaching methods:

One semester long: interactive lectures, workshops, case study analysis, problem based learning, patient-centred learning.

Grading system:

Pre-exam obligations	**Points**	**Exam**	**Points**
Active involvement during the lesson		Practical exam	

Practical classes	5	Written exam	70
Tests	25	Oral exam	Student may have to continue with an oral exam, if the professor determines that the written exam is not enough for the assessment.
Seminars			
Other			

University of Belgrade Faculty of Pharmacy	Integrated academic studies PHARMACY	

Study programme: Pharmacy

Course title: Industrial Pharmacy

Teachers: Đurić R. Zorica, Parojčić V. Jelena, Ibrić R. Svetlana, Đuriš D. Jelena

Course status: mandatory

Semester: IX	**Study year: V**
ECTS: 5	**Course code: F5O2**

Course prerequisites: Pharmaceutical Technology 2 and Pharmaceutical Technology 3

Course aims:

Introduction to, and understanding of principles and specific aspects of industrial scale manufacture of pharmaceuticals with respect to: formulation development, product stability, regulatory requirements related to development, manufacture and storage of drug products; requirements of Good Manufacturing Practice; assurance of the appropriate conditions for manufacturing of pharmaceutical products; characteristics and selection of equipment for drug manufacture; Pharmaceutical quality systems and quality assurance.

Course outcomes:

Knowledge and understanding of the principles of research and development in pharmaceutical industry; regulatory requirements for pharmaceuticals development, manufacturing, storage, marketing authorization, and requirements related to pharmaceutical quality system in drug manufacture; knowledge of principles of operation and types of equipment used in drug manufacturing; thereby, students qualify for various job positions in pharmaceutical industry, in the fields of research and development, manufacturing and quality assurance.

Course contents:

Lectures

Regulations regarding development, manufacturing and storage of drug products in the European Union and Republic of Serbia. International and national guidances and regulations related to quality assurance and accomplishment of requirements for all aspects from drug development to marketing of the product. Importance of standardization and standards used in the pharmaceutical industry. Good practices in pharmaceutical industry. Requirements of Good manufacturing practice for medicinal products for human and veterinary use. Pharmaceutical quality system. Risk management in pharmaceutical industry – significance and applications. Pharmaceutical preformulation and formulation. Application of Quality by Design principles in pharmaceutical development. Stability of drug products. Influence of the formulation factors and manufacturing methods process parameters on drug product stability. Methods for drug products stabilization. Marketing authorization application. Requirements, documentation and procedures for approval of variations or additions to the marketing authorization. Chemical-pharmaceutical-biological documentation. Variations. Unit operations in pharmaceutical industry. Characteristics of equipment used in drug manufacturing. New concepts in pharmaceutical industry: continuous production, process analytical technology.

Practical classes

Pharmaceutical development. Principles of drug products stabilization and shelf-life estimation (calculations). Requirements of Good manufacturing practice. Unit operations: principles of operation and application of laboratory scale equipment; principles of operation and application of industrial scale equipment.

Recommended literature:

1. Jovanović M, Đurić Z. Osnovi industrijske farmacije. Zemun: Nijansa; 2005.
2. Gibson M, Ed. Pharmaceutical Preformulation and Formulation, 2nd Ed. New York: Informa Healthcare; 2009.
3. Guidelines for good manufacturing practices for medicinal products for human and veterinary use.
Volume 4. (http://www.ec.europa.eu).
4. Parojčić J, Ibrić S, Đuriš J, Aleksić I, Čalija B. Odabrane farmaceutsko-tehnološke operacije. (multimedia publication). Beograd: Univerzitet u Beogradu, Farmaceutski fakultet; 2013.
5. Huynh-Ba K, Ed. Handbook of Stability Testing in Pharmaceutical Development: Regulations, Methodologies, and Best

Practices. New York: Springer; 2009.

The total of active learning classes

Lectures: 45	**Practical classes:** 45

Teaching methods:

lectures, interactive lectures, practical and demonstrative classes, educational videos, usage of multimedia publication, case studies, seminars, workshops

Grading system:

Pre-exam obligations	Points	Exam	Points
Class Participation	0-3	Practical exam	
Practical classes	0-7	Written exam	31-60
Tests (colloquia)	0-15	Oral exam	
Seminar work	0-15		

University of Belgrade Faculty of Pharmacy	Integrated academic studies PHARMACY	

Study programme: Pharmacy

Course title: Drug analysis

Teachers: Zečević L. Mira, Malenović M. Anđelija, Stojanović S. Biljana, Otašević M. Biljana, Protić D. Ana

Course status: Mandatory

Semester: IX	**Study year: V**
ECTS: 6	**Course code: F5O3**

Course prerequisites: Pharmaceutical chemistry

Course aims:

Acquiring knowledge and skills related to pharmacopoeial drug quality testing and methods used in these procedures. Training students for the selection of appropriate methods for drug control. Making students familiar with basic principles of the development of new methods for the control of drugs, as well as the validation process. Acquisition of expert knowledge on the structure of certificates of analysis and basic regulatory requirements to drug control.

Course outcomes:

After this course, students are expected to apply the knowledge in routine control of pharmaceutical substances and pharmaceutical dosage forms. Select the appropriate method for the control of drugs, demonstrate and explain the importance of the development and validation of new methods and to interpret and apply current regulatory requirements to drug control.

Course contents:

Lessons

Pharmacopoeial tests for pharmaceutical substances control: identification of pharmaceutical substances, testing purity of pharmaceutical substances, related substances, as well as other tests provided in the monographs. Preparation of pharmaceutical substances and pharmaceutical dosage forms samples for qualitative and quantitative analysis. Application extraction in sample preparation - the most common type of extraction applied in drug analysis. Application titrimetric methods in drug analysis. The application of UV / VIS spectrophotometry and infrared (IR) spectroscopy in drug analysis. Application of chromatographic methods (partition, affinity, gel, etc) in drug analysis. The analysis of available stationary and mobile phase modifications in the analysis of drugs. Development of chromatographic methods. Derivatization and HPLC analysis of the chiral drugs. The analysis of selected organic, inorganic and biological drugs. The active pharmaceutical ingredient certificate of analysis. Pharmaceutical dosage forms certificate of analysis - general and specific according to current pharmacopoeia. Validation parameters, method validation documentation and regulatory requirements. Pharmaceutical - chemical - biological documetation.

Practical classes

Validation of spectrophotometric methods. Evaluation and presentation of results. Application of pharmacopoeial HPLC method, as well as internally validated methods for the analysis of related substances in active pharmaceutical substances and pharmaceutical dosage forms. Purity testing by thin layer chromatography. Semiquantitative determination of water content. Solid-phase extraction for sample preparation of pharmaceutical dosage forms.

Recommended literature:

1. European Pharmacopoeia seventh Edition, Strasbourg: Council of Europe, 2011.

2. Watson D. Pharmaceutical analysis: A Textbook for Pharmacy students and Pharmaceutical Chemists. London: Churchill Livingstone; 1999.

3. Lee DC, Webb ML, editors. Pharmaceutical Analysis. Boca Raton: Blackwell, CRC Press; 2003.

4. Roth HJ, Eger K, Troschutz R. Pharmaceutical chemistry, Volume 2: Drug Analysis, English Edition. Chichester: Ellis Horwood; 1991.

5. Kazakevich Y, Lobrutto R, editors. HPLC for pharmaceutical scientist. New York: John Wiley & Sons, Inc.; 2007.

6. Маленовић А, Стојановић Б. Фармацеутска анализа, практикум. Београд: Фармацеутски факултет, Универзитет у Београду; 2010.

The total of active learning classes 120			
Lectures: 60		**Practical classes:** 60	
Teaching methods: lessons, practical classes, interactive teaching.			
Grading system:			
Pre-exam obligations	**Points**	**Exam**	**Points**
Class Participation	0-5	Practical exam	
Practical classes	15	Written exam	70
Tests (colloquia)	10	Oral exam	
Seminar work	/		

University of Belgrade Faculty of Pharmacy	Integrated academic studies PHARMACY	

Study programme: Pharmacy

Course title:Cosmetology

Teachers: Vuleta M. Gordana, Savić D. Snežana, Vasiljević D. Dragana

Course status: mandatory

Semester: IX	**Study year: V**
ECTS: 4	**Course code: F5O4**

Course prerequisites: Pharmaceutical technology 1

Course aims:

Introducing with legislative and regulations on cosmetic products and dermocosmetic preparations, the most important ingredients (raw materials) for preparation of cosmetic and dermocosmetic products, carriers for cosmetic active substances (CAS), with types, forms, preparation/manufacturing procedures, as well as with cosmetic/dermocosmetic products effects on skin and its adnexa; giving the adequate advices and recommendations on way of application and possible non-side effects of cosmetic and dermocosmetic products.

Course outcomes: Knowledge on low regulations connected to cosmetic products and dermocosmetic preparations; knowledge on types, preparation/manufacturing procedures and quality control, as well as testing of cosmetic and dermocosmetic products efficacy; critical perceiving of marketing information on cosmetic products effects and developing of ability for advicing on cosmetic products choice and their application; knowledge on potentially non-side effects of different cosmetic products.

Course contents:

Lectures

The subject definition, relation of cosmetology with pharmacy and medicine, low regulations on cosmetic products and dermocosmetic preparations in European countries and Republic of Serbia; requirements for quality of cosmetic ingredients for formulation/preparation of cosmetic and dermocosmetic products; novel carriers for CAS in cosmetic/dermocosmetic products, cosmetic products for skin cleansing, care and protection; anti-dandruff shampoos,; anti-age dermocosmetic preparations, dry skin care products, anti-acne cosmetic products, sunscreens/ cosmetic products for sun protection, cosmetic products for babies and kids; deodorants and antiperspirants; properties and requirements for quality of organic and natural cosmetic products; preparation/manufacturing procedures and quality control of cosmetic and dermocosmetic products, evaluation of their effects and safety.

Practical classes

Formulation, preparation and investigation of certain cosmetic products for skin/skin adnexa cleansing, care and protection; formulation and preparation of deodorants and antiperspirants and selected dermocosmetic preparations; discussion of the composition of some comercial cosmetic products, critical perceiving of marketing information on cosmetic products effects and developing of student ability for advicing the patient/consumer for use of an appropriate cosmetic/dermocosmetic product.

Recommended literature:

1. Vasiljević D, Savić S, Đorđević Lj, Krajišnik D. Priručnik iz kozmetologije. Beograd: Nauka; 2009.
2. Schlossman ML. Chemistry and Manufacture of Cosmetics: Cosmetic Specialties and Ingredients. Illinois: Allured Publishing; 2010.
3. Rieger MM. Harry`s Cosmetology. 8th ed. New York; Chemical Publishing; 2000.
4. Kemper FH, Luepke N-P, Umbach W. Blue List: Cosmetic Ingredients. Aulendorf: ECV-Editio-Cantor-Verlag; 2000.
5. Regulation (EC) No 1223/2009 of the European Parliament and of the Council of 30 November 2009 on cosmetic products. Official Journal of the European Union 2009; L342/59-L342/209..

The total of active learning classes

Lectures: 30	**Practical classes: 30**

Teaching methods: Lectures and interactive teaching/workshops, practical classes, seminar works preparation, problem-based

learning.			
Grading system:			
Pre-exam obligations	**Points**	**Exam**	**Points**
Class Participation	0 or 3	Practical exam	/
Practical classes	3-5	Written exam	50
Tests (colloquia)	12-22	Oral exam	/
Seminar work	10-20		

University of Belgrade Faculty of Pharmacy	Integrated academic studies of PHARMACY	

Study programme: Pharmacy

Course title: Basics of Pharmaceutical Management

Teachers: Tasić M. Ljiljana, Marinković D. Valentina, Krajnović M. Dušanka, Lakić M. Dragana

Course status: Mandatory

Semester: IX	**Year of studies: V**
ECTS points: 2	**Course code:**

Requirements: none

Course aims:

Introduction of students to the general and basic principles of contemporary business/management, and the need for development of the proper work organization; mastering of healthcare system management and the organization of the whole pharmaceutical sector; management of skills required for pharmaceutical business and provision of pharmaceutical services.

Course outcomes:

Understanding of specifics of the pharmaceutical businesses in relation to the healthcare system and the economy; their interrelationships and significance to the society, pharmacies/medicines manufacturers and patients/individuals; has mastered the basic skills of organization/management of pharmaceutical work processes by knowing the basic working standards; knows and understands the concepts of supply chain and the lifecycle of medicines.

Course contents:

Lectures

Introduction to pharmaceutical management. Basic theories on organization principles; quality system management; organizational changes; organizational models. Healthcare system management; healthcare policy. National drug policy; logistics and supply of the public healthcare system. Pharmaceutical market and businesses of originator, innovative and generic medicines; medicines on the free market and the social concept of medicines. Principles of pharmaceutical marketing. Standards in pharmaceutical businesses; performances and quality. Supply chain (vendor – supplier – healthcare institution). Management of resources in the pharmacy; processes of pharmaceutical care (process maps/algorithms). Management of projects in the pharmaceutical practice; information and communications technologies in pharmacy; assessment of competition in the pharmaceutical businesses.

Practical classes

Panel discussion on topics of processes and management functions – case studies from the industry and pharmacies. Panel discussion and analysis of examples of the national drug policy and procedures of the open procurement of medicines. Analysis of the healthcare organizations from the point of view of legislation, finances, human resources and needs of patients/public. Workshop – examples of strategies of development of businesses according to the selected therapeutic groups of medicines and markets. Homework – analysis and scoring of the good pharmaceutical practices; proposition of concepts for improvement of the pharmaceutical care and industry. Process maps creation.

Recommended literature:

1. Winfield AJ. Pharmaceutical Practice. 3th ed. Churchill Livingstone; 2004.
2. Tasić LJ. Farmaceutski menadžment i marketing. 2. izdanje. Beograd: Placebo; 2007.
3. Smith F. Research Methods in Pharmacy Practice. London: Pharmaceutical Press; 2005.
4. Kayne SB. Pharmacy business management. New York: Pharmaceutical Products Press; 2005.
5. Remington: Science and Practice of Pharmacy. 23st ed. Philadelphia: Lippincott Williams and Wilkins; 2012.

The total of active learning classes

Lectures: 15	**Practical classes:** 15

Teaching methods: interactive lectures, panel discussions, workshop, homework

Grading system:

Exam prerequisites	Points	Final exam	Points
Active participation in lectures	5	Practical	
Practical classes	25	Written	50
Colloquia	20	Oral	

Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Integrated academic studies of PHARMACY	

Study programme: Pharmacy

Course title: Pharmaceutical Marketing

Teachers: Tasić M. Ljiljana, Marinković D. Valentina

Course status: elective

Semester: IX	**Year of studies: V**
ECTS points: 3	**Course code: F5I1**

Requirements: none

Course aims:

Widening the knowledge in the field of pharmaceutical marketing; familiarization with the contemporary methods of marketing strategies; awareness of the communication processes taking place in the marketing activities; promotion of the integration of pharmaceutical sciences and management skills.

Course outcomes:

Student will understand the pharmaceutical market and the importance of the appropriate selection of business methods oriented towards the social values; master the analytical methods for the assessment of market conditions (SWOT and portfolio analyses); understand the concept of added value in the strategic pharmaceutical marketing.

Course contents:

Lectures

General concepts in marketing. Strategic marketing, management and development of medicines. General principles of pharmaceutical marketing; marketing mix, models, methods and marketing techniques. Marketing and its purpose. Market segmentation. Strategy and tactics. Analysis of the client needs (medicines prescriber, financier, end users – patients). Marketing research methods. Post approval monitoring of medicines. Marketing of the public health (the social marketing). Legislation and ethics in advertising and marketing of the pharmaceutical products and services. Integrated marketing communications. The value chain and cost effectiveness of medicines.

Practical classes

Investigation, analysis and discussion on the practical examples of the topics presented in lectures. Workshops with case studies on marketing strategies and methods in selected groups of medicines for selected markets. Market research with various methods: strength, weaknesses, opportunities and threats (SWOT), Boston Consulting Group (BSG) matrix. Analysis of the position of selected products and services and comparison to the competitor products/services (benchmarking). Analysis of outer and inner influential factors (situational analysis). Preparation and presentation of the seminar.

Recommended literature:

1. Kotler F. Marketing menadžment. Beograd: Data status; 2006.
2. Tasić LJ. Farmaceutski menadžment i marketing. Beograd: Placebo; 2007.
3. Spilker B. Multinational Pharmaceutical Companies: principles and practices. 2nd ed. Boston: Ravens press; 1994.
4. Dogramatzis D. Pharmaceutical Marketing a Practical Guide. Denver: Interpharm Press; 2002.
5. Dimitris D. Pharmaceutical Marketing a Practical Guide. Denver: Interpharm Press; 2001.

The total of active learning classes

Lectures: 30	**Practical classes:** 15

Teaching methods: interactive lectures, panel discussions, workshops, homework

Grading system:

Exam prerequisites	Points	Final exam	Points
Active participation in lectures	10	Practical	
Excersices	40	Written	
Colloquia		Oral	50
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Integrated academic studies of PHARMACY	

Study programme: Pharmacy

Course title: Medicines Supply Management

Teachers: Marinkovic D. Valentina, Lakić M. Dragana

Course status: elective

Semester: IX	**Year of studies: V**
ECTS points: 3	**Course code: F5I1**

Requirements: none

Course aims:

Introduction of students to: legal regulations and processes related to the selection, procurement (public procurement), distribution and usage of medicines. Student is also familiarized with the basic principles in selection of medicines, methods of public procurement; and good practices in medicines procurement, storage, distribution and transport, as well as with procedures in assurance of traceability of medicines and medical devices, and principles in usage/consumption of medicines.

Course outcomes:

Student is able to understand the principles and definitions related to the good medicines supply. The acquired knowledge enables: understanding of activities in selection, procurement, and usage/consumption of medicines, as well as the working principles related to the sources of supplies, procurement, storage and medicines distribution; gaining skills in analysis, organization and working in the field of medicines and medical devices supply management.

Course contents:

Lectures

Principles and regulations related to the field of wholesales of medicines; principles and regulations related to the public procurements in the healthcare; medicines supply cycle; selection of medicines (guides and formularies, medicines, medical devices and equipment); principles of medicines and medical devices procurement and methods of public procurement (quantification of medicines and medical devices; basic qualitative and quantitative analyses, management of the tender process, tender documentation, medicines donations); assurance of the quality of medicines public procurements; assurance of the quality in the wholesales of medicines; distribution (management of the distribution, transport, storage); organization of the storage and distribution; transport and the cold chain principles; analysis of the medicines usage – aspects of the wholesalers and healthcare institutions.

Practical classes

Examples and analyses of the procedure of qualification and quantification of medicines and medical devices for the public procurements; examples of the work organization and assurance of the quality in companies dealing with the medicines supply; examples of procedures related to the complaints and product recalls from the market. Seminar.

Recommended literature:

1. World Health Organization. Managing Drug Supply. 2nd ed. Connecticut: Kumarian Press; 1997.
2. World Health Organization. Quality assurance of pharmaceuticals, vol. 1 and 2. Connecticut: Kumarian Press; 1999.
3. Zakoni, propisi i tehnička uputstva od značaja za upravljanje snabdevanjem lekovima i medicinskih sredstava.
4. Lilja J, Salek S, Alvarez A, Hamilto D. Pharmaceutical system. Chichester: John Wiley & Sons. 2008.

The total of active learning classes

Lectures: 30	**Practical classes:** 15

Teaching methods: lectures, seminars, visits to medicines wholesalers, problem based learning

Grading system:

Exam prerequisites	Points	Final exam	Points
Active participation in lectures	5	Practical	
Practical classes	25	Written	50
Colloquia		Oral	
Seminars	20		
Other activities			

University of Belgrade Faculty of Pharmacy	Integrated academic studies of PHARMACY	

Study programme: Pharmacy

Course title: Pharmacoepidemiology and Pharmacoeconomics

Teachers: Tasić M. Ljiljana, Lakić M. Dragana

Course status: elective

Semester: IX	**Year of studies: V**
ECTS points: 3	**Course code:**

Requirements: none

Course aims:

Introduction to the basic principles in the fields of pharmacoepidemiology and pharmacoeconomy. Training for the critical assessment of information in the fields of pharmacoepidemiology and pharmacoeconomy. Introduction to research methods in these fields. In order to accomplish this, student is familiarized with the different types of pharmacoepidemiologic and pharmacoeconomic methods.

Course outcomes:

Upon completion of this course, student will be able to critically evaluate pharmacoepidemiologic pharmacoeconomic and problems, to use databases related to the usage of medicines, to apply the basic methods in pharmacoepidemiology, to recognize methods of pharmacoeconomic analyses, to critically evaluate expenses and outcomes of usage of medicines and medical devices.

Course contents:

Lectures

The importance of pharmacoepidemiology and pharmacoeconomy. Rational usage of medicines. Basic principles of pharmacoepidemiologic methods of collection, processing and analysis of data related to the usage of medicines and medical devices. Methods of detection of adverse and useful effects of medicines, including spontaneous reporting, *ad hoc* epidemiological studies and by using the databases. Study designs. Cross section studies, observational studies (cohort studies and case-control studies) and clinical studies. Medicines usage studies. Favoritism. Healthcare economy and the quality of life related to the health. Healthcare technologies and assessment of suitability. Health, social and economic aspects and outcomes of medicines usage. Basic principles in pharmacoeconomic methods of collection, processing and analysis of data. CMA, CEA, CBU and CUA studies.

Practical classes

Usage of pharmacoeconomic and pharmacoepidemiologic databases. Analysis of pharmacoepidemiologic studies. Analysis of pharmacoeconomic studies. Assessment and selection of the pharmacoeconomic method for the selected therapeutical procedures – case studies. Calculation of expenses for the prevention, diagnostics and treatment. Application of the quality of life measurements – case studies.

Recommended literature:

1. Strom BL. Pharmacoepidemiology. 4th ed. Chichester: John Wiley & Sons; 2005.
2. Hartzema AG , Porta M, Tilson HH, editors. Pharmacoepidemiology. An Introduction. 3th ed. Cincinnati: Harvey Whitney Books Company; 1998.
3. Drummond M, OBrien B, Stoddart G, Torance G. Methods for the Economic Evaluation of Health Care Programmes. 2nd ed. Oxford: Oxford University Press; 1997.
4. Novaković T. Priručnik za farmakoekonomske evaluacije. Beograd: EAR; 2006.
5. Bootman J, Townsend R, McGhan W. Principles of Pharmacoeconomics. 3rd ed. Cincinnati: Harvey Whitney Books Company; 2005.

The total of active learning classes

Lectures: 30	**Practical classes:** 15

Teaching methods: lectures, seminars, workshops, calculations, case studies (homework), discussion

Grading system:

Exam prerequisites	Points	Final exam	Points
Active participation in lectures	5	Practical	
Practical classes	30	Written	30
Colloquia		Oral	20
Seminars	15		

Other activities			

University of Belgrade Faculty of Pharmacy	Integrated academic studies of PHARMACY	

Study programme: Pharmacy

Course title: Pharmaceutical Practice

Teachers: Tasić M. Ljiljana, Krajnović M. Dušanka, Marinković D. Valentina, Lakić M. Dragana, Tadić B. Ivana

Course status: Mandatory

Semester: X	**Year of studies: V**
ECTS points: 3	**Course code: F5O6**

Requirements: Pharmacotherapy

Course aims:

Gaining of the knowledge, basic concepts and the skills of pharmaceutical practice at all levels of the healthcare system. Introduction to the essential and the current medicines list; classification of medicines and medical devices; sources of information on medicines and medical devices. Mastering of all aspects of medicines usage; processes of medicines dispensing (prescription and over-the-counter); administrative processes; concepts of medicines safety and medicines usage.

Course outcomes:

Student is familiar with the pharmaceutical healthcare system; knows the classification of medicines, medical devices and pharmaceutical services. Student correctly searches for information on medicines; analyzes information; properly handles prescriptions and orders; performs basic calculations; is familiar with the basic logistic processes of the pharmacy; understanding and accepting the concepts of: clinical practice, management of the safety and risks related to medicines, as well as the health promotion.

Course contents:

Lectures

Pharmaceutical sector and the healthcare system; concept of the essential, national, hospital list of medicines. Pharmaceutical practice in the public and hospital pharmacies in the healthcare system (management of activities: planning, procurement, storage, dispensing, and distribution of medicines). Medicines – classification, groups, dosage forms. Medical devices and healthy products. Proscription – the structure and dispensing of the finished medicines and medical devices. Resources od information: types of information, sources, levels, information management. The role of the public pharmacy in the promotion of health and prevention of illnesses. Patient counseling. Clinical practice – basic concepts of improvement of therapy and outcomes in both public and hospital pharmacies.

Practical classes

Analysis of the healthcare and pharmaceutical legislative related to the pharmaceutical practice. Independent work and solving of the presented case study from the pharmaceutical practice. Critical analysis of case studies – selected working activities in the public and hospital pharmacy; simulation of working procedures with prescription or order, calculations; simulation of patient counseling; working with the pharmaceutical sources of information; classification of information and preparation of report. Monitoring of the safe usage of medicines. Workshop on the selected topic from the pharmaceutical practice. Dispensing of over the counter medicines. The role of pharmacist in self-medication. The role of pharmacists in the promotion of health and prevention of illnesses

Recommended literature:

1. Winfield AJ, Richards RME, eds. Pharmaceutical practice. 4rd ed. Philadelphia: Churchill Livingstone; 2009.
2. Taylor K, Harding G. Pharmacy Practice. New York: Taylor & Francis London; 2001.
3. Nerecenzirana skripta za predmet Farmaceutska praksa, 2012.
4. Remington: Science and Practice of Pharmacy. 21st ed. Philadelphia:Lippincott Williams and Wilkins; 2005.
5. Tasić LJ, Krajnović D, Petrić M, Lakić D, Tadić I. Farmaceutska praksa. Praktikum. Beograd: Univerzitet u Beogradu - Farmaceutski fakultet; 2009.

The total of active learning classes

Lectures: 30	**Practical classes:** 30

Teaching methods: interactive lectures, panel discussions, workshop, homework

Grading system:

Exam prerequisites	Points	Final exam	Points
Active participation in lectures	0 or 2	Practical	0 or 3

Practical classes	15	Written	60
Colloquia	20	Oral	
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Integrated academic studies PHARMACY	

Study programme: Pharmacy

Course title: Introduction to pharmaceutical biotechnology

Teachers: Savić D. Snežana, Milić R. Jela, Živković P. Lada, Savić M. Miroslav, Stojić-Vukanić M. Zorica, Antić-Stanković A. Jelena, Stojanović S. Biljana

Course status: elective

Semester: X	**Study year: V**
ECTS: 4	**Course code: F5I4**

Course prerequisites: Biology with human genetic, Microbiology, Immunology, Pharmaceutical chemistry 1, Pharmaceutical chemistry 2, Pharmaceutical chemistry 3, Pharmaceutical technology 1, Pharmaceutical technology 2

Course aims:

Introducing with possibilities of recombinant DNA technology and hybridoma DNA technology in biomedicine, particularly in the context of biological drugs/biopharmaceutics development; informing on formulation, production and therapeutical application of peptide and protein drugs/ monoclonal antibodies; enabling for critical perceiving on biologics, using and ability of patient or other health professional informing on biologics.

Course outcomes: Knowledge of basic development of biopharmaceutics/biologics, and production of recombinant peptids/proteins/monoclonal antibodies for therapeitical application; possessing the information on the most significant biologics which are approved or in the phase of clinical approval; enabled for critical perceiving, perceiving on biologics, using and ability of patient or other health professional informing on biologics.

Course contents:

Lectures

Molecular biotechnology – recombinant DNA technology (DNA transfer, DNA sources, synthetic DNA, cDNA, DNA sequencing, DNA hybridization). Cell cultures. Expression systems. Review of techniques for production and purification of proteins. Monoclonal antibodies – types and techniques of production. Protein characterization techniques. Protein stability. Excipients in formulation of biologics/biopharmaceutics for parenteral and other administration routes. Formulation and biopharmaceutical aspects of biologics. Manufacturing of biologics with particular accent on the lyophilisation procedure. Procedures for improvement of biologics stability and pharmacokinetic profiles and reduction of their immunogenic potential – mutagenesis on primary sequence, PEGylation techniques, encapsulation/adsorption in/on special carriers: biodegradable microspheres, colloidal/nanoparticulate drug delivery systems for protein/monoclonal antibodies delivery and mechanisms of targeted delivery of protein drugs. Some examples of therapeutic biologics/biopharmaceutics: insulines, erythropoietins, coagulation factors, colony stimulating factors, monoclonal antibodies. Shelf life of protein drugs, biopharmaceutics storage. Regulation for approval of biopharmaceutics/biologics and biosimilars. Prescription and application of biopharmaceutics/biologics.

Practical classes

Work on some topics throughout the interactive disscussion and preparation/presentation of seminar work.

Recommended literature:

1. Kayser O, Warzecha H. Pharmaceutical Biotechnology: Drug Discovery and Clinical Applications. 2nd ed. Weinheim: Wiley-VCH Verlag GmbH&Co. KGaA; 2012.

2. Groves MJ. Pharmaceutical Biotechnology. 2nd ed. Boca Raton: CRC Press Taylor&Francis Group; 2006.

3. Allen L, Ansel H. Ansel's Pharmaceutical Dosage Forms and Drug Delivery Systems. 10th ed., New York, Lippincott Williams and Wilkins; 2014.

4. Aulton M. The Design and Manufacture of Medicines. 4th ed., Edinburgh, Churchill Livingstone; 2013.

5. Selected papers from scientific journals: Journal of Biotechnology, Nature Biotechnology, Trends in Biotechnology, Current Pharmaceutical Biotechnology, Journal of Industrial Microbiology and Biotechnology, Journal of Biomedicine and Biotechnology.

The total of active learning classes			
Lectures: 30		**Practical classes: 15**	
Teaching methods: Lectures and seminars.			
Grading system:			
Pre-exam obligations	**Points**	**Exam**	**Points**
Class Participation	0-5	Practical exam	/
Practical classes	5-10	Written exam	35-70
Tests (colloquia)	0	Oral exam	/
Seminar work	10-15		

University of Belgrade Faculty of Pharmacy	Integrated academic studies of PHARMACY	

Study program: Pharmacy

Course title: Acute Drug Poisoning

Teachers: Matović J. Vesna, Vujanović L. Dragana, Đukić M. Mirjana, Antonijević M. Biljana, Bulat L. Zorica

Course status: elective

Semester: X	**Year of studies: V**
ECTS points: 4	**Course code:**

Prerequisite for attending course: none

Course aims:

The course provides approach to mechanisms of toxicity, toxic doses, clinical presentation, and treatment of poisoning with specific drugs, as well as on detection and determination of these drugs and their metabolites in biological material.

Course outcomes:

Qualification of masters of pharmacy to detect and determine drugs in biological material relevant to toxicological analysis and to have an important role in the prevention of drug poisonings.

Course contents:

Lectures:

Epidemiological aspects of drug poisoning. General principles of drug poisoning treatment. Mono and polymedicament poisoning. Toxicity of important groups of drugs: benzodiazepines, nonopioid analgesics (nonsteroidal anti-inflammatory drugs and paracetamol), antibiotics (the penicillins, cephalosporins, aminoglycoside antibiotics, tetracyclines, chloramphenicol…), drugs affecting CNS (barbiturates, benzodiazepines, antidepressants, antipsychotics, antiepileptics), drugs affecting CVS (beta blockers, Ca-channel blockers, cardiotonic glycosides), oral antidiabetics, antihistaminics, antineoplastics (alkilating agents, antimetabolites, cytotoxic antibiotics, plant derivatives).

Practical training:

Case study of poisonings caused by most important representatives of groups of therapeutic drugs. Case study analysis with special attention given to analytical procedures.

Recommended literature:

1. Olson KR. Poisoning & Drug Overdose. 4th ed. Olson RK, editor. New York: McGraw-Hill Medical; 2004.
2. Barile FA. Clinical Toxicology-Principles and Mechanisms. London: Informa Healthcare; 2007.
3. Moffat AC, Osselton MD, Widop B. Clark□s analysis of drugs and poisons in pharmaceutical, body fluids and post-mortem materials. 3rd ed. London: Pharmaceutical Press; 2004.

The total of active learning classes

Lectures: 30	**Practical training:** 15

Teaching methods: lectures, case study analysis

Grading system:

Exam prerequisites	Points	Final exam	Points
Active participation in lectures	10	Practical	
Practical training	20	Written	50
Colloquia	20	Oral	
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Integrated academic studies PHARMACY	

Study programme: Pharmacy

Course title: Regulatory affairs in drug quality control

Teachers: Zečević L. Mira, Malenović M. Anđelija, Stojanović S. Biljana, Otašević M. Biljana, Protić D. Ana

Course status: Elective

Semester: X	**Study year: V**
ECTS: 4	**Course code: F5I6**

Course prerequisites: -

Course aims:

Acquiring knowledge in the field of drug control and quality assurance of drugs. Introduction to the basic legislation for drug control.

Course outcomes:

After passing the exam, the student should possess the knowledge which can be successfully applied in laboratories for investigation and control of drugs, in the drafting and preparation of documents for the registration of drugs as well as in regulatory bodies that implement an integrated registration procedure and issue marketing approval for drug products.

Course contents:

Theoretical lessons

Students learn about the importance of constant monitoring and quality assurance of drugs under the existing laws of EU and RS. Introducing the legislation in placing the finished drug product on the market. The implementation of quality control from the synthesis of the drug substance to the final product. Drug stability monitoring and defining degradation profile of the drug substance. Introduction with up-to-date requirements for the validation of methods for monitoring the quality of drug substances and dosage forms. Standard operating procedures in pharmaceutical analysis and control of drugs. The content of the registration file especially Part II according to the format of the EU (pharmaceutical-chemical-biological part), module 3 of general technical document. And at the end statistical methods in drug control with result interpretation.

Practical classes

Routine quality control of pharmaceutical forms, according to specification. Discussion of results regarding the conformity with the specification for active pharmaceutical ingredients and pharmaceutical dosage forms. The analysis of potential degradation pathways of active pharmaceutical ingredients. Evaluation of shelf life - procedures and practical examples.

Recommended literature:

1. FDA Documents; 2. International Conference on Harmonization Guidances; 3. S. Ahuja, Impurities evaluation of pharmaceuticals, Marcel Dekker, New York, 1998.; 4. J. Ermer, J. Miller, Method validation in pharmaceutical analysis, Wiley-VCH, Darmstadt, 2005.; 5. Deming S. N., Morgan S. L., Experimental design: a chemometric approach, Elsevier, Amsterdam, Netherlands, (1993)

The total of active learning classes 45

Lectures: 25	**Practical classes:** 20

Teaching methods: Lectures, workshops, seminars, interactive teaching and internet.

Grading system:

Pre-exam obligations	Points	Exam	Points
Class Participation	5	Practical exam	
Practical classes	25	Written exam	60
Tests (colloquia)	10	Oral exam	

Seminar work	/	

University in Belgrade Faculty of Pharmacy	Integrated academic studies PHARMACY	

Study program: Pharmacy

Course Title: Novel Drug Delivery Systems

Teachers: Primorac M. Marija, Ibrić R. Svetlana, Đekić M. Ljiljana

Course Status: Elective

Semester: X	**Year of Study: V**
ECTS points: 4	**Course code: F5I7**

Requirements: Pharmaceutical Technology 2, Pharmaceutical Technology 3

Course aims: Educating the students about the types, composition and properties of novel pharmaceutical dosage forms / therapeutic systems for oral, parenteral, transdermal, pulmonary, buccal, ophthalmic, intravaginal, intrauterine and nasal administration; introduction in the specific aspects of colloidal drug carriers; introduction in the concepts of the influence of physico-chemical, biological and pharmaceutical-technological factors on the process of absorption and release of drug substance from novel pharmaceutical dosage forms / therapeutic systems.

Course outcomes: A student has knowledge on types, composition and properties of novel pharmaceutical dosage forms / therapeutic systems for oral, parenteral, transdermal, pulmonary, buccal, ophthalmic, intravaginal, intrauterine and nasal administration; a student has knowledge and understands concepts related to the influence of physico-chemical, biological and pharmaceutical-technological factors on the process of absorption and release of drug substance from novel pharmaceutical dosage forms / therapeutic systems.

Course contents:

Theoretical classes

Formulation approach of novel pharmaceutical dosage forms / therapeutic systems and the mechanisms of the active ingredient release. The novel pharmaceutical dosage forms / therapeutic systems for oral, parenteral, transdermal, pulmonary, buccal, ophthalmic, intravaginal, intrauterine and nasal administration - the types, composition and properties. The novel pharmaceutical dosage forms / therapeutic systems for target drug delivery. Chronotherapeutic Drug Delivery Systems. Colloidal drug carriers: liposomes, nanoparticles, microemulsions and nanoemulsions - characteristics and applications.

Practical classes

The novel pharmaceutical forms / therapeutic systems for oral, parenteral, transdermal, pulmonary, buccal, ophthalmic, intravaginal, intrauterine and nasal administration - examples and tasks related to the release profiles of active substances. Self-dispersing carriers for oral drug delivery - classification, composition and review of selected examples. Colloidal drug carriers - preparation, pharmaceutical technology and biopharmaceutical characterization (selected examples). Essay.

Recommended literature:

1. Allen L, Ansel H. Ansel's Pharmaceutical Dosage Forms and Drug Delivery Systems. 10th ed., Philadelphia, Walters Kluwer; 2014.
2. Swarbrick J, Boylan JC. Encyclopedia of Pharmaceutical Technology. Second edition. Vol. 1-3. New York, Basel: Marcel Dekker Inc; 2002.
3. Rathbone MJ, Hadgraft J, Roberts MS. Modified-Release Drug Delivery Technology. New York, Basel: Marcel Dekker Inc; 2003.
4. Allen L. Remington: The Science and Practice of Pharmacy. 22nd edition. London: Pharmaceutical Press; 2012.
5. Aulton M, Taylor K. The Design and Manufacture of Medicines. 4th ed., Edinburgh, Churchill Livingstone; 2013.

The total of active learning classes

Lectures: 30	**Practical: 15**

Teaching methods:

Theoretical classes, interactive classes, practical classes, demonstration practical classes , seminars, educational film-presentations, calculations.

Grading system:

Exam prerequisites	**Points**	**Final exam**	**Points**
Active participation in lectures	0-3	Practical exam	
Practical classes	8-12	Written exam	70
Colloquia		Oral exam	
Seminars	7-15		
Other activities	/		

University of Belgrade Faculty of Pharmacy	Integrated academic studies PHARMACY	

Study programme: Pharmacy

Course title: Experimental design in manufacture and qualiy control

Teachers: Zečević L. Mira; Malenović M. Anđelija; Stojanović S. Biljana; Ibrić R. Svetlana

Course status: elective

Semester: X	**Study year: V**
ECTS: 3	**Course code: F5I9**

Course prerequisites: -

Course aims:

Teaching students about importance and application of experimetal design in different phases of method development, optimization and validation, which are used in quality control and pharmaceutical formulation development.

Course outcomes:

After completing this course, student is able to apply the knowledge for selecting appropriate experimental design in different phases of pharmaceutical development, performing experiments by the selected design, and to interpretate obtained results.

Course contents:

Lectures

Experimental design – importance and application. Basic terms and definitions. One factor experiments and multiple factor experiments. Table and graphical presentation of experimetal plans. Response surface and its interpretation. Application of different types of experimetal design in screenig phase (full factorial and fractional factorial design). Optimization by using experimental design (central composition design, Box- Benhken design and the other types). Estimation of method robustness by using Plackett-Burman design and fractional factorial design with appropriate graphical and statistical estimation of factor significance. Definition of system suitability limits from results obtained by estimation of robustness. Definition of mathematical model and statistical estimation of its suitability. Application experimental design in different phases of drug production and quality control (development and method optimization for quality control, development of optimal formulation etc).

Practical classes

Creating plan of experiments for different types of experimental design by using appropriate software package. Performing experiments, data entry and interpretation of results. Analysis of different examples from method develompent and formulation development. Solving problems , showing and presentation of the results with appropriate theoretical analysis.

Recommended literature:

1. Deming SN, Morgan SL. Experimental design: a chemometric approach. Amsterdam: Elsevier; 1993.

2. Hinkelmann K, Kempthorne O. Design and analysis of experiments. New Jersey: John Wiley & Sons; 2005

3. Wu JCF, Hamada MS. Experiments: planning, analysis, and optimization. New Jersey: John Wiley & Sons; 2009.

4. Vander Heyden Y, Nijhuis A, Smeyers-Verbeke J, Vandeginste BGM, Massart BGM. Guidance for Robustness/Ruggedness Tests in Method Validation. J Pharm Biomed Anal. 2001; 24: 723–53. **5.** Ermer J, Miller JHMcB Editors: Method Validation in Pharmaceutical Analysis. Weinheim: WILEY-VCH Verlag GmbH & Co. KgaA; 2005.

The total of active learning classes 45

Lectures: 30	**Practical classes: 15**

Teaching methods:g lectures, laboratory practice, interactive teaching

Grading system:

Pre-exam obligations	Points	Exam	Points
Class Participation	0 – 5	Practical exam	-

Practical classes	25	Written exam	50
Tests (colloquia)	-	Oral exam	-
Seminar work	20		

University of Belgrade Faculty of Pharmacy	Integrated academic studies PHARMACY	

Study programme: Pharmacy

Course title: Medical devices

Teachers: Malenović M. Anđelija, Vasiljević D. Dragana, Drobac M. Milica

Course status: Elective

Semester: X	**Study year: V**
ECTS: 3	**Course code: F5I8**

Course prerequisites: Pharmaceutical technology 1

Course aims:

Introduction to the legal regulations relating manufacturing, quality control, safety assessment, the conformity assessment procedure, registration in the Register of Medical Devices and marketing of medical devices. Gaining knowledge of types, composition, structure and basic functional properties of specific categories and classes of medical devices.

Course outcomes:

After completion of the course the student is able to apply the gathered knowledge in order to provide professional information regarding medical devices, as well as appropriate recommendations and advice to the patient according to his needs and the diagnosis. Student is capable to engage in the affairs of registration in the Register of Medical Devices, monitoring the sales of medical devices, documentation quality assessment and vigilance on medical devices.

Course contents:

Lectures

Laws and regulations in the field of medical devices, national and European legislative. Classification of medical devices, quality and safety requirements for the general medical devices, *in vitro* diagnostic medical devices and active implantable medical devices. Rules for classification of the general medical devices. Clinical studies, biocompatibility assessment, biological tests for the assessment of biocompatibility. Materials for manufacturing of medical devices – types, properties, stability and application. Requirements regarding manufacturing of medical devices. Structure of the technical document. The conformity assessment procedure of medical devices, selection of the procedure according to the category and class of the medical device. Application of the risk management principles for medical devices. Marketing authorization and vigilance on medical devices. Types, composition, manufacturing and properties of selected groups of marketed medical devices.

Practical classes

Making students familiar with the general properties of the medical devices available in pharmacies. Case studies of classification of selected medical devices. Procedure of the registration in the Register of Medical Devices – case study. Laboratory practical classes: determination of the blood sugar level using the self-test apparatus, testing and interpretation of results obtained using strips for urine analysis.

Recommended literature:

1. Law on medicinal products and medical devices. The Official Gazette of the Republic of Serbia, 30/2010 and 107/2012. 2. Directive 90/385/EECof the European parliament and of the council on active implantable medical devices, 1990L0385 — EN— 11.10.2007. 3. Directive 98/79/EC of the European parliament and of the council on in vitro diagnostic medical devices, 1998L0079 — EN — 20.11.2003. 4. Directive 93/42/EEC of the European parliament and of the council concerning medical devices, 1993L0042 —EN—11.10.2007. 5. Gad SC, McCord MG. Safety Evaluation in the Development of Medical Devices and Combination Products. New York: Informa Healthcare; 2008.

The total of active learning classes

Lectures: 30	**Practical classes:** 15

Teaching methods: lectures, interactive lectures, practical classes, seminars

Grading system:

Pre-exam obligations	Points	Exam	Points
Class Participation	-	Practical exam	
Practical classes	4-10	Written exam	70
Tests (colloquia)	-	Oral exam	
Seminar work	12-20		