University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY – MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy – Medical Biochemistry

Course title: Biology with human genetics

Teachers: Biljana M. Potparević; Lada P. Živković

Course status: obligatory

Semester: I	**Year of studies:** I
ECTS points: 5	**Course code:** B1O1

Requirements: none

Course aims:

The aim of the course is to introduce students with basic knowledge about the structure and function of the cell, with a special emphasis on the importance of genetic factors in its functioning. Also, the student needs to get

acquainted with the basic changes in genetic material and the consequences that they have by their carriers and offspring.

Course outcomes:

Course outcome: After completing the course, the student should be able to:

· Rules microscopy techniques

· Describes and describes the structure and function of the cell

· Understand and explain the mechanisms of genetic material mutation formation and link the mentioned changes with the corresponding phenotype

· Apply acquired knowledge in this subject to other biomedical subjects during the course of studies

Course contents:

Lectures

Basic structure of prokaryotic and eukaryotic cells, chemical composition of the cell, plasma membrane, plasma membrane transport mechanisms, cytoplasmic organelles: nucleus and nucleolus, endoplasmic reticulum, Golgi apparatus, lysosomes, peroxisomes, mitochondria, ribosomes, cytoskeletal elements microtubules, actin filaments and intermediate filaments. Nucleic Acids: DNA and RNA-structure and biological role, genetic code, replication of DNA molecules, transcription, translation, regulation of gene activity in prokaryotic and eukaryotic cells. Mendel's laws, genes, genotype, and phenotype, mono-hybrid, dihibrid, intermediate and codominant gene interaction. Cell cycle, human chromosomes, mitosis, meiosis, gametogenesis, fertilization, zygote formation, human embryonic development stages. Chromosomal aberrations: numerical and structural, Robertsonian translocations, gene muta-tions, pedigree analyses, symbol interpretation, monogenic diseases and monogenic inheritance, genetic medita-tion of prenatal diagnostics, mechanisms of DNA reparation.

Practical classes

Types of microscope, light microscope and microscopy, cell size and shape, plasma membrane, cytoplasmic orga-nelles, cell cycle, mitosis, gametogenesis, replication, transcription and translation, chromosome aberrations: nu-merical and structural aberrations, structure and function of different types cell: epithelial, connective, muscular and nerve tissue cells.

Recommended literature:

1. Potparević B, Živković L. Practicum of biology with human genetics. Faculty of Pharmacy, Belgrade; 2014.

2. Đelić N, Stanimirović Z. Principles of genetics. Elite-Medika.Belgrade; 2004.

3. Matić G, Savić Pavićević D. Molecular Biology 1. NNK Internatinal, Belgrade; 2011.

4. Brajušković G. Molecular Biology 2. Savremena administracija,Belgrade; 2012.

5. Papović R, Luković Lj, Novaković: Human genetics. Faculty of Medicine, Belgrade; 2007.

The total of active learning classes

Lectures: 45	**Practical classes:** 30
Research work:	**Other forms of teaching:**

Teaching methods:

theoretical lectures with video presentations, interactive teaching and consultations

practical teaching - video presentations and individual work on a light microscope, observation, analysis and drawing of the preparation, solving tasks from genetics.

Grading system			
Exam prerequisites	**Points**	**Final exam**	**Points**
Active participation in lectures	2	Practical	20
Practical classes	8	Written	70
Workshops		Oral	
Colloquia			
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY – MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy – Medical Biochemistry

Course title: Human functional morphology

Teachers: Popović Dejana

Course status: Mandatory

Semester: I	**Year of studies:** I
ECTS points: 5	**Course code:** B1O2

Requirements: 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:

Lectures

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 classes

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 classes:** 30
Research work:	**Other forms of teaching:**

Teaching methods:

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

Grading system

Exam prerequisites	Points	Final exam	Points
Active participation in lectures	3	Practical	

Practical classes	12	Written	70
Workshops	15	Oral	
Colloquia			
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY – MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy – Medical Biochemistry

Course title: General and inorganic chemistry

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

Course status: Basic

Semester: I	**Year of studies:** I
ECTS points: 5	**Course code:** B1O3

Requirements:

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; osmolarity; 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; 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. Čakar M, Popović G, Tanasković S, Dražić B. Guidelines for practical work

The total of active learning classes

Lectures: 60	**Practical classes:** 30
Research work:	**Other forms of teaching:**

Teaching methods:

Lectures, practical work, discussion, problem solving.

Grading system

Exam prerequisites	Points	Final exam	Points
Active participation in lectures	5	Practical	

Practical classes	5	Written	50
Workshops	40	Oral	
Colloquia			
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY – MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy – Medical Biochemistry

Course title: Physics

Teachers: Todorović-Vasović D. Neli Kistina

Course status: obligatory

Semester: I	**Year of studies:** I
ECTS points: 3	**Course code:** F104

Requirements: 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

Principles of measuring physical quantities in physics. Basic methods for processing the measurement result. Physical models and their application. Kinematics and body dynamics. Force (Basic Mechanics Laws – Newton's Laws, First Newton's Law, Second Newton's Law, and III Newton's Law. Work and Energy. Potential and kinetic energy. Law of conservation of mechanical energy. Elastic and quasielastic force. Frictional force. Oscillations and harmonic oscillations. Damped oscillations. Forced oscillations. Oscillatory motion and mechanical waves. Mechanical waves. wave propagation in an elastic environment, progressive wave, propagation wave, reflection and wave reflection. Interference (wave propagation), diffraction, interference, standing wave. Fluid statics. Fluid Dynamics. Thermodynamic systems. (1st law of thermodynamics. thermodynamic state of the system. Thermodynamic work. The thermodynamic equilibrium. 2nd law of thermodynamics). Thermodynamics of ideal and real gas. Electromagnetism. Kulon force and electric field. Work and energy of the electric field. Connection between electric and magnetic fields. Electromagnetic wave.Photoelectric effect. Modern physics and optics. Elements of atomic physics. (Basic principle of laser. Nuclear reactions. The law of radioactive decay. Alpha, beta and gamma radiation. Systematization of subatomic particles)

Fundamentals of quantum mechanics (Heisenberg's uncertainty principle, De Broll's hypothesis. Quantum mechanical model of a single-electron atom (a hydrogen atom), Multi electron atoms, Pauli principle). Optics (Basic laws of geometric optics. Optical elements. Basic photometric quantities. Lenses. Characteristics of the lens, depending on the shape of the lens and the position of the object. Analogy between optical and electronic lenses. optical microscope. The types of optical microscopes. Electron microscope. Types of electron microscopes: TEM and SEM).

Practical classes

Basic physical measurements. Processing of Measurement data. Use of computer animation . Spectral analysis. Spectrometer and the spectroscope. 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. Simulations: The gas laws. Equations of fluid dynamics. Photoelectric effect.

Recommended literature:

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

2. Todorović-Vasović N.K, Prekrat D., Autorizovana skripta iz fizike sa praktikumom za laboratorijske vežbe iz fizike, Farmaceutski fakultet u Beogradu, Univerzitet u Beogradu, 2017.

3. Vučić V , Ivanović D, Fizika I, dvadesetdrugo izdanje, Beograd: Naučna Knjiga; 1990.

4. Stanković D , Osmokrović P. Praktikum laboratorijskih vežbi iz fizike, Zavod za fiziku tehničkih fakulteta Univerziteta u Beogradu; 2004

The total of active learning classes

Lectures: 30	**Practical classes:** 15

Research work:		**Other forms of teaching:**	
Teaching methods:			
Grading system			
Exam prerequisites	**Points**	**Final exam**	**Points**
Active participation in lectures		Practical	
Practical classes	21	Written	70
Workshops	9	Oral	
Colloquia			
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY – MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy – Medical Biochemistry

Course title: Mathematics

Teachers: Dragana Ranković

Course status: Mandatory

Semester: I	**Year of studies:** I
ECTS points: 4	**Course code:** B1O5

Requirements: 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.

Practical classes

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	**Practical classes:** 30
Research work:	**Other forms of teaching:**

Teaching methods:

The course is in one semester using lectures, exercises, tutorials and 4 homeworks.

Grading system

Exam prerequisites	Points	Final exam	Points
Active participation in lectures		Practical	
Practical classes		Written	60
Workshops	40	Oral	
Colloquia			
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY – MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy – Medical Biochemistry

Course title: Organic chemistry

Teachers: Dilber P. Sanda, Gordana Tasic

Course status: Mandatory

Semester: I	**Year of studies:** I
ECTS points: 7	**Course code:** B1O6

Requirements: none

Course aims:

gaining knowledge about chemical bonds, types of hybridization, electronic effects (inductive effects and resonance) and organic compounds stereochemistry; gaining knowledge about the basic classes of organic compounds and an introduction to the chemistry of heterocyclic compounds (naming, structure, and reactivity); introduction to the ionic and radical reaction mechanisms typical for the organic compounds, carbocations, stability, transfer reactions, radicals (radical stability).

Course outcomes:

acquiring knowledge about the structure, stereochemistry and reactivity of organic compounds; understanding functional groups, their properties and identification reactions, reactions for distinguishing of different compounds of the same class (distinguishing between primary, secondary and tertiary alcohols, the reactions for distinguishing the aryl- and vinyl halides, reactions for differentiation of primary, secondary and tertiary amines), understanding the mechanisms of organic reactions (radical, ionic); creating a logical framework for the connection of the structure and function of organic molecules.

Course contents:

Lectures

the structure, bond types, electronic effects in organic molecules (inductive effects, resonance); saturated aliphatic alkanes (nomenclature, obtaining, reactions, radicals and their stability), cycloalkanes (stability, conformations of cyclohexane, axial and equatorial bonds), unsaturated alkanes, alkenes and alkadienes (Synthesis, reactions, carbocations, stability, transfer reactions); aromatic compounds (conditions for aromaticity, mechanism of electrophilic aromatic substitution, position of second substituent, o- p- and meta- directing groups, inductive and resonant effects); stereochemistry: configuration, chiral molecules, Fischer projection formulas, compounds with more than one chiral carbon atoms, conformations; alkyl-, alkenyl-, and aryl halides (structure, reactivity, mechanisms and stereochemistry of SN reactions); alcohols (structure, reactivity, acid-base properties); ethers; phenols and quinones (reactivity, factors affecting the acidity of phenols); sulfur-containing compounds (thiols, sulfides, disulfides, sulfones, sulfonic acids and derivatives); carbonyl compounds; mechanism of nucleophilic addition of aldehydes and ketones; keto-enol equilibrium, enolate ions in the formation of C-C bonds; carboxylic acids and derivatives (structure and reactivity); amines, aminoalcohols (basicity, reactions of the amino group). Heterocyclic compounds: nomenclature, five-membered with one heteroatom (pyrrole, furan, thiophene) and with more than one heteroatom (imidazole, thiazole), six-membered with one heteroatom (pyridine and some derivatives) and with more than one heteroatom (pyrimidine, pyrazine).

Practical classes

problem-oriented seminars

Recommended literature:

1. Peter C. Volhardt, Neil E. Schore, Organic Chemistry: Structure and Function, 7th Edition, W. H. Freeman, 2014.

2. John A. Joule, Keith Mills, Heterocyclic Chemistry, 5th Edition, Blackwell Publishing Ltd, 2010

3. Reinhard Bruckner, Michael Harmata, Organic Mechanisms, Reactions, Stereochemistry and Synthesis, Springer-Verlag Berlin Heidelberg, 2010

The total of active learning classes

Lectures: 60	**Practical classes:** 30
Research work:	**Other forms of teaching:**

Teaching methods:

lectures; problem-oriented seminars in the exercises; consultations

Grading system

Exam prerequisites	Points	Final exam	Points
Active participation in lectures	5	Practical	
Practical classes	25	Written	40
Workshops	30	Oral	
Colloquia			
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY – MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy – Medical Biochemistry

Course title: Introduction to medical biochemistry

Teachers: Topić S. Aleksandra, Mirković S. Duško, Matović J. Vesna, Bulat Zorica, Đorđević Brižita, Šobajić Slađana

Course status: Mandatory

Semester: II	**Year of studies:** I
ECTS points: 5	**Course code:** B1O7

Requirements: no

Course aims:

Introduction to medical biochemistry as a scientific discipline and the role of medical biochemists in the health system; getting acquainted with the organization of clinical-biochemical, toxicological and sanitary laboratories as well as phases in laboratory testing; familiarization with the development of medical biochemistry, bromatology and toxicological chemistry, and the role of the Faculty of Pharmacy in the education of medical biochemists, as well as the possibilities of training in the profession, acquiring professional and scientific titles.

Course outcomes:

Understanding the role of medical biochemists in the health care system; knowledge of laboratory work and clinical and biochemical testing; knowledge of basic protective measures when working with biological material; knowledge of basic prerequisites for providing quality laboratory services; knowledge of the possibilities for continuous professional development.

Course contents:

Lectures

Development of medical biochemistry, toxicological and sanitary chemistry. Organization of clinical-biochemical, toxicological and laboratory of sanitary chemistry. The role of medical biochemistry and medical biochemists in the health system. The concept of biomarkers and the basic principles of validation of laboratory findings. Introduction to the phases of laboratory testing and the principles of good laboratory practice. Types of biological and other materials with which the biochemist works in the laboratory. Getting to know the standards that apply in laboratory practice. Potentially harmful chemical and infectious agents and occupational safety in the laboratory. Ethical norms in performing work in the health service - general principles of ethics in health. Education of medical biochemists at the Faculty of Pharmacy and levels of education of medical biochemists. Review of professional associations of medical biochemists in the country and abroad and possibilities for further professional and scientific training.

Practical classes

Visit of laboratories for clinical-biochemical laboratory diagnostics, sanitary and toxicological chemistry. Introducing practical aspects related to the organization of the laboratory and work with biological material. Practical introduction to the phases in laboratory testing from the reception of biological material to the formation of the laboratory report. Workshops and seminars.

Recommended literature:

1. Burtis CA, Ashwood ER, Bruns DE. Tietz Textbook of Clinical Chemistry and Molecular Diagnostics. 5th ed, USA: Elsevier Saunders; 2011.

2. IFCC Handbook. 2012-2014, International Federation of Clinical Chemistry and Laboratory Medicine. April 2012.

3. Larry J. Kricka, John Savory. A Guide to the History of Clinical Chemistry. Clin Chem. 2011; 57 (8): 1118–26.

4. Мајкић-Сингх Н, Ђурђевић Ј, Каварић Ј. Развој медицинске биохемије у Југославији. ДМБЈ Београд; 1998.

5. Klaassen CD ed. Casarett and Doul's Toxicology: The Basic Science of poisons. 7th ed, New York: Mc Graw Hill Medical; 2008.

The total of active learning classes

Lectures: 15	**Practical classes:** 45
Research work:	**Other forms of teaching:**

Teaching methods:

Lectures, interactive lectures, laboratory visits, workshops, seminars, use of the Internet and library.

Grading system

Exam prerequisites	Points	Final exam	Points

Active participation in lectures		Practical	
Practical classes	5-10	Written	31-60
Workshops		Oral	
Colloquia	15-30		
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY – MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy – Medical Biochemistry

Course title: Physiology 1

Teachers: Plećaš-Solarović A. Bosiljka, Pešić R. Vesna, Marin M. Jukić

Course status: mandatory

Semester: II	**Year of studies:** I
ECTS points: 5	**Course code:** B1O8

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:

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
Research work:	**Other forms of teaching:**

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
Workshops	10	Oral	
Colloquia			
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY – MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy – Medical Biochemistry

Course title: Analytical Chemistry 1

Teachers: Karljiković-Rajić D. Katarina, Ražić S. Slavica, Uskoković-Marković M. Snežana, Odović V. Jadranka, Đogo Mračević M. Svetlana

Course status: mandatory

Semester: II	**Year of studies:** I
ECTS points: 4	**Course code:** B1O9

Requirements: none

Course aims:

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 classes

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;2017.

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 classes:** 30

Research work:	**Other forms of teaching:**
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 classes	16	Written	50
Workshops	28	Oral	The student may be invited in certain cases.
Colloquia			
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY – MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy – Medical Biochemistry

Course title: Bioorganic chemistry

Teachers: Zorana Tokic-Vujosevic, Milena Simic, Sanda P. Dilber

Course status: compulsory

Semester: II	**Year of studies:** I
ECTS points: 6	**Course code:** B1O10

Requirements: none

Course aims:

Knowledge acquisition about the structure of some biomolecules: amino acids (synthesis, amphoteric properties) peptides, peptide bond, proteins (properties, structure, importance), purine and pyrimidine bases (synthesis, acidity, basicity), of nucleoside and nucleotide, nucleic acid (RNA, DNA), Lipids (structure and properties, importance, classification), carbohydrates;

learning about experimental technique applied in the synthesis and purification of organic compounds;

Course outcomes:

• Understanding of structure and chemical properties of biomolecules (aminoacids, peptides, proteins, purine and pyrimidine bases, nucleoside, nucleotide, nucleic acid, lipids,carbohydrates); acquired skill in experimental techniques used in synthesis and purification of organic compounds;

Knowledge of qualitative reactions of aminoacids (reaction with ninhydrine, xanthoproteic reaction, Millon test, diazotation of aminoacids, Sakaguchi reaction,) knowledge of qualitative reactions of carbohydrates (Molisch test, Fehling reaction, Tollens reaction, test for polysaccharides)

Course contents:

Lectures

Carbohydrates: distribution and classification, nomenclature, structure (Haworth and Newman formules), chemical properties and reactivity, reaction of monosaccharides: oxidation, reduction, reaction with ammonia derivatives, mutarotation, anomeric effect, epimerization, anhydro sugars, nomenclature of glycosides, chain extension and shortening, sugar derivatives (glycosides), disaccharides, polysaccharides. Peptides: amino acids (preparation and reaction, amphoteric properties, acidity, essential amino acids, racemisation), peptide bond: peptide synthesis, determination of N- and C-terminal amino acids, solid-phase and solution synthesis of polypeptides, properties, structure of proteins: primary, secondary and tertiary structure. Nucleic acids: structure and properties of nucleosides and nucleotides; synthesis; structure and properties of nucleic acids; functions of RNA and DNA; lipids: classification; fats, waxes, phospholipids (glycerophospholipis, sphingophospholipids), glycolipids (glyceroglycolipids, sphingoglycolipids), prostaglandins (arachidonic acid, prostanoic acid), terpenoids, steroids(stereochemistry of steroids, A/B trans conformation, A/B cis conformation), fatty acids (saturated, unsaturated, structure, properties, soaps)

Practical classes

Distillation, extraction, crystallization, characterisation of organic molecules, chemical properties of biomolecules;

Recommended literature:

1. Peter C. Vollhardt, Neil E. Shore, Organic Chemistry: Structure and Function, 7th Edition, W. H. Freeman, 2014.

2. P. Collins, R. Ferrier, Monosaccharides: Their chemistry and their roles in natural products, J. Wiley and sons, 1995.

The total of active learning classes

Lectures: 30	**Practical classes:** 30
Research work:	**Other forms of teaching:**

Teaching methods:

lectures; laboratory work; problem oriented seminars in practical classes; consultations

Grading system

Exam prerequisites	Points	Final exam	Points
Active participation in lectures	3	Practical	
Practical classes	37	Written	60

Workshops		Oral	
Colloquia			
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY – MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy – Medical Biochemistry

Course title: Physical Chemistry

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

Course status: mandatory

Semester: II	**Year of studies:** I
ECTS points: 5	**Course code:** B1O11

Requirements:

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: state functions (enthalpy, enhopy, Gibbs free energy), 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: crystalline 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 classes

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; 2015.

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
Research work:	**Other forms of teaching:**

Teaching methods:

Lectures, consultation, practical laboratory training.			
Grading system			
Exam prerequisites	**Points**	**Final exam**	**Points**
Active participation in lectures		Practical	
Practical classes	18	Written	70
Workshops	8	Oral	
Colloquia			
Seminars	4		
Other activities			

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY – MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy – Medical Biochemistry

Course title: Introduction to Laboratory Work

Teachers: Karljiković-Rajić D. Katarina, Ražić S. Slavica, Uskoković-Marković M. Snežana, Odović V. Jadranka, Đogo Mračević M. Svetlana

Course status: Elective

Semester: I	**Year of studies:** I
ECTS points: 2	**Course code:** B1I1

Requirements: none

Course aims:

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
Research work:	**Other forms of teaching:**

Teaching methods:

Laboratory practice, work in small groups, interactive teaching

Grading system

Exam prerequisites	Points	Final exam	Points
Active participation in lectures		Practical	30
Practical classes	30	Written	
Workshops	40	Oral	
Colloquia			
Seminars			

Other activities		

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY – MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy – Medical Biochemistry

Course title: Selected topics in Organic chemistry

Teachers: Milena Simić, Vladimir Savić, Zorana Tokić Vujošević, Sanda Dilber

Course status: elective

Semester: II	**Year of studies:** I
ECTS points: 4	**Course code:** B1I2

Requirements:

Course aims:

discussion of the properties of organic compounds and reactions with significance in biochemical processes; acquir-ing knowledge related to the roles of electrophilic, nucleophilic and radical transformations in biochemical pro-cesses; heterocyclic compounds and they significance in biochemistry

Course outcomes:

understanding of general properties of organic compounds important for biochemical systems, understanding of reaction transformations on molecular level and their role in biochemical transformations; understanding and antic-ipating the properties of heterocyclic compounds and their significance in biochemical transformations

Course contents:

Lectures

Acids and bases in organic chemistry: general concept, effect of the structural, electronic and steric factors, ac-id/base properties of heterocyclic compounds, importance of acid/base in biochemical processes. Reaction mecha-nism in biochemistry: weak interactions, nucleophilic transformation-general concept and reactivity, nucleophilicity of N, S, O, C, properties of carbocations, biological nucleophilic reactions, nucleophilic reactions on carbonyl, sul-phate and phosphate groups; electrophilic reactions-general concept and reactivity, electrophilic reactions on un-saturated atoms. Heterocyclic compounds: five-membered/six-membered heterocycles and their role in biochemi-cal transformations, purine and pteridine derivatives in biochemical processes. .

Practical classes

Seminars based on lectures contents.

Recommended literature:

D. Klein, Organic Chemistry, Wiley, 2011; Dewick P. M. Essentials of Organic Chemistry (for students of pharmacy, medicinal chemistry and biological chemistry). Chichester: Wiley, 2006.

The total of active learning classes

Lectures: 30	**Practical classes:** 15
Research work:	**Other forms of teaching:**

Teaching methods:

lectures, seminars, tutorials

Grading system

Exam prerequisites	Points	Final exam	Points
Active participation in lectures	5	Practical	
Practical classes	35	Written	60
Workshops		Oral	
Colloquia			
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY – MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy – Medical Biochemistry

Course title: English Language

Teachers: Dr Sc. Leontina Kerničan

Course status: elective

Semester: I	**Year of studies:** I
ECTS points: 2	**Course code:** B1I3E

Requirements:

Course aims:

Student will be able to:

- Acquire and develop terminology in medical biochemistry
- Develop abilities in oral and written communication regarding professional issues
- Develop abilities in understanding written information
- Develop abilities in text structural reconstruction (abstract, synthesis)
- Deepen abilities in oral communication (presentation)

Course outcomes:

Student will be able to:

- Express his opinion on the majority of professional issues
- Understand and paraphrase professional literature from many pharmaceutical disciplines
- Actively apply the language in professional life

Course contents:

Lectures

Introduction to general concepts of medical biochemistry and its technical terminology. Chemistry, measuring units. Laboratory equipment (instruments and devices) and working in a laboratory. Biochemical, hematological, immunological, microbiological and toxicological analyses. Diet. Health and disease. Drugs – classification and side effects. Composition and text analysis. Introduction to more comprehensive texts (structural analysis). Exercises in verbal communication. Discussions on professional issues (based on provided materials). Lexical exercises in applying professional terminology. Text definition and reformulation. Presentation on the requested topic. Brief overview of the English professional literature. Text reconstruction leading to abstract and text synthesis. Text analysis.

Practical classes

Recommended literature:

1. Kerničan L., English Language in Pharmacy Practice, collection of technical texts with exercises in technical terminology, fourth edition, Grafopan Beograd, 2016

2. Moini J. Pharmacy Terminology, Delmar, 2010

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

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

5. Bujas Z., Englesko-hrvatsko-engleski rečnik, Nakladni zavod Globus, Zagreb, 2001.

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

The total of active learning classes

Lectures: 30	**Practical classes:** 0
Research work:	**Other forms of teaching:**

Teaching methods:

Interactive lessons, team working, role playing, individual tasks.

Grading system

Exam prerequisites	Points	Final exam	Points

Active participation in lectures	1-10	Practical	
Practical classes	1-20	Written	15-30
Workshops		Oral	15-30
Colloquia			
Seminars	43374		
Other activities			

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY – MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy – Medical Biochemistry

Course title: Foreign Language for Pharmacy - French

Teachers: Mirić M. Milica

Course status: Elective

Semester: II	**Year of studies:** I
ECTS points: 3	**Course code:** B1I3F

Requirements:

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:** 0
Research work:	**Other forms of teaching:**

Teaching methods:

Interactive lectures, group work, individual tasks

Grading system

Exam prerequisites	Points	Final exam	Points
Active participation in lectures	0-2	Practical	
Practical classes		Written	15-30
Workshops	0-18	Oral	
Colloquia			

Seminars	0-50	
Other activities		

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY – MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy – Medical Biochemistry

Course title: Application of Information Technology in Medical Biochemistry

Teachers: Zeljković R. Aleksandra, Vekić Z. Jelena, Ninić R. Ana, Sopić D. Miron

Course status: elective

Semester: II	**Year of studies:** I
ECTS points: 4	**Course code:** B1I4

Requirements:

Course aims:

Utilization of contemporary informatics methods in learning process. Acquiring new skills and knowledge in the field of information technology for the future professional development.

Course outcomes:

Student will be able to: use MS Word, MS Excel, MS PowerPoint for the purposes of learning and the future professional work, as well as to search though the web pages in order to find studying materials, various on-line learning possibilities, databases and other information relevant for their professional development.

Course contents:

Lectures

WINDOWS operative system and its purpose, its working environment, folders and files, basic elements of windows and manipulation, saving of files, work in Windows explorer.

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.

MS POWERPOINT. Making effective and informative presentation.

INTERNET. Standard searching tools. Finding studying material. On-line learning. Database search and acquiring information relevant for professional development.

Practical classes

Use of acquired knowledge during lectures on various examples.

Recommended literature:

1. On-line materials; relevant websites.
2. HELP in programs coverd by this course.

The total of active learning classes

Lectures: 30	**Practical classes:** 15
Research work:	**Other forms of teaching:**

Teaching methods:

Teaching takes place in one semester using the following methods: interactive lectures, group work, panel discussions and individual assignments.

Grading system

Exam prerequisites	Points	Final exam	Points
Active participation in lectures	5	Practical	
Practical classes	20	Written	60
Workshops		Oral	
Colloquia	15		
Seminars			

Other activities		

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY – MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy – Medical Biochemistry

Course title: Physiology 2

Teachers: Plećaš-Solarović A. Bosiljka, Pešić R. Vesna, Marin M. Jukić

Course status: mandatory

Semester: III	**Year of studies:** II
ECTS points: 5	**Course code:** B2O1

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:

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
Research work:	**Other forms of teaching:**

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
Workshops	10	Oral	
Colloquia			
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY – MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy – Medical Biochemistry

Course title: Analytical Chemistry 2

Teachers: Karljiković-Rajić D. Katarina, Ražić S. Slavica, Uskoković-Marković M. Snežana, Odović V. Jadranka, Đogo Mračević M. Svetlana

Course status: mandatory

Semester: III	**Year of studies:** II
ECTS points: 5	**Course code:** B2O2

Requirements: none

Course aims:

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 classes

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; 2015.

<table>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="4">The total of active learning classes</td></tr>
<tr><td colspan="2">Lectures: 45</td><td colspan="2">Practical classes: 45</td></tr>
<tr><td colspan="2">Research work:</td><td colspan="2">Other forms of teaching:</td></tr>
<tr><td colspan="4">Teaching methods:
lectures, laboratory practice, work in groups, consultations, interactive teaching</td></tr>
<tr><td colspan="4">Grading system</td></tr>
<tr><td>Exam prerequisites</td><td>Points</td><td>Final exam</td><td>Points</td></tr>
<tr><td>Active participation in lectures</td><td>6</td><td>Practical</td><td></td></tr>
<tr><td>Practical classes</td><td>24</td><td>Written</td><td>70</td></tr>
<tr><td>Workshops</td><td></td><td>Oral</td><td>The student may be invited in certain cases.</td></tr>
<tr><td>Colloquia</td><td></td><td></td><td></td></tr>
<tr><td>Seminars</td><td></td><td colspan="2" rowspan="2"></td></tr>
<tr><td>Other activities</td><td></td></tr>
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University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY – MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy – Medical Biochemistry

Course title: Instrumental Methods

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

Course status: mandatory

Semester: III	**Year of studies:** II
ECTS points: 6	**Course code:** B2O3

Requirements: Physical Chemistry

Course aims:

To introduce a student with selected instrumental methods useful for his further education and work. The aim is for the student to acquire knowledge and comprehend the theoretical principles of the methods, to understand the operating principles of the instruments, method of performing the experiment, and data processing.

Course outcomes:

The student acquired complete knowledge of the basic physicochemical principles of selected optical, chromatographic, electrophoretic and electrochemical instrumental methods. The student is familiar with the operation principle of the device, is able to apply the instrumental method to a specific analyte of importance for biochemistry and to perform the data processing.

Course contents:

Lectures

Optical methods: Electromagnetic spectrum, interaction of electromagnetic radiation with matter. Molecular absorption spectrometry: UV□VIS spectrophotometry (electronic absorption spectra, chromophores, colour of the compound, Beer-Lambert law, absorptivity, transparency, calibration curve method, quantitative analysis). IR spectrophotometry. Atomic absorption spectrophotometry. Emission spectrometry: Flame photometry, Fluorimetry (theory of fluorescence, phosphorescence and chemiluminescence), fluorophores, fluorescence and chemiluminescence labelling. Methods based on the polarized light: Fluorescence anisotropy, Polarimetry. Methods based on light scattering: Turbidimetry and Nephelometry. Mass spectrometry: electron ionization, chemical ionization. Chromatography: classification of chromatography. Chromatographic techniques: Thin layer chromatography, Gas chromatography, Liquid chromatography (HPLC), Gel filtration, Ion□exchange chromatography, Affinity chromatography. Chromatogram. Electrophoresis: Theory of electrophoresis, apparatus. Electrophoresis techniques: Agarose□gel electrophoresis, Disc□gel electrophoresis, SDS-PAGE electrophoresis, Isoelectric focusing, Capillary electrophoresis. Centrifugal sedimentation: theoretical principle of centrifugation, Swedberg equation, types of centrifuges, centrifugation techniques, efficiency of a centrifuge. Electrochemical methods: Electrochemical cell, electrode potential, types and classification of electrodes, pH□metry and pX□metry.

Practical classes

Experiments in laboratory: Optical methods: Colorimetry, UV□VIS spectrophotometry. Fluorimetry, Polarimetry. Separation methods: Thin layer chromatography, Paper electrophoresis. Electrochemical methods: pH□meter and ion□selective electrodes.

Recommended literature:

1. Kuntić V. Odabrane instrumentalne metode u medicinskoj biohemiji. Beograd: Farmaceutski fakultet; 2009.

2 Kaplan LA, Pesce AJ. Clinical chemistry: theory, analysis, correlation. St.Louis: Mosby Inc; 1996.

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

4. Torović M, Đurđević P, Antonijević V. Optičke metode instrumentalne analize. Beograd: Hemijski fakultet; 1997.

5. Skoog DA, Holler JF, Crouch SR. Principles of Instrumental Analysis. Ontario: Brooks-Cole; 2006.

The total of active learning classes

Lectures: 45	**Practical classes:** 45
Research work:	**Other forms of teaching:**

Teaching methods:

Lectures, consultation, practical laboratory training.

Grading system

Exam prerequisites	Points	Final exam	Points

Active participation in lectures	5	Practical	
Practical classes	18	Written	60
Workshops	5	Oral	10
Colloquia			
Seminars	2		
Other activities			

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY – MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy – Medical Biochemistry

Course title: Immunology with Immunochemistry

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

Course status: Mandatory

Semester: III	**Year of studies:** II
ECTS points: 6	**Course code:** B2O4

Requirements: none

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.
- The principles underlying some of the most commonly used laboratory methods in immunology and immunochemistry.

Course outcomes:

After completing the course the students are expected to know:

- The effector mechanisms of innate and adaptive immunity in defense against infection.
- The pathogenesis and clinical manifestations of selected immunologic diseases as well as the novel therapies for these diseases.
- General principles of transplantation immunology and immunity to tumors.
- 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. Innate immunity cytokines. Properties of antigens recognized by T and B lymphocytes. Structure and function of major histocompatibility complex (MHC) molecules. Capture, processing and presentation of protein antigens to T lymphocytes. 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. Adaptive immunity cytokines. B cell activation and antibody production. Structure of immunoglobulins. Receptors for immunoglobulins. The complement system – activation pathways, biological functions, receptors for complement proteins, regulation of the complement cascade. 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 and acquired immunodeficiencies (AIDS).

Practical classes

Immunization, the production of polyclonal and monoclonal antibodies. Isolation and purification of immunoglobulins. Electrophoresis. Western blot. 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). Immunocytochemistry and 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. 5th ed. Philadelphia: Elsevier Saunders; 2017.

Abbas AK, Lichtman A, Pillai S. Cellular and molecular immunology. 9th ed. Philadelphia: Elsevier Saunders; 2018.

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

Murphy K, Weaver C. Janeway's Immunobiology, Garland Science, Taylor & Francis Group, LLC, 9th ed., 2017.

The total of active learning classes	
Lectures: 45	**Practical classes:** 45
Research work:	**Other forms of teaching:**
Teaching methods: Lectures, practical classes	

Grading system			
Exam prerequisites	**Points**	**Final exam**	**Points**
Active participation in lectures	5	Practical	
Practical classes	5	Written	65
Workshops	25	Oral	
Colloquia			
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY – MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy – Medical Biochemistry

Course title: General Biochemistry

Teachers: Spasojević-Kalimanovska V. Vesna, Zeljković R. Aleksandra, Stefanović Ž. Aleksandra, Vekić Z. Jelena, Ninić R. Ana, Sopić D. Miron

Course status: Required

Semester: III, IV	**Year of studies:** II
ECTS points: 14	**Course code:** B2O5

Requirements: Organic Chemistry, Bio-organic chemistry

Course aims:

To gain knowledge and perception of basic catabolic, anabolic and common metabolic pathways in the cell, as well as their regulation.

Course outcomes:

After successfully finished course, it is expected that the student can describe and analyze main catabolic, anabolic and common metabolic pathways.

Course contents:

Lectures

Structure - function relationships of biomolecules. Enzyme structure and mechanism of action. Basic principles of bioenergetics. Catabolism and anabolism of carbohydrates, lipids and nitrogen containing compounds. Biosynthesis of proteins and nucleic acids. Recombinant DNA and mitochondrial proteins biosynthesis. Protein and nucleic acids biosynthesis. Cell signaling. Mechanisms for control of gene expression. Metabolism in special physiological and pathophysiological conditions. Integration and hormone regulation of metabolic pathways in the liver, muscle and adipose tissue. Molecular structure and metabolism of extracellular matrix. Biochemical aspects of coagulation.

Practical classes

Laboratory work:

• Enzyme kinetics. Enzyme inhibition. Separation techniques in biochemistry – gel filtration, dialysis, chromatography (thin layer chromatography for separation of serum lipids; two-dimension paper chromatography for separation of amino acids), electrophoresis of serum proteins.

Workshops

• Enzymes: 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.

• Integration of metabolic pathways in different tissues and organs.

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.

3. Nelson DL, Cox MM. Lehninger Principles of Biochemistry 5th Edition, W.H. Freeman & Company, 2008.

4. Topić A, Stanojević-Bogavac N, Kotur-Stevuljević J. Praktikum za vežbe iz opšte biohemije, Beograd 2015.

5. Doul's Toxicology: The Basic Science of poisons. 7th ed, New York: Mc Graw Hill Medical; 2008.

The total of active learning classes

Lectures: 75	**Practical classes:** 90

Research work:	**Other forms of teaching:**
Teaching methods: Lectures, practical classes – interactive classes, disscussions, problem solving, seminars, e-learning, experimental laboratory work.	

Grading system			
Exam prerequisites	**Points**	**Final exam**	**Points**
Active participation in lectures	3	Practical	
Practical classes	19	Written	60
Workshops	10	Oral	
Colloquia	8		
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY – MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy – Medical Biochemistry

Course title: Pharmaceutical Chemistry

Teachers: Vujić B. Zorica, Olivera A. Čudina, Jasmina S. Brborić, Branka M. Ivković

Course status: mandatory

Semester: IV	**Year of studies:** II
ECTS points: 6	**Course code:** B2O6

Requirements: Bioorganic Chemistry

Course aims:

Acquiring basic knowledge about medicinal chemistry of certain drug groups (antibiotics, drugs which have effects on cardiovascular and central nervous system) which student will use in mastering courses of biochemistry, pharmacology and other medicinal courses.

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

General principles of drug action, physicochemical properties, prodrug, drug metabolism, drug interaction with plasma proteins, enzymes, receptors. Specific drug groups:

Steroid hormones (male and female sex hormones, agonists and antagonists of estrogen and androgen receptors), corticosteroids (mineralocorticoids and glucocorticoids), insulin and hypoglycemic agents, thyroxine. Vitamins

Drugs affecting central nervous system: gaba receptor agonists - anticonvulsants, drugs modulating activity of parasympathetic nervous system (biosynthesis and stability of acetylcholine, acetylcholine agonists and antagonists, neuromuscular blocking agents), opioid analgesics, antitussive agents, general and local anesthetic agents, hallucinogens, analeptics;

Specific drug groups affecting the cardiovascular system: drugs affecting adrenergic neurotransmission (chemistry and metabolism of catecholamine, adrenergic receptors, agonists and antagonists of α and β receptors), antihyperlipoproteinemics (HMGCoA reductase inhibitors), anticoagulant therapy (warfarin, heparin), thrombolytics (thienopyridines, aspirin), ACE inhibitors (captopril and analogs), angiotensin II receptor blockers (sartans), calcuim channel blockers (calcium homeostasis, subclasses and function of calcium channels, dihydropyridines, verapamil, diltiazem);

Specific antimicrobial agents: penicillins, cephalosporins, carbapenems, monobactams, tetracyclines, erythromycin, sulphonamides. Drugs modulating activity of mediators of inflammation , nonselective and selective COX-inhibitors (NSAIDs, coxibs, antipyretic analgesics).

Practical classes

Seminars, 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. Nadendla RR. Principle of Organic Medicinal Chemistry, New Age International Publisher (P) LTD. 2005.

The total of active learning classes

Lectures: 60	**Practical classes:** 15
Research work:	**Other forms of teaching:**

Teaching methods:

oral lectures, interactive teaching

Grading system

Exam prerequisites	Points	Final exam	Points
Active participation in lectures		Practical	
Practical classes	30	Written	30+40
Workshops		Oral	
Colloquia			
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY – MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy – Medical Biochemistry

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	**Year of studies:** II
ECTS points: 4	**Course code:** B2O7

Requirements: 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. 12 th 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
Research work:	**Other forms of teaching:**

Teaching methods:

Lectures, recorded laboratory in vivo and in vitro experiments on animals, computer simulations of experiments

Grading system

Exam prerequisites	Points	Final exam	Points
Active participation in lectures		Practical	

Practical classes	5	Written	
Workshops	25	Oral	70
Colloquia			
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY – MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy – Medical Biochemistry

Course title: Pathophysiology 1

Teachers: Gordana Leposavić, Mirjana Nacka-Aleksić

Course status: Mandatory

Semester: IV	**Year of studies:** II
ECTS points: 5	**Course code:** B2O9

Requirements: 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 con-sequences.

•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, patho-genesis, 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; 2014.
3. Živančević-Simonović S. Opšta patološka fiziologija. Kragujevac: Medicinski fakultet u Kragujevcu; 2006.
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; 2013.

The total of active learning classes	
Lectures: 30	**Practical classes:** 30
Research work:	**Other forms of teaching:**

Teaching methods:

Lectures and problem-based learning

Grading system

Exam prerequisites	**Points**	**Final exam**	**Points**
Active participation in lectures		Practical	
Practical classes	20	Written	70
Workshops	10	Oral	
Colloquia			
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY – MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy – Medical Biochemistry

Course title: Microbiology

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

Course status: mandatory

Semester: IV	**Year of studies:** II
ECTS points: 6	**Course code:** B2O9

Requirements: none

Course aims:

To provide knowledge regarding : classification, structure and virulence factors of pathogenic and opportunistic microorganisms (bacteria, viruses, protozoa, helminthes, fungi) , principles of laboratory diagnosis of human infectious diseases, epidemiology, prevention and control of human infections (active and passive immunization). Acquiring basic knowledge about mechanisms of action and spectrum of the most commonly used antimicrobial agents. Mechanisms of bacterial resistance.

Course outcomes:

Student is expected to obtain knowledge about classification, morphology and virulence factors of pathogenic microorganisms (bacteria, viruses, protozoa, helminthes, fungi). Knowing epidemiology , measures of prevention and laboratory diagnosis of human infectious diseases. Knowing the general principles and skills of aseptic work in microbiological laboratory.

After completing the course the students are exprected to know 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 drugsclassifications 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) mushrooms. Basic diagnostic methods in mycology.

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.

The total of active learning classes

Lectures: 60	**Practical classes:** 30
Research work:	**Other forms of teaching:**

Teaching methods:

teaching, laboratory work			
Grading system			
Exam prerequisites	**Points**	**Final exam**	**Points**
Active participation in lectures	2	Practical	
Practical classes	18	Written	60
Workshops	20	Oral	
Colloquia			
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY – MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy – Medical Biochemistry

Course title: Selected topics in Physiology

Teachers: Pešić R. Vesna, Plećaš-Solarović A. Bosiljka, Marin M. Jukić

Course status: elective

Semester: IV	**Year of studies:** II
ECTS points: 3	**Course code:** B2I1

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:

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
Research work:	**Other forms of teaching:**

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
Workshops		Oral	
Colloquia	20		
Seminars	20		
Other activities			

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY – MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy – Medical Biochemistry

Course title: Colloid chemistry

Teachers: Aleksić M. Mara, Pejić D. Nataša

Course status: elective

Semester: IV	**Year of studies:** II
ECTS points: 3	**Course code:** B2I2

Requirements:

Course aims:

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 outcomes:

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

Course contents:

Lectures

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 classes

Conductometric determination of the critical micelle concentration of ionic surfactant; Turbidimetric determination of the casein concentration; Viscometric determination of the polymer average molecular weight.

Recommended literature:

1. Pejić N, Aleksić M. Odabrana poglavlja koloidne hemije, Beograd: Farmaceutski fakultet, Univerzitet u Beogradu; 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

The total of active learning classes

Lectures: 30	**Practical classes:** 15
Research work:	**Other forms of teaching:**

Teaching methods:

Lectures, practical laboratory training, student scientific research, consultation.

Grading system

Exam prerequisites	Points	Final exam	Points
Active participation in lectures		Practical	
Practical classes	30	Written	60
Workshops		Oral	

Colloquia	10		
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY – MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy – Medical Biochemistry

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	**Year of studies:** III
ECTS points: 6	**Course code:** B3O1

Requirements: 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. 12 th 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
Research work:	**Other forms of teaching:**

Teaching methods:

Lectures, recorded laboratory in vivo and in vitro experiments on animals, computer simulations of experiments

Grading system			
Exam prerequisites	**Points**	**Final exam**	**Points**
Active participation in lectures		Practical	
Practical classes	5	Written	
Workshops	25	Oral	70
Colloquia			
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY – MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy – Medical Biochemistry

Course title: Pathophysiology 2

Teachers: Gordana Leposavić

Course status: Mandatory

Semester: V	**Year of studies:** III
ECTS points: 5	**Course code:** B3O2

Requirements: 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 uđbenika, 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	
Lectures: 30	**Practical classes:** 30
Research work:	**Other forms of teaching:**

Teaching methods:
Lectures and problem-based learning

Grading system

Exam prerequisites	**Points**	**Final exam**	**Points**
Active participation in lectures		Practical	
Practical classes	20	Written	70
Workshops	10	Oral	
Colloquia			
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY – MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy – Medical Biochemistry

Course title: Bromatology

Teachers: Slađana S. Šobajic, Ivan M. Stanković, Brižita I. Đorđević. Ivana D. Đuričić, Bojana B. Vidović

Course status: Mandatory

Semester: V	**Year of studies:** III
ECTS points: 8	**Course code:** B3O3

Requirements: Organic chemistry, Biochemistry

Course aims:

Knowledge of food composition and its potential to fulfil nutritive and energy needs. General characteristics of macro- and micronutriments and their nutritive value. Information on chemical and nutritive changes of foods during thermal treatment. Nutrient /nutrient and nutrient-drug interactions.

Course outcomes:

Upon completion of the course student is trained to give informations on optimal foods' choices and their combinations for different population groups; advices on usual food preparation techniques; patient proper informations on nutri-ent/nutrient and nutrient/drug interactions

Course contents:

Lectures

Bromatology as a science, relations with other sciences and with pharmaceutical practice; Definition of diet, foodstuffs and nutriments; Factors affecting the choice of foods; Energy value of foods; Macronutiments–energy value, chemical characteristics, basic roles in body and bilological value; Protective nutriments; Classes of foodsuffs acorrding to their role in body; Drinking water as a part of diet; Dietetic products

Practical classes

Usual methods used in analysis of food ; Assesment of quality of foods and dietetic products (chemical composition, appropriatness of composition of dietetics for special nutritive needs, rancidity of foods, food labeling, food packaging)

Recommended literature:

1. HD Belitz, W Grosch: "Food Chemistry", Springer, Berlin, 3rd edition, 2004.

2. TP Coultate: "Food: The chemistry of its components", Royal Society of Chemistry, Herts, 1995.

3. Ђорђевић Б, Ђуричић И, Видовић Б. Практикум из броматологије, Фармацеутски факултет, Београд, 2011.

4. Handouts

5. Vaclavik VA, Christian EW. Essentials of Food Science. Springer, London, 2008

The total of active learning classes

Lectures: 60	**Practical classes:** 60
Research work:	**Other forms of teaching:**

Teaching methods:

lectures, laboratory practice

Grading system

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

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY – MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy – Medical Biochemistry

Course title: Medical biochemistry

Teachers: Spasojević-Kalimanovska V. Vesna, Bogavac-Stanojević Nataša, Kotur-Stevuljević Jelena, Zeljković R. Aleksandra

Course status: Mandatory

Semester: V, VI	**Year of studies:** III
ECTS points: 20	**Course code:** B3O4

Requirements: Physiology 1, Physiology 2, General biochemistry, Pathophysiology 1

Course aims:

Investigation and assessment of biochemical changes during human diseases and understanding of clinical, scientific and technological principles of medical biochemistry.

Course outcomes:

Understanding the role of biochemical laboratory in diagnostics, monitoring and therapy of human diseases; comprehension of the principles of analytical methods that are performed in clinical-biochemistry laboratories and capacity to evaluate and interpret laboratory results

Course contents:

Lectures

Metabolic regulation and disorders of carbohydrate metabolism. Laboratory diagnostics and monitoring of diabetes. Characteristics and functions of major plasma proteins and changes in their concentrations. Amino acids metabolism disorders. Metabolism and metabolic disorders of lipids. Laboratory diagnostics of dyslipidemia. Biochemical markers and risk factors for development of atherosclerosis. Disorders of water metabolism. Regulation of electrolytes in body fluids and metabolic disorders of electrolytes. Disruption of acide-base balance. Disorders in calcium, phosphate and magnesium metabolism. Uric acid. Trace elements.

Practical classes

Types of biological specimens. Interfering factors in the assessment of various analytes. Developing and application of analytical techniques in medical biochemistry for diagnosis and monitoring of diseases. Qualitative and quantitative methods in analysis of glucose, total protein, lipids, non-protein nitrogen compounds and electrolytes in various biological samples.

Students in small groups will elaborate specific themes, resolve problems and cases from practice and present their work.

Recommended literature:

1. Spasić S, Jelić-Ivanović Z, Spasojević-Kalimanovska V. Medicinska biohemija. Farmaceutski fakultet, Beograd 2004.

2. Spasić S, Jelić-Ivanović Z, Spasojević-Kalimanovska V. Praktikum za vežbe iz medicinske biohemije. Farmaceutski fakultet, Beograd, 2005.

3. Burtis CA, Ashwood ER, Bruns DE (editors). Tietz Textbook of Clinical Chemistry and Molecular Diagnostics, 5th Edition. St. Louis, MO: Elsevier, 2012.

4. Internal scripts, lectures.

The total of active learning classes

Lectures: 120	**Practical classes:** 330
Research work:	**Other forms of teaching:**

Teaching methods:

Lectures, interactive teaching. Practical classes - laboratory work, workshops, seminars, analysis of cases from clinical practice.

Grading system

Exam prerequisites	Points	Final exam	Points
Active participation in lectures		Practical	
Practical classes	24	Written	50
Workshops	26	Oral	

Colloquia			
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY – MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy – Medical Biochemistry

Course title: Haematology

Teachers: Marisavljević Dragomir

Course status: Mandatory

Semester: V	**Year of studies:** III
ECTS points: 4	**Course code:** B3O5

Requirements: Pathophysiology 1

Course aims:

The main objective of the course is to provide students with basic knowledge from clinical hematology and to understand laboratory changes that occur in diseases and disorders of the blood and blood-forming organs.

Course outcomes:

Understanding the physiology, pathology and pathophysiology of blood and blood-forming organs.

Course contents:

Lectures

Physiology of blood and blood-forming organs. Basic biology of hematopoietic stem cells. Erythropoiesis, granulocytopoiesis and thrombocytopoiesis. Clinical manifestations of different diseases of hematopoietic stem cells. Clinical significance of changes of the number of peripheral blood cells. Clinical features and differential diagnosis of anemia. Clinical characteristics, classification, diagnosis and treatment of myeloproliferative diseases. Clinical characteristics, classification, diagnosis and treatment of lymphoproliferative diseases. Physiology of hemostasis. Congenital and acquired disorders of hemostasis and thrombosis. Transfusion of blood and blood products.

Practical classes

Testing and improving acquired knowledge about the physiology, pathology and pathophysiology of blood and blood-forming organs. Cytological features of myeloproliferative and lymphoproliferative diseases. The clinical significance and interpretation of different laboratory tests in various disorders of hemostasis and thrombosis.

Recommended literature:

1. Dragomir Marisavljević et al. Clinical hematology. Institute for Textbooks of Serbia, Belgrade, 2012. ISBN 978-86-17-17742-1.

2. Violeta Dopsaj, Vesna-Kalimanovska Spasojevic, Dragomir Marisavljević, et al. Basics of laboratory diagnostic and treatment of anemia. Faculty of Pharmacy, Belgrade, 2012.

The total of active learning classes

Lectures: 30	**Practical classes:** 15
Research work:	**Other forms of teaching:**

Teaching methods:

Lectures, interactive sessions, tour of clinical departments and laboratories, workshops, colloquiums, seminars.

Grading system

Exam prerequisites	Points	Final exam	Points
Active participation in lectures	2	Practical	
Practical classes	20	Written	60
Workshops	3	Oral	
Colloquia	15		
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY – MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy – Medical Biochemistry

Course title: Statistics

Teachers: Kotur-Stevuljevic Jelena, Bogavac-Stanojevic Natasa

Course status: obligatory

Semester: VI	**Year of studies:** III
ECTS points: 3	**Course code:** B3O6

Requirements: Matematics

Course aims:

The objective of the course is to get the student to become acquainted with statistical terminology, to learn how to collect data, how to organize, understand simple statistical methods and interpret ststistical results, apply statistical tests on medical biochemistry examples, learn to use the statistical package.

Course outcomes:

After completing the theoretical and practical program and passing the exam, the student will be able to: correctly select the sample and collect the data, select the appropriate statistical method for data analise, interpret the obtained results, with the use of MS Excel and the statistical package.

Course contents:

Lectures

Statistical terminology. Population and sample. Variable sizes (variables) and data. Editing data. Graphic display and tabulation of data. Measures of central tendency. Measures of deviation. Normal distribution. Standard normal distribution. Calculate the area below the normal curve. Testing the hypothesis. Type I and Type II Errors. P-value. One-sided and double-sided Student t-test. A variance relationship test. Variance analysis. Variance analysis for one classification criterion. Variance analysis for two classification criteria. Linear regression analysis. Regression equation. Correlation analysis. The correlation coefficient. Determination coefficient. Standard error of regression error. Using regression analysis for predicting. Non-parametric methods. Non-parametric t-test (Mann-Whitney U-test). Non-parametric analysis of variance. Non-parametric correlation. Chi-square test. Stacking test. Independence test. Homogeneity test. Interval of reliability of expected values.

Practical classes

Application of statistical tests on examples from medical biochemistry using statistical packages.

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. internal script, lecture material, web pages on the Internet

The total of active learning classes

Lectures: 30	**Practical classes:** 30
Research work:	**Other forms of teaching:**

Teaching methods:

Teaching is conducted in one semester using the following methods: lectures, use of statistical programs in a computer laboratory, interpretation of results in relation to their laboratory significance, homework assignments, use of the Internet and library

Grading system

Exam prerequisites	Points	Final exam	Points
Active participation in lectures		Practical	
Practical classes	15	Written	70
Workshops		Oral	
Colloquia	15		
Seminars			

Other activities		

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY – MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy – Medical Biochemistry

Course title: Laboratory hematology

Teachers: Violeta B. Dopsaj

Course status: Mandatory

Semester: VI	**Year of studies:** III
ECTS points: 4	**Course code:** B3O7

Requirements: Hematology

Course aims:

Introduction to laboratory methods used to determine blood cells in the peripheral blood, automation in the haematological laboratory, interpretation of the results of complete blood counts from the hematologic analyser.

Course outcomes:

Acquiring knowledge about standard blood sampling procedures for hematology tests in clinical laboratories, determination of complete blood cell counts on hematology analysers and with manual methods, determination of cell antigens by flow cytophluorometry, the significance of haematological tests in clinical practice.

Course contents:

Lectures

Organization of hematology laboratories. Morphological analysis of blood cells in peripheral blood - blood sampling, pre-analytical factors, complete blood cell counts, peripheral blood smear. Routine manual methods for determination of erythrocytes, leukocytes, platelets and reticulocytes. Automated analysis of blood cells (erythrocytes, leukocytes and platelets) on hematology analysers, principles of determining the number and morphology of blood cells. Standardization of methods in cellular analysis. Indicators of abnormalities, causes of false results on the hematology analysers. Validation and interpretation of results from hematology analysers. Flow cytometry in blood cell analysis. Normal morphology of the bone marrow. Cytochemical, immunocytochemical, histochemical and immunohistochemical staining of peripheral blood and bone marrow. Fundamentals of molecular diagnostics in hematology. Fundamentals of immunohematology. Quantitative and qualitative disorders of leukocytes and platelets. Erythrocyte disorders, anemia diagnosis, hemoglobinopathy, and thalassemia. Hematological tests in elderly and children. Quality control in the hematology laboratory. Testing the patient's bedside (POCT) in hematology.

Practical classes

Practical work in the haematological laboratory. Standard blood sampling procedures in hematology. Determination of complete blood cell count on the hematology analyser. Determination the number of leukocytes, differential formula, platelets and reticulocytes by microscopic method. Making and staining peripheral blood smears. Determination of the leukocytic formula on the hematology analyser using three-part- and five-part-diff technology. Identification of blood cells abnormalities and errors on the hematology analyser. Determination of erythrocyte sedimentation rate. Implementation of quality control procedures in the hematology laboratory.

Recommended literature:

1.Miroljub Petrović, Violeta Dopsaj, Miodrag Rajić, Zoran Milojević. Laboratory hematology. Faculty of pharmacy Belgrade, 2009.
2.SM Lewis, BJ Bain, I Bates. Dacie and Lewis Practical Hematology. Churchill Livingstone 2006.

3.Shirlyn B McKenzie, J. Lynne Williams. Clinical Laboratory hematology. Pearson 2010.

4.Kandice Kottke-Marchant, Bruce H Davis. Laboratory Hematology Practice. Wiley Blackwell 2012.

5. Violeta Dopsaj, Vesna-Spasojević Kalimanovska, Dragomir Marisavljević, and sar. Basics of laboratory diagnostics and treatment of anemia. Faculty of Pharmacy Belgrade, 2012.

The total of active learning classes

Lectures: 30	**Practical classes:** 30
Research work:	**Other forms of teaching:**

Teaching methods:

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

Grading system

Exam prerequisites	Points	Final exam	Points
Active participation in lectures		Practical	
Practical classes	10	Written	30
Workshops	20	Oral	40
Colloquia			
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY – MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy – Medical Biochemistry

Course title: Pharmacology 3

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

Course status: Mandatory

Semester: VI	**Year of studies:** III
ECTS points: 5	**Course code:** B3O8

Requirements: 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. 12 th 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

The total of active learning classes

Lectures: 45	**Practical classes:** 15
Research work:	**Other forms of teaching:**

Teaching methods:

Lectures, recorded laboratory in vivo and in vitro experiments on animals, computer simulations of experiments

Grading system

Exam prerequisites	Points	Final exam	Points
Active participation in lectures		Practical	
Practical classes	5	Written	
Workshops	25	Oral	70
Colloquia			
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY – MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy – Medical Biochemistry

Course title: Free radicals and antioxidants-laboratory diagnostics

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

Course status: Elective

Semester: VI	**Year of studies:** III
ECTS points: 2	**Course code:** B3I1

Requirements: none

Course aims:

Gaining the knowledge of free radicals toxicology and oxidative/nitrosative stress as a mechanism of toxicity. Teaching students about chemical agents/drugs that exert their toxic/pharmacological efects through free radicals overproduction or antioxidant defence system supression. The classification of free radicals. Types and role of antioxidants and modes of their action. Biomarkers of oxidative/nitrosative cell damage in diseases and poisonings.

Course outcomes:

Qualification of Master of Pharmacy-Medical Biochemistry to be a part of multidisciplinary teams dealing with research on oxidative / nitrosative stress and to master laboratory techniques for determining the biological parameters of oxidative/nitrosative stress.

Course contents:

Lectures

Free radicals: species and reactivity. Antioxidant defence system. Types of oxidative and nitrosative damage of biomolecules, emphasizing lipid peroxidation, oxidative/nitrosative modification of proteins and DNA. Oxidative/nitrosative stress as a mechanism of toxicity and diseases. Apoptosis. Xenobiotics with a prooxidative effect (drugs, metals, dipyridyl herbicides , etc.). Pharmaceuticals with antioxidant action and their rational use. Laboratory diagnostics of oxidative / nitrosative stress.

Practical classes

Practical training is an integral part of theoretical teaching and is designed to enable students to master the problem of oxidative/nitrosative stress. Students are introduced to the parameters of oxidative stress, antioxidant protection and methods of their determination. Practical classes are conducted using the Moodle Platform for e-learning.

Recommended literature:

1. Oxidative stress-clinical diagnostic significance. Mirjana M. Djukic. Ed. / author. Belgrade: Mono & manjana; 2008.
2. Oxidative stress-free radicals, antioxidants. Mirjana M. Djukic. Ed. / author. Belgrade: Mono & manjana; 2008.
3. Oxidative mechanisms of toxicity of cadmium. Danijela Đukić-Ćosić. Ed. / author. Belgrade: Endowment Andrejević-Pharmaceutical Faculty, 2017.
4. Đorđević V. Biochemistry of Free Radicals, Faculty of Medicine, Nis; 2000.
5. Wallace KB.: Free Radical Toxicology. Wallace KB, editor. London: Taylor & Francis; 1997.
5. Baskin SE: Oxidants, antioxidants and free radicals. Washington: Taylor & Francis; 1997.

The total of active learning classes

Lectures: 15	**Practical classes:** 15
Research work:	**Other forms of teaching:**

Teaching methods:

Lectures, seminar papers, laboratory practice, Lectio (e-learning platform).

Grading system

Exam prerequisites	Points	Final exam	Points
Active participation in lectures	10	Practical	
Practical classes	10	Written	50

Workshops	10	Oral	
Colloquia			
Seminars	20		
Other activities			

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY – MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy – Medical Biochemistry

Course title: Selected chapters of laboratory microbiology

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

Course status: elective

Semester: VI	**Year of studies:** III
ECTS points: 2	**Course code:** B3I3

Requirements: none

Course aims:

To provide knowledge regarding classification and characteristics of pathogenic microorganisms (bacteria, viruses, protozoa, helminthes, fungi) , principles of laboratory diagnosis of human infectious diseases, epidemiology and prevention and control of human infections (active and passive immunization).

Course outcomes:

Knowing classification and morpholgy characteristic and virulence factors of pathogenic microorganisms (bacteria, viruses, protozoa, helminthes, fungi). Knowing methods in laboratory diagnosis. Knowing the general principles and skills of aseptic work in microbiological laboratory.

Course contents:

Lectures

Morphology and physiology of bacterial cells. Virulence factors of the pathogenic bacteria. Bacterial growth and requirenments for growth in in vitro conditions. Pathogenesis of bacterial infection. Gram positive and Gram negative bacteria essential for medicine. Gram positive and Gram negative sporulating rods.Characteristics of enterobacteria that cause human infections. Morphological characteristics and replication of viruses. Laboratory diagnosis of viral infections. Characteristics of DNA and RNA viruses significant for human pathology. Protozoa digestive and urogenital tract. Protozoa of blood and tissue. Medical mycology: morphology in fungi biology. Medically significant mushrooms. Basic diagnostic methods in mycology.

Protozoa of intestinal and urogenital tract, blood and tissue protozoa. Laboratory diagnosis of parasitic infections. Medical mycology: Medically important fungi (yeasts, dermatophytes). Laboratory methods in mycology.

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. Medical parasitology: microscopy of urogenital and blood and tissue protozoa.

Recommended literature:

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

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

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

The total of active learning classes

Lectures: 15	**Practical classes:** 15
Research work:	**Other forms of teaching:**

Teaching methods:

teaching, laboratory work

Grading system

Exam prerequisites	Points	Final exam	Points
Active participation in lectures	5	Practical	
Practical classes	15	Written	60
Workshops	20	Oral	

Colloquia			
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY – MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy – Medical Biochemistry

Course title: Substances of abuse with analytics

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

Course status: Elective

Semester: VI	**Year of studies:** III
ECTS points: 3	**Course code:** B3I4

Requirements: none

Course aims:

Gaining the knowledge of the mechanisms of action and toxicity of substances of abuse, the social aspect of their abuse, therapy and prevention, as well as the strategies to reduce the number of addicts.

Course outcomes:

Qualification of Master of Pharmacy-Medical Biochemistry to be a part of a multidisciplinary team dealing with the problem of substances of abuse, especially from the aspect of education and prevention of abuse, especially among young people.

Course contents:

Lectures

History. Different classifications of agents that cause addiction. Theories of dependence. Basic principles and chemical characteristics of addictive agents. Acute vs. chronic intoxication with substances of abuse and appropriate treatment approaches. Pharmacokinetic and pharmacological profilies of substances of abuse. Individual presentation of substances of abuse includes: alcohol, opiates (opium, morphine, heroin), cocaine, amphetamines, cannabis (marijuana, hashish), LSD, drug of abuse (methadone, selective serotonin uptake inhibitors, barbiturates, benzodiazepines, anabolic agents). Legislation. Situation in Serbia.

Practical classes

Practical trainings follow theoretical units and are designed to enable students to master the issues of psychoactive substances that couse addiction. Single case repots promote interactive students engagement, analytical approach and the assessment. Established students guideline for qualitative and quantitative analysis of the most important psychoactive substances enables students for laboratory work. Practical classes are provided through the Lectio e-learning platform.

Recommended literature:

1. Đukić M, Đukić-Ćosić D. Substances that cause dependence with analytics. Practical instruction manual. Belgrade: University of Belgrade - Faculty of Pharmacy; 2009.
2. Blachford S, Krapp K. Drugs and Controlled Substances Information for Students. Blachford S., Krapp K, editors. Michigan: Gale; 2002.
3. Joseph DE. Drugs of Abuse. Wahington: U.S. Department of Justice. Drug Enforcement Administration; 2003.
4. Cole MD. The Analysis of Controlled Substances, Chichester: Wiley; 2003.
5. Emmett D, Nice G. Understanding Street Drugs. Philadelphia: Jessica Kingsley Publishers; 2006.

The total of active learning classes

Lectures: 30	**Practical classes:** 15
Research work:	**Other forms of teaching:**

Teaching methods:

Lectures, laboratory practice, case studies, Lectio (e-learning platform).

Grading system

Exam prerequisites	Points	Final exam	Points
Active participation in lectures	10	Practical	
Practical classes	10	Written	50

Workshops	10	Oral	
Colloquia			
Seminars	20		
Other activities			

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY – MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy – Medical Biochemistry

Course title: Pharmacokinetics

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

Course status: obligatory

Semester: VII	**Year of studies:** IV
ECTS points: 6	**Course code:** B4O1

Requirements: 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
Research work:	**Other forms of teaching:**

Teaching methods:

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

Grading system

Exam prerequisites	Points	Final exam	Points
Active participation in lectures		Practical	
Practical classes	5	Written	70

Workshops	25	Oral	Student may have to continue with an oral exam, if the professor determines that the written exam is not enough for the assessment.
Colloquia			
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY-MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy-Medical Biochemistry

Course title: Toxicology

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, VIII	**Year of studies:** IV
ECTS points: 13	**Course code:** Б4О2

Requirements: none

Course aims:

Gaining the knowledge on different topics of toxicology (general toxicology, forensic toxicology, professional toxicology, clinic toxicology, toxicology of food, toxicology of drugs, ecotoxycology, analytical toxicology...) with the aim to improve human health and safety environment.

Course outcomes:

Gained knowledge on different topics in Toxicology opens the possibility of qualified work of Master of Pharmacy-Medical Biochemistry in the forensic, clinical, occupational toxicology and ecotoxicology laboratories.

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, genotoxicity, chemical carcinogenes; 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 (carbonmonoxide, carbon dioxide, sulfur dioxide, hydrogen sulfide, 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.), herbal and synthetic poisons (alkaloids, heterosides, pesticides, drugs, substancesof abuse, etc.), drug poisoning (salicylates, barbiturates, benzodiazepines, phenothiazines, beta blockers and others), natural toxins: zootoxins, phytotoxins, mycotoxins, mushrooms toxins, basics of radioactivity and plastics, b asics 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 determinati on of investigated poisons (will be written in English).

The total of active learning classes

Lectures: 90	**Practical classes:** 210
Research work:	**Other forms of teaching:**

Teaching methods:

lectures, laboratory work in groups

Grading system

Exam prerequisites	Points	Final exam	Points
Active participation in lectures		Practical	
Practical classes	15	Written	
Workshops	20	Oral	60
Colloquia			
Seminars	5		
Other activities			

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY – MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy – Medical Biochemistry

Course title: Clinical Enzymology

Teachers: Spasojević-Kalimanovska V. Vesna, Vekić Z. Jelena, Ninić R. Ana

Course status: Required

Semester: VII	**Year of studies:** IV
ECTS points: 5	**Course code:** B4O3

Requirements: General Biochemistry

Course aims:

Understanding of enzymatic processes by introducing the structure, physico-chemical and catalytic properties of the enzymes, as well as phylogenetic and ontogenetic development of tissue enzymes, topology and morphometry of enzymes. Knowledge of physiological classification and mechanisms of efflux and extracellular distribution of cell enzymes. Understanding enzyme profiles of the organs and application of serum enzymes for the diagnosis of organs' diseases.

Course outcomes:

Understanding selection, constitution and significance of enzyme patterns of the organs and serum enzymatic profile for diagnosis of organs' diseases; knowledge of genetic polymorphism and inborn errors of metabolism. Knowledge of the principles and methods for enzymatic analysis and practical application of enzyme assays.

Course contents:

Lectures

Structure, physical, chemical and catalytic properties of enzymes. Classification and nomenclature of enzymes. Biological material for enzymatic analysis. Diagnostic enzymology: physiological classification of cell enzymes, efflux and extracellular distribution of enzymes. Isoenzymes in the diagnosis of organ diseases. Enzymes in muscle, heart, liver, pancreatic diseases and diseases of gastrointestinal tract. Enzymes as markers of disorders of bone metabolism. Enzymes as tumor markers and risk factors for cardiovascular disease. Genetic polymorphism and inborn errors of metabolism. Preanalytical factors in the determination of enzyme activity.

Practical classes

General principles of enzyme analysis. Optimization of conditions for the measurement of enzyme activity. Examples of enzymatic analysis: determination of enzyme activity, determination of substrate concentration with enzymes, enzyme immunoassay. Application of Warburg's optic test: examples of single-step and multistage enzymatic reactions. Continuous and discontinuous methods for determination of serum enzymes activities. Analysis of assay conditions for enzyme determination using automatic analyzer (selected examples). Methods for separation and determination of isoenzymes. Determination of enzyme and isoenzyme activity profiles of heart, bones, liver diseases and diseases of gastrointestinal tract. Interpretation of the results of serum enzymes and isoenzymes assays and application of appropriate algorithms with examples from the practice.

Recommended literature:

1. Majkić-Singh N. Klinička enzimologija, DMBJ, Beograd, 2012.

2. Burtis CA, Ashwood ER, Bruns DE (editors). Tietz Textbook of Clinical Chemistry and Molecular Diagnostics, 5th Edition. St. Louis, MO: Elsevier, 2012.

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

4. Moss WD, Rosalki SB. Enzyme Test in Diagnosis. Arnold, London, 1996.

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

The total of active learning classes

Lectures: 45	**Practical classes:** 15
Research work:	**Other forms of teaching:**

Teaching methods:

Lectures, laboratory work, e-learning, workshops, seminars, practical cases analysis, problem based learning.

Grading system

Exam prerequisites	Points	Final exam	Points
Active participation in lectures	4	Practical	
Practical classes	26	Written	60
Workshops	10	Oral	
Colloquia			
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY – MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy – Medical Biochemistry

Course title: Laboratory hemostasis

Teachers: Violeta B. Dopsaj, Jelena Z. Vekic

Course status: Mandatory

Semester: VII	**Year of studies:** IV
ECTS points: 4	**Course code:** B4O4

Requirements: Hematology

Course aims:

Acquiring wider knowledge in the field of laboratory diagnostics in haemostasis in order to investigate haemostasis disorders, application of therapy and monitoring the effects of therapy, application of laboratory guides and diagnostic protocols for better knowledge of clinical aspects of haemostasis.

Course outcomes:

Qualify a student for performing tests in the field of haemostasis and interpretation of results in relation to the applied laboratory protocol for the examination of haemostasis disorders.

Course contents:

Lectures

Physiology of hemostasis. Clinical aspects of haemostasis and thrombosis. Laboratory tests in hemostasis-screening tests and specialized tests. Standard blood sampling procedures for tests in hemostasis. Automation in the laboratory of hemostasis-coagulometers and aggregometers. Determination of coagulation factors and inhibitors. Diagnosis of haemophilia and von-Vilebrand's disease. Conditions of hypercoagulability and venous thromboembolism. Diagnostic tests in venous thromboembolism. Determination and clinical knowledge of D-dimer. Laboratory monitoring of the effects of anticoagulant therapy in the treatment of deep vein thrombosis and pulmonary embolism. Heparin-induced thrombocytopenia-laboratory tests. Fundamentals of thrombophilia. Testing of platelet function and laboratory monitoring of the effects of antiagregation therapy. Laboratory diagnostics of acquired haemostasis disorders, application of clinical score in DIK diagnosis. Laboratory tests in fibrinolysis disorder.

Practical classes

Practical work in a laboratory for hemostasis. Screening tests-PT, aPTT, TT, fibrinogen. Specialized tests - coagulometric, chromogenic and immunochemical tests. Interpretation of screening results and specialized tests. Workshops and seminars.

Recommended literature:

1.Miroljub Petrović, Violeta Dopsaj, Miodrag Rajić, Zoran Milojević. Laboratory hematology. Faculty of pharmacy Belgrade, 2009.
2.SM Lewis, BJ Bain, I Bates. Dacie and Lewis. Practical Hematology. Churchill Livingstone 2006.
3.Shirlyn B McKenzie, J. Lynne Williams. Clinical Laboratory hematology. Pearson 2010.
4.Kandice Kottke-Marchant, Bruce H Davis. Laboratory Hematology Practice. Wiley Blackwell 2012.
5. Dopsaj V, Jelic-Ivanovic Z, Marisavljevic D, et al. Anticoagulant therapy-clinical and laboratory aspects. Faculty of Pharmacy, Belgrade 2005.

The total of active learning classes

Lectures: 30	**Practical classes:** 15
Research work:	**Other forms of teaching:**

Teaching methods:

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

Grading system

Exam prerequisites	Points	Final exam	Points
Active participation in lectures		Practical	
Practical classes	10	Written	70
Workshops	20	Oral	

Colloquia			
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY – MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy – Medical Biochemistry

Course title: Laboratory Endocrinology

Teachers: Spasojević-Kalimanovska V. Vesna, Ignjatović D. Svetlana, Stefanović Ž. Aleksandra

Course status: Mandatory

Semester: VII	**Year of studies:** IV
ECTS points: 3	**Course code:** B4O5

Requirements: Phathophysiology 1, Phathophysiology 2

Course aims:

Understanding the complex mechanisms of horome actions and new analitical methodology for hormones determinations.

Course outcomes:

After a successfully finished course, students will be able to understand endocrine disorders as a consequence of abnormal hormone production, or inappropriate receptors – hormon interactions.

Understanding of a negative feedback loop in control of hormone biosynthesis, also as a general hormone profiles in different endocrine disorders. Conception of importance of autoimmunity in endocrine disorders. Understanding of laboratory technics which are used in routine laboratory practise for determinations of hormone concentratios in different bilogical samples. Unrestanding of preanalytical and analytical errors in laboratory testing and potential interferences, also as results interpretation.

Course contents:

Lectures

Hormone biosynthesis and secretion control mechanisms. The main reasons of endocrine disorders development. Biosynthesis, mechanism of action and role of hormones secreted by pituitary gland. Laboratory diagnostics od endocrine disorders. Biosynthesis and secretion of thyroid hormones - control mechanisms. Laboratory diagnosis of hypothiroidism and hyperthiroidism. Autoimmune thyroiditis. Thyiroid hormones in pregnancy. Biogenic amines. Glucocorticoids. Mineralocorticoids and adrenal androgens. Laboratory diagnosis of disorders of adrenal cortex. Laboratory Diagnosis of reproductive endocrine disorders. Parathormone. Gastrointestinal hormones and their functions.

Practical classes

Characteristics of the biological specimens for hormones with circadian variation. Analytical methods for the determination of hormones concentrations: HPLC, LC/MS, ECLIA. Sources of preanalytical and analytical errors and potential interferences. Methods for the determination of TSH, fT4 и thiroid antybodies (TPOat i TgAt). Results interpretation. Methods for the determination of hormone of adrenal medula: epinephrine, norepinephrine, dopamine and serotonin. Results interpretation. Methods for the determination of steroid hormones aldosterone, cortisol, adrenal androgens, testosterone and estradiol.

Recommended literature:

1. Stojanov M. Laboratorijska endokrinologija, EXCELSIOR, Beograd, 2016.

2. Whitehead S, Miell J. Clinical Endocrinology, Scion Publishing Ltd., 2012.

3. Greenspans Basic and Clinical Endocrinology. 9th ed, Lange, McGraw Hill, 2011.

4. Hall JE, Nieman LK. Hnadbook of Diagnostic Endocrinology. Humana Press, 2010.

5. Scott MG, Gronowski AM, Eby CS. Tietz Applied Laboratory Medicine, Wiley, 2007.

The total of active learning classes

Lectures: 30	**Practical classes:** 15
Research work:	**Other forms of teaching:**

Teaching methods:

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

Grading system

Exam prerequisites	Points	Final exam	Points
Active participation in lectures	5	Practical	

Practical classes	15	Written	60
Workshops		Oral	
Colloquia	20		
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY – MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy – Medical Biochemistry

Course title: Laboratory statistics

Teachers: Kotur-Stevuljevic Jelena, Bogavac-Stanojevic Natasa

Course status: obligatory

Semester: VII	**Year of studies:** IV
ECTS points: 4	**Course code:** B4O6

Requirements: Satistics

Course aims:

Objectives of the course are: to encourage students to use advanced statistical techniques for analyzing and interpreting results, to get a practical insight into the evaluation of analytical methods, to use statistics in clinical-chemical laboratories.

Course outcomes:

After successful completion of the program and the passed exam, students will be able to: define the following terms: precision, accuracy, random error, systematic error, reference interval, quality assurance, quality control, to understand and apply the methods of selection and evaluation of methods, calculate diagnostic sensitivity, specificity, efficiency and predictive values, understand the statistical quality control principles, choose the appropriate experimental design to solve the laboratory problem, use MS Excel and statistical package packages.

Course contents:

Lectures

Evaluation of analytical methods. Determination of imprecision. Determination of inaccuracy. Limit detection. Linearity. Estimation of interference. Comparison of methods. Standard additive method. Objectives of analytical quality. Measuring uncertainty. Quality control.

Practical classes

Use of a statistical package in the preparation of a case from laboratory practice.

Recommended literature:

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

2. Tamhane AJ, Dunlop DD. Statistics and data analysis. Prentice Hall Inc. Upper saddle River, NY, USA, 2000.

3. Deming, SN, Morgan, SL. Experimental design: A chemometric approach. Elsevier, Amsterdam, 1993.

4. Internal script, lecture material, web pages on the Internet.

The total of active learning classes

Lectures: 30	**Practical classes:** 30
Research work:	**Other forms of teaching:**

Teaching methods:

Teaching is conducted in one semester using the following methods: lectures, use of statistical programs in a computer laboratory, interpretation of results in relation to their laboratory significance, homework assignments, use of the Internet and library

Grading system

Exam prerequisites	Points	Final exam	Points
Active participation in lectures	6	Practical	
Practical classes	20	Written	70
Workshops		Oral	
Colloquia	4		
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY – MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy – Medical Biochemistry

Course title: Dietetics

Teachers: Slađana S. Šobajic, Ivan M. Stanković, Brižita I. Đorđević. Ivana D. Đuričić, Bojana B. Vidović

Course status: Mandatory

Semester: VIII	**Year of studies:** IV
ECTS points: 4	**Course code:** B4O7

Requirements: Bromatology

Course aims:

Informations on available guidelines, recommendations and other tools for designing diets; Informations on specific nutritive needs of different age categories and in prevention and therapy of certain diseases

Course outcomes:

After having passed the exam student should be able to understand and apply dietary recommendations; give basic advi-ces concerning healthy diet regimes and nutritive advices to patients suffering from chronical deseses where dietothe-rapy is needed; recognize nutritive disorders and instruct patients to approriate health facilities

Course contents:

Lectures

The roles of food in human organisam; the principles of rationale nutrition; food guide pyramide and other dietary guide-lines to healthy eating; balance studies of nutritional requirements; nutrient standards, RDA and DRI values; energy requ-irements; designing the optimal and balanced diets; dietetic regimes for health promotion of vulnerable population gro-ups; nutritional epidemiology and dietetic regimes in prevention and therapy of certain nutrition-related diseases; nutri-tional support in certain diseases; adverse reactions to foods (food allergy and food intolerance); nutrition disorders (anorexia, bulimia); food fortification, functional foods, dietetic products, dietary supplements; role of pharmacists in promotion of optimal nutrition, wholesome food, wellness in the community and in nutritive education of patients

Practical classes

Nutritional status determination; estimation of energy requirements (examples); calculations of fat, carbohydrate and protein input in total diet energy value; calculating energy value of foods; using food content tables/examples; estimati-on of minerals' and vitamins' content in dietary supplements and their correlation with RDA values; estimation of dietary intake – examples of data collection methods (three days food record); role playing on communication with patients concerning nutrition; analysis of articles from literature, other media or Internet

Recommended literature:

1.Present knowledge of nutrition, editors EE. Ziegler, LJ Filer, ILSI Press, Washington DC, 1996;

2. Encyclopedia of human nutrition, editori MJ Sadler, JJ Strain, B Cabalero, Academic Press, London, CD version;

3. Dietary reference intake for energy, carbohydrate, fiber, fat, fatty acids, cholesterol, protein, and aminoacids (macronutrients), Institute of Medicine, National Academic Press, 2002;

4. Handouts

The total of active learning classes

Lectures: 30	**Practical classes:** 30
Research work:	**Other forms of teaching:**

Teaching methods:

lectures, interactive practical work- problem based learning, case studies, role playing, analyses of texts related to nutri-tion

Grading system

Exam prerequisites	Points	Final exam	Points
Active participation in lectures	0-7	Practical	
Practical classes	9-18	Written	30-60
Workshops		Oral	

Colloquia	8-15		
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY – MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy – Medical Biochemistry

Course title: Clinical chemistry with molecular diagnostics 1

Teachers: Ignjatović D. Svetlana, Mirković S. Duško

Course status: Mandatory

Semester: VIII	**Year of studies:** IV
ECTS points: 7	**Course code:** B4O8

Requirements: Medical biochemistry

Course aims:

Studying and testing biochemical changes that occur in human diseases through the acquisition of knowledge and skills related to organization of work, automation, computerization, quality control and the use of evidence-based medicine and specific technologies and analytical procedures for examining biological samples in medical laboratories. The acquired knowledge and skills are the basis for the subject Clinical chemistry with molecular diagnostics 2.

Course outcomes:

Understanding the biochemical basis of human diseases. The role of a biochemical laboratory in diagnostics, monitoring and treatment of the disease and the clinical significance of determining biochemical parameters. Knowledge of theoretical principles and factors influencing the choice of methods used in biochemical laboratories, principles of assessment of laboratory tests and the clinical significance of determining biochemical parameters.

Course contents:

Lectures

Organization and optimization of the pre-analytical, analytical and postanalytical phases of the total testing process in clinical laboratory (basic concepts of clinical laboratory design, accreditation, occupational health protection in the clinical laboratory, pre-analytical phase, automation and computerization of the pre-analytical, analytical and post-analytical phases, determining beside the patient-POCT, control of the quality of the total testing process in clinical laboratory, interpretation of the laboratory results). Evidence-based laboratory medicine -EBLM (set up a clinical issue, research design, systematic reviews, guides, economic evaluation). Clinical value of laboratory determinations; specific analytical techniques in clinical chemistry; basic principles of management and leadership of a medical laboratory.

Practical classes

Practical work in a clinical laboratory. Requirements for the proper taking of biological samples; requirements related to staff, reagents and equipment in a clinical laboratory; automation and computerization of the pre-analytical, anlytical and post-analytical phases of the total testing process in clinical laboratory; determination beside the patient-POCT; conducting quality control in a clinical laboratory; laboratory evidence-based medicine (formulation of questions according to P(P)ICO strategy and selection of designs, calculation of different parameters of diagnostic accuracy and their interpretation, critical evaluation of diagnostic tests with the use of standardized checklist). Clinical value of laboratory determination; application of HPLC in medical laboratories.

Recommended literature:

1. Spasić S, Jelić-Ivanović Z, Spasojević-Kalimanovska V. Medicinska biohemija. Farmaceutski fakultet, Beograd 2004.

2. Spasić S, Jelić-Ivanović Z, Spasojević-Kalimanovska V. Praktikum za vežbe iz medicinske biohemije. Farmaceutski fakultet, Beograd, 2005.

3. Burtis CA, Ashwood ER, Bruns DE (editors). Tietz Textbook of Clinical Chemistry and Molecular Diagnostics, 5th Edition. St. Louis, MO: Elsevier, 2012.

4. Internal scripts, lectures.

The total of active learning classes

Lectures: 45	**Practical classes:** 60
Research work:	**Other forms of teaching:**

Teaching methods:

Lectures, interactive classes and workshops, practical classes - work in a clinical laboratory, seminar paper, discussions and practical cases analysis, problem based learning, internet and library use, e-learning

Grading system			
Exam prerequisites	**Points**	**Final exam**	**Points**
Active participation in lectures		Practical	
Practical classes	10	Written	30
Workshops	20	Oral	40
Colloquia			
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY – MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy – Medical Biochemistry

Course title: Food Safety Control 1

Teachers: Slađana S. Šobajic, Ivan M. Stanković, Brižita I. Đorđević. Ivana D. Đuričić, Bojana B. Vidović

Course status: Mandatory

Semester: VIII	**Year of studies:** IV
ECTS points: 5	**Course code:** B4O9

Requirements: Bromatology

Course aims:

Introduction to the process of hazard analysis and risk evaluation on contaminants in food and drinking water; Biological, chemical and physical hazards. Hazard analysis and critical control points. Classification of hazards associated with food consumption. Types of contaminantion. Legislation on food contamination.

Course outcomes:

Upon completion of the course student is trained to provide information on the importance of the food quality and food safety, as well as on types of contamination and classes of contaminanats, as well as legislation. Student should be able to conduct basic chemical analyses and to interprete the results acorrding to actual legislation.

Course contents:

Lectures

Basic data on hazard analysis and food safety; types of contamination and classes of contaminants in food and drinking water, assesment on contaminants' daily intake, food forgery.

Practical classes

Basic techniques and methods used in analysis of food quality and safety, determination of certain contaminants (Pheno-lic compounds, heavy metals, antibiotics, pesticides); drinking water safety analysis – determinantion of certain parame-tres, assesment on uptake on certain contaminants; creating analytical reports. Fundamental working principles in labo-ratory of sanitary chemistry.

Recommended literature:

1. M. Mirić; S. Šobajić. Zdravstvena ispravnost namirnica., Beograd, 2002.
2. Trajković J., Mirić M., Baras J., Šiler S. Analiza životnih namirnica. Tehnološko-metalurški fakultet, Beograd, 1983.
3. AOAC metode, 2005
4. Радна свеска из Здравствене исправности намирница
5. Izvodi sa predavanja (handouts).

The total of active learning classes

Lectures: 30	**Practical classes:** 30
Research work:	**Other forms of teaching:**

Teaching methods:

Grading system

Exam prerequisites	Points	Final exam	Points
Active participation in lectures	0-7	Practical	
Practical classes	9-18	Written	33-65
Workshops	6-10	Oral	
Colloquia			
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY – MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy – Medical Biochemistry

Course title: Ethics and Legislation

Teachers: Krajnović M. Dušanka, Marinković D. Valentina

Course status: elective

Semester: VII	**Year of studies:** IV
ECTS points: 3	**Course code:** B4I1

Requirements:

Course aims:

Students will be able to

- understand the importance of ethics in biochemical health discipline
- to see the differences between ethical and legislative problems
- to acquire the knowledge and skills for passing the ethical analyses
- to understand the national and international legislative provisions on the health services and their applying into practice

Course outcomes:

- student will be able see the difference between legislative and ethical problems which a biochemist is encountered in his professional activities;
- student is able to apply the normative principles and the ethical theories dealing with patients and human materials
- student will know and will apply the legislative acts which are important for medical and biochemical as well as laboratory proceedings

Course contents:

Lectures

Bioethics: definition, subdivisions and research disciplines. Fundamental ethical principles of the utmost importance for medical and biochemical as well as laboratory practice. The ethical normative theories related to medical and biochemical as well as laboratory practice. The institutional ethical committees in preclinical and clinical researches: role, place, working procedures, duties and responsibilities. Biomedical researching in the developing countries. The ethical principles in data reporting in medical and biochemical i.e. laboratory analysis and published literature evaluation. The legislative principles in the health care and the health assurance. The rights and responsibilities of patients. The Chamber of Serbian Medical Biochemists. The working licence for pharmacists. The Court of Honour.

Practical classes

The analysis and discussion of the case studies from practical engagements. Problem-based learning. Panel discussions (applying of the ethics and legislation on the actual problems such as: ethics in the common biochemical and laboratory practice, ethical approach to poisoning, keeping of confidential information on a patient, ethics in the protection of the human environment, ethical analyses in the food quality control analyses. The actual bioethical topics. Medical devices. Health insurance.

Recommended literature:

1. Krajnović D, Milošević Georgiev A, Marinković V. Etika i zakonodavstvo. Praktikum. Beograd: Univerzitet u Beogradu-Farmaceutski fakultet; 2013.
2. Parojčić D. Razvoj etike u farmaciji od teorije do savremene prakse. Beograd: Konstisi; 2006.
3. Beachamp TL. Childress J.F. Principles of Biomedical Ethics. 5th ed. New York: Oxford University Press; 2001.
4. Pens G. Klasični slučajevi u medicinskoj etici. Beograd: Službeni glasnik Beograd; 2008.
5. Fatović-Ferenčić S, Tucak A. Medicinska etika. Zagreb: Medicinska naklada; 2011.

The total of active learning classes

Lectures: 30	**Practical classes:** 15
Research work:	**Other forms of teaching:**

Teaching methods:

Interactive and practical teaching (workshops: case studies from practical engagements, problem-based learning, panel discussions, tests, homework).

Grading system			
Exam prerequisites	**Points**	**Final exam**	**Points**
Active participation in lectures	20	Practical	
Practical classes	40	Written	40
Workshops		Oral	A student is called for oral exam if the teacher considers that it is of importance for a reliable evaluation
Colloquia			
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY-MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy-Medical Biochemistry

Course title: Acute Drug Poisoning with Analytics

Teachers: Matovid J. Vesna, Vujanovid L. Dragana, Đukid M. Mirjana, Antonijevid M. Biljana, Bulat L. Zorica

Course status: elective

Semester: VII	**Year of studies:** IV
ECTS points: 3	**Course code:** B4I2

Requirements: none

Course aims:

Acquisition, adoption, synthesis and implementation of knowledge on the toxicity of the most important groups of drugs, including their toxic effects, mechanisms of toxicity, as well as the analytics.

Course outcomes:

Qualification of Masters of Pharmacy-Medical Biochemistry to prove and determine the drug that caused poisoning, to follow the kinetics of the drugs during the therapy and to contribute to the prevention of drug poisoning.

Course contents:

Lectures

Epidemiological aspect of drug poisoning. General principles of drug poisoning treatment. Mono and

polymedicament poisoning. 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 (aliklating agents, antimetabolites, cytotoxic antibiotics, plant derivatives), antiretroviral agents.

Practical classes

Practical training is integrated part of lectures which is focused on sample preparation and determination of drugs-induced poisonings.

Recommended literature:

1. Olson KR. Poisoning & Drug Overdose. 4th ed. Olson RK, editor. New York: McGraw-Hill Medical;

2004.

2. Joksovid D. Akutna trovanja lekovima, Beograd: Rivel , 1999.

3. Barile FA. Clinical Toxicology-Principles and Mechanisms. London: Informa Healthcare; 2007.

4. 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 classes:** 15
Research work:	**Other forms of teaching:**

Teaching methods:

lectures, case study analysis

Grading system

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

Seminars		
Other activities		

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY – MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy – Medical Biochemistry

Course title: Laboratory Diagnosis of reproductive endocrine disorders

Teachers: Stefanović Ž. Aleksandra, Zeljković R. Aleksandra

Course status: elective

Semester: VIII	**Year of studies:** IV
ECTS points: 3	**Course code:** B4I3

Requirements: Medical biochemistry

Course aims:

Broadening of students' knowledge and skills in the area of laboratory diagnostics and monitoring of the reproductive endocrine disorders.

Course outcomes:

Understanding of laboratory technics which are used in routine laboratory practise for determinations of reproductive hormone concentratios in different bilogical samples. Unrestanding of preanalytical and analytical errors in laboratory testing and potential interferences.

Students will know how to perform and analyse biochemical analysis results from the laboratory diagnostics of reproductive endocrine disorders. Also, students will know how to analyse the influence of other different endocrine disorders on reproductive hormons.

Course contents:

Lectures

Disorders of androgen biosynthesis. Laboratory diagnostics of fetal, neonatal and pediatric male reproductive endocrine disorders. The role of hypotalamic-pituitary- gonadal axis in pathogenesis of male reproductive endocrine disorders: infertility, erectile dysfunction, gynecomastia; laboratory diagnostics of disorders. Disorders of estrogen biosynthesis. Laboratory diagnostics of fetal, neonatal and pediatric female reproductive endocrine disorders. Irregular menses. Laboratory diagnostics of primary and secondary amenorrhea. Polycystic ovary syndrome. Female infertility. Estrogens and breast cancer. The role of estrogen and progesterone receptors testing in breast cancer diagnosis and monitoring.

Practical classes

Characteristics of the biological specimens for reproductive hormones determination; Sources of preanalytical and analytical errors. Methots for the determination of FSH, LH, androstendion, DHEA, free, bioavailable and total testosterone. Analytical methods for the determination of estradiol, estriol, estron, progesteron, estrogen and progesreton receptors. Potential interferences. Results interpretation.

Recommended literature:

1. Marina Stojanov : Laboratorijska endokrinologija, EXCELSIOR, Beograd, 2016.
2. Saffron Whitehead, John Miell : Clinical Endocrinology, Scion Publishing Ltd., 2012.
3. Raghvendra K. Dubey: Sex Hormones, In Tech, 2012.
4. Burtis CA, Ashwood ER, Bruns DE. Tietz Textbook of Clinical Chemistry and Molecular Diagnostics; Elsevier; 5th ed (2012).

The total of active learning classes

Lectures: 0	**Practical classes:** 15
Research work:	**Other forms of teaching:**

Teaching methods:

lectures, seminars, workshops, e-learning, problem based learning

Grading system

Exam prerequisites	Points	Final exam	Points
Active participation in lectures	7	Practical	
Practical classes	15	Written	40
Workshops	18	Oral	

Colloquia	20		
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY-MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy-Medical Biochemistry

Course title: Ecotoxicology

Teachers: Matovid J. Vesna, Vujanovid L. Dragana, Đukid M. Mirjana, Antonijevid M. Biljana, Bulat L. Zorica

Course status: elective

Semester: VII	**Year of studies:** IV
ECTS points: 3	**Course code:** B4I4

Requirements: none

Course aims:

Introduction, gathering of knowledge, understanding, application, analysis end evaluation of the knowledge and skills in the field of ecotoxicology with the special emphasis on the most important pollutants and their global effects on humans and environment.

Course outcomes:

Student will gain competencies to be a part of multidisciplinary team that deals with the problems and prevention of the environmental pollution, as well as with the human health.

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 environment 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 toxic and ecotoxic effects on the environment. Ecotoxicological risk assessment. Effects of the environment on the human health.

Practical classes

Case studies and analysis of the most important environment pollutants. Eco-toxicity tests. Ecological catastrophes.

Recommended literature:

1. Walker CH, Hopkin SP: Principles of Ecotoxicology. 2nd ed. Walker CH, Hopkin CH, Sibly RM, Peakall DB, editors. London: Taylor and Francis; 2001.

2. Newman MC, Unger MA. Fundamentals of Ecotoxicology. 2nd ed. Boca Raton: Lewis Publishers; 2003.

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
Research work:	**Other forms of teaching:**

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
Workshops	20	Oral	20

Colloquia			
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY – MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy – Medical Biochemistry

Course title: Laboratory diagnostics of immune disorders

Teachers: Bufan S. Biljana, Jančić R. Ivan

Course status: Elective

Semester: VIII	**Year of studies:** IV
ECTS points: 3	**Course code:** B4I7

Requirements: Immunology with immunochemistry

Course aims:

To provide knowledge about pathogenesis of the diseseas caused by dysfunction of the immune system and immune/immunochemical parameters used for their diagnosis. Also, to get to know about immune/immunochemical techniques and assay used for quantitative/qualitative assesment of immune parameters and to develop a critical attitude towards application of adequate test and interpretation of obtained results.

Course outcomes:

After completing the course the students are expected to:

• know pathogenesis of immune disorders

• know immune/immunochemical parameters that are indicators of immune disorders

• know and understand technics and assays for quantitative/qualitative assesment of immune parameters.

Course contents:

Lectures

Hypersensitivity diseases. Immediate hypersensitivity: ethiology, pathogenesis, clinical manifestations, diagnosis. Ethiology, pathogenesis and diagnosis of autoimmune diseases of: endocrine system, nervous system, liver, skin, gastrointestinal tract and kidney. Ethiology, pathogenesis and diagnosis of: connective tissue diseases, autoimmune hematological disorders and immunoproliferative diseases. Immunodeficiency: primary and secondary (aquired immunodeficiency syndrome, AIDS).

Practical classes

In vitro and in vivo tests for diagnosis of immediate hypersensitivity. Immune/immunochemical tests for diagnosis and monitoring of autoimmune and immunoproliferative diseases. Tests that are used for diagnosis of immunodeficiencies. Immunomonitoring of HIV+ patients.

Recommended literature:

1. Abbas AK, Lichtman A, Pillai S. Cellular and molecular immunology. 9th ed. Philadelphia: Elsevier Saunders; 2018.

2. Rich RR, Fleisher TA, Shearer WT, Schroeder HW, Frew AJ, Weyand CM. Clinical immunology principles and practice. Mosby Elsevier, Philadelphia, PA, USA, 3rd ed. 2008.

3. Dorrestyn Stevens DS. Clinical Immunology & Serology A Laboratory Perspective. FA Davis Company, Philadelphia, PA, USA, 3rd ed. 2010.

4. Zabriskie JB. Essential Clinical Immunology. Cambrigde University Press, Cambrigde, UK, 2009.

5. Spickett G. Oxford Handbook of Clinical Immunology and Allergy. Oxford University Press, 2013.

The total of active learning classes

Lectures: 25	**Practical classes:** 20
Research work:	**Other forms of teaching:**

Teaching methods:

Lectures, seminars, workshops, case studies.

Grading system

Exam prerequisites	Points	Final exam	Points
Active participation in lectures	10	Practical	
Practical classes	10	Written	60

Workshops		Oral	
Colloquia	20		
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY - MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy - Medical Biochemistry

Course title: Analyses in clinical toxicology

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

Course status: Mandatory

Semester: IX	**Year of studies:** V
ECTS points: 5	**Course code:** B5O1

Requirements: none

Course aims:

Gaining the knowledge of the role and significance of the toxicological laboratory and analytics of drugs and other relevant substances for clinical, occupational and forensic toxicology.

Course outcomes:

Competence of Master of Pharmacy -Medical Biochemistry for work in clinical toxicology and forensic laboratory: proper sampling, sample preparation and analysis, results interpretation. In addition to the proactive role and team work concerning issues in poisoning therapy, the acquired knowledge will enable students to take active part in the prevention of poisoning.

Course contents:

Lectures

Clinical Toxicology as a field of toxicology. Poison Control Centers. Clinical toxicological laboratory, role of toxicologist-analyst in diagnosis and treatment of poisoning. Organization of a toxicological laboratory and good laboratory practice. Sampling and samples (blood, urine, gastric contents, saliva, skin, hair, vitreous body fluid, synovial fluid etc.). Preparation of samples for toxicological analysis: mineralization, extraction. Screening methods. Methods of detection and determining of poisons-the most important causes of acute poisonings: drugs (benzodiazepines, phenothiazines, tricyclic antidepressants, non-steroidal analgesics, ß-blockers), substances of abuse, and other substances of relevance in terms of clinical and forensic toxicology. Kinetics, toxicity mechanisms, clinical picture, toxic doses and the basis of poisoning therapy.

Practical classes

Practical training is an integral part of theoretical teaching and is designed to enable students to master the complete process of clinical toxicological and forensic analysis. Case studies of poisonings by drugs, carbon monoxide, ethanol, pesticides,substances of abuse. Case studies and interpretation of results.

Recommended literature:

1. Jickells S, Negrusz A. Clarke's Analytical Forensic Toxicology. 3rd ed. Jickells S, Negrusz A, editors. London, UK: Pharmaceutical Press;2008.

2. 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.

3. Olson KR. Poisoning & Drug Overdose. 4th ed. Olson RK, editor. New York: Lange Medical Books; 2004.

The total of active learning classes

Lectures: 30	**Practical classes:** 60
Research work:	**Other forms of teaching:**

Teaching methods:

Lectures, presentation and analysis of case studies, practical work in groups, laboratory of clinical toxicology and forensic laboratories.

Grading system

Exam prerequisites	Points	Final exam	Points
Active participation in lectures		Practical	
Practical classes	15	Written	
Workshops	20	Oral	60

Colloquia			
Seminars	5		
Other activities			

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY – MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy – Medical Biochemistry

Course title: Clinical chemistry with molecular diagnostics 2

Teachers: Ignjatović D. Svetlana, Dopsaj B. Violeta, Topić S. Aleksandra, Mirković S. Duško, Ninić R Ana

Course status: Mandatory

Semester: IX	**Year of studies:** V
ECTS points: 10	**Course code:** B5O5

Requirements: Medical biochemistry

Course aims:

Studying and testing the biochemical changes that occur in human diseases through the acquisition of knowledge and skills in the application of specific clinical-biochemical and molecular-biological tests in screening, prevention, diagnostics, monitoring, prognosis and the success of the treatment of individual organs and system organs.

Course outcomes:

Understanding the biochemical basis of human diseases, the role of a biochemical laboratory in diagnostics, monitoring and treatment of the disease and the clinical significance of determining biochemical parameters. Knowledge of theoretical principles and factors influencing the choice of methods used in biochemical laboratories and principles of assessment of laboratory tests and the clinical significance of determining biochemical parameters.

Course contents:

Lectures

Hemoglobin metabolism, hemoglobinopathy, thalassemia. Iron, iron status, iron deficiency and iron loading. Porphyrins and porphyria. Examination of liver function. Laboratory diagnosis of kidney disease. Examination of gastrointestinal tract function. Heart function and biomarkers of the cardiovascular system. Examination of the bone system function. Laboratory diagnostics of cancer and tumor markers. Biochemical analysis of various body fluids (cerebrospinal, amniotic, synovial and seminal fluid, serous liquids, saliva and sweat). Diagnostics of diseases and disorders in specific conditions (prenatal and pediatric diagnostics of the disease, diagnostics of diseases in geriatrics, diagnosis of disorders in pregnancy). Monitoring the concentration of drugs in body fluids. Basic principles and techniques of molecular diagnostics. Organization of laboratories for molecular diagnostics. Molecular diagnostics of monogenic diseases (cystic fibrosis, Huntington's disease, haemophilia A) and complex diseases, in oncology, paternity assessment, transplantation and infectious diseases.

Practical classes

Practical work in a clinical laboratory. Requirements for the proper taking of various body fluids. Iron status test. Determination of urea, creatinine, examination of the glomerular function of the kidney; chemical examination of urine and urine sediment. Determination of bilirubin, bile acids and ammonia. Faecal, cerebrospinal and pleural fluid analysis. Determining the biomarker of the cardiovascular system. Determination of tumor markers. Determination of bone biomarkers. Determining the concentration of drugs. Organization of laboratories for molecular diagnostics. Examination of occult bleeding and malabsorption in faeces; determination of elastase in faeces.

Recommended literature:

1. Spasić S, Jelić-Ivanović Z, Spasojević-Kalimanovska V. Medicinska biohemija. Farmaceutski fakultet, Beograd 2004.

2. Spasić S, Jelić-Ivanović Z, Spasojević-Kalimanovska V. Praktikum za vežbe iz medicinske biohemije. Farmaceutski fakultet, Beograd, 2005.

3. Burtis CA, Ashwood ER, Bruns DE (editors). Tietz Textbook of Clinical Chemistry and Molecular Diagnostics, 5th Edition. St. Louis, MO: Elsevier, 2012.

4. Internal scripts, lectures.

The total of active learning classes

Lectures: 60	**Practical classes:** 75
Research work:	**Other forms of teaching:**

Teaching methods:

Lectures, interactive classes and workshops, practical classes - work in a clinical laboratory, seminar paper, discussions and practical cases analysis, problem based learning, internet and library use, e-learning

Grading system			
Exam prerequisites	**Points**	**Final exam**	**Points**
Active participation in lectures		Practical	
Practical classes	10	Written	30
Workshops	20	Oral	40
Colloquia			
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY – MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy – Medical Biochemistry

Course title: Food Safety Control 2

Teachers: Slađana S. Šobajic, Ivan M. Stanković, Brižita I. Đorđević. Ivana D. Đuričić, Bojana B. Vidović

Course status: Mandatory

Semester: IX	**Year of studies:** V
ECTS points: 5	**Course code:** B5O3

Requirements: Bromatology

Course aims:

Introduction to general features of additives and their usage, as well as risk analsys. Key characteristics of flavours and enzymes. Legislation on food additives, enzymes and flavours Key principles of the determination of ADI. Basic knowledge on food packiging matherials. Informations on nutrients' interactions during thermal treatment and theirs' health impact. Maillards' reaction. Basic knowledge on naturally ocurring toxic compounds in food.

Course outcomes:

Upon completion of the course student is trained to provide information on the importance of the food quality and food safety, as well as on classes of additives, flavours and enzymes, as wel as their legislation. Student should be able to conduct basic calculations on ADI and to interprete the results acorrding to actual legislation. Student should be able to conduct basic chemical analyses on addives and thermal treatment' products.

Course contents:

Lectures

Basic data on hazard analysis and food safety; types of additives, assesment additives' daily intake. Influence on thermal treatment upon composition on foods. Naturally ocurring toxic compounds. Packaging matherials.

Practical classes

Basic techniques and methods used in analysis of food quality and safety, determination of certain additives (sorbic acid, benzoic acid); determinantion of Maillards' reaction products, assesment on uptake on certain additives; creating analyti-cal reports. Using EU database for evaluation of additives' intake.

Recommended literature:

1. M. Mirić; S. Šobajić. Zdravstvena ispravnost namirnica., Beograd, 2002.
2. Trajković J., Mirić M., Baras J., Šiler S. Analiza životnih namirnica. Tehnološko-metalurški fakultet, Beograd, 1983.
3. AOAC metode, 2005
4. Радна свеска из Здравствене исправности намирница
5. Izvodi sa predavanja (handouts).

The total of active learning classes

Lectures: 30	**Practical classes:** 30
Research work:	**Other forms of teaching:**

Teaching methods:

lectures, practical classes.

Grading system

Exam prerequisites	Points	Final exam	Points
Active participation in lectures	0-7	Practical	
Practical classes	9-18	Written	33-65
Workshops	6-10	Oral	
Colloquia			
Seminars			

Other activities		

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY – MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy – Medical Biochemistry

Course title: Prenatal diagnostic and screening in pregnancy

Teachers: Ignjatović D. Svetlana

Course status: Elective

Semester: IX	**Year of studies:** V
ECTS points: 4	**Course code:** B5I1

Requirements: Medical biochemistry

Course aims:

The acquisition of wider knowledge of principles of prenatal diagnostic. Serum markers biology. Screening with biochemical marker characteristics. First trimester screening, second trimester and integrated screening, serum marker determination. Factors that influence the results of serum markers.

Course outcomes:

Understanding the meaning of MoM and its distribution. Calculate the degree of fetal disorders detection and the level of false positive results. Evaluate the screening value. Apply a computer program to calculate the risk.

Course contents:

Lectures

All aspects of prenatal screening for trisomy 21 (Down syndrome), trizomy 18 (Ed-wards syndrome), trisomy 13 (Patau's syndrome) and defects of the neural tube, from the screening to technical and practical application. Biology of serum markers. Markers for the first trimester: pregnancy-related plasma protein A (PAPP-A), free β-human chorionic gonadotropin (free β-hCG), ultrasound markers (nuchal translucency, abscess of the nasal bone). Markers for the second trimester: alpha-fetoprotein (AFP), unconjugated estriol (uE3), inhibin-A, β-human chorionic gonadotropin (β-hCG). Integrated Screening. Contigent screening. Sequential screening. Determination of serum markers. Multiplies of the median (MoM). Factors that influence the setting of screening parameters. Calculating the risk, the degree of detection of fetal disorders, and the degree of false positive results. Screening efficiency. Software packages for risk calculation.

Practical classes

Practical work in a clinical laboratory. Analytical procedures for determining markers for the first and second trimesters. Quality control. Use a commercial software package to calculate the risk. Interpretation of results, introduction to instructions and report of prenatal screening.

Recommended literature:

1. Carl A. Burtis, Edward R. Ashwood, David E. Bruns: Tietz Textbook of Clinical Chemistry and Molecular Diagnostics, Elsevier 2012.

2. Lawrence A Kaplan, Amadeo J Pesce, Steven Kazmierczak: Clinical Chemistry, 5th Edition - Theory, Analysis, Correlation, Elsevier, 2011.

3. Wald NJ, Rodeck C, Hackshaw AK, Walters J, Chitty L, Mackinson AM. First and second trimester antenatal screening for Down's syndrome: the results of the Serum, Urine and Ultrasound Screening Study (SURUSS). J Med Screen 2003;10:56-104.

4.Malone FD, Canick JA, Ball RH, Nyberg DA, Comstock CH, Bukowski R, Berkowitz RL, Gross SJ, Dugoff L, Craigo SD, Timor-Tritsch IE, Carr SR, Wolfe HM, Dukes K, Bianchi DW, Rudnicka AR, Hackshaw AK, Lambert-Messerlian G, Wald NJ, D'Alton ME. First- and Second-Trimester Evaluation of Risk (FASTER) Research Consortium. First-trimester or second-trimester screening, or both, for Down's syndrome. N Engl J Med 2005;353:2001-2011.

The total of active learning classes

Lectures: 30	**Practical classes:** 15
Research work:	**Other forms of teaching:**

Teaching methods:

Lectures, interactive classes and workshops, practical classes - work in a clinical laboratory, seminar paper, discussions and practical cases analysis, problem based learning, internet and library use, e-learning

Grading system

Exam prerequisites	Points	Final exam	Points

Active participation in lectures	10	Practical	
Practical classes	10	Written	70
Workshops	10	Oral	
Colloquia			
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY - MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy - Medical Biochemistry

Course title: Toxicology in practice

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

Course status: Elective

Semester: IX	**Year of studies:** V
ECTS points: 4	**Course code:** B5I2

Requirements: none

Course aims:

Gaining of knowledge in various areas of toxicology: clinical toxicology, forensic toxicology, occupational toxicology and environmental pollution, with special emphasis on laboratory work.

Course outcomes:

The qualification of Master of Pharmacy-Medical Biochemistry to be the part of multidisciplinary teams dealing with problems of clinical, professional, forensic toxicology and ecotoxicology and competences and skills for the work in toxicological laboratories.

Course contents:

Lectures

Organization of a toxicological laboratory and good laboratory practice. Specifics of clinical toxicology and laboratory for clinical toxicology, as well as the most relevant poisons. Specifics of forensic toxicology and laboratory for forensic toxicology, as well as the most important poisons. Specifics of occupational toxicology and laboratories of occupational toxicology, as well as the most important toxic agents in the occupational environment. Specifics of ecotoxicology and ecotoxicological laboratories, as well as the most significant environmental pollutants. Exposure to a large number of toxic agents: toxicology of the mixtures. Medical waste.

Practical classes

Practical training is an integral part of theoretical teaching and is carried out through representative case studies in terms of clinical toxicology, forensic toxicology, occupational toxicology and environmental pollution. Case studies and interpretation of results.

Recommended literature:

1. Casarett & Doull's Toxicology: The Basic Science of Poisons. 7th ed. Klaassen CD, editor. New York: McGrawHill;

2008.

2. Jickells S, Negrusz A. Clarke's Analytical Forensic Toxicology. 3rd ed. Jickells S, Negrusz A, editors. London, UK: Pharmaceutical Press; 2008.

3. Olson KR. Poisoning & Drug Overdose. 4th ed. Olson RK, editor. New York: Lange Medical Books; 2004.

4. Forbes VE, Forbes TL. Ecotoxicology in theory and practice. London:Chapman and Hall; 1994.

The total of active learning classes

Lectures: 30	**Practical classes:** 15
Research work:	**Other forms of teaching:**

Teaching methods:

Lectures, case studies, laboratory practice, Moodle (e-learning platform).

Grading system

Exam prerequisites	Points	Final exam	Points
Active participation in lectures	10	Practical	
Practical classes	20	Written	
Workshops	20	Oral	50

Colloquia			
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY - MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy - Medical Biochemistry

Course title: Chemical carcinogens

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

Course status: Elective

Semester: IX	**Year of studies:** V
ECTS points: 4	**Course code:** B5I3

Requirements: none

Course aims:

Gaining the knowledge on chemical carcinogens, their mechanisms of action, genotoxicity tests, risk assessment of genotoxic and epigenetic carcinogens.

Course outcomes:

The qualification of Master of Pharmacy - Medical Biochemistry to be a part of a team engaged in research into chemical carcinogens and assessing the risks of carcinogens for human health, as well as the cancer prevention.

Course contents:

Lectures

History. Basics of carcinogenesis. Chemical structure and carcinogenic activity relationship. Types and classifications of chemical carcinogens. Mechanisms of action. Oxidative stress as a mechanism of carcinogenic effect. Genotoxic and epigenetic carcinogens. The most important chemical carcinogens: professional and environmental exposure. Dose-response relationship in chemical carcinogens. Risk asessment of genotoxic and epigenic carcinogens on human health.

Practical classes

As an integral part of the lectures, these classes are designed to enable students to gain practical knowledge and analytics of certain chemical carcinogens. Assessment of the dose-response relationship and estimation of exposure of general population, as well as the calculation of the carcinogenic risk assessment.

Recommended literature:

1. Hsu C.H., Stedeford T. Cancer Risk Assessment. New Jersey: John Wiley & Sons; 2010.

2. Choy W.N. Genetic toxicology and cancer risk assessment. New York: Marcel Dekker Inc; 2001.

3. Shields PG. Cancer Risk Assessment. Shields PG, editor. Boca Raton: Taylor&Francis Group; 2005.

4. Leeuwen CJ, Vermeire TG. Risk Assessment of Chemicals. 2nd edition, Netherlands: Springer. 2007.

5. Casarett & Doull's Toxicology: The Basic Science of Poisons. 7th ed. Klaassen CD, editor. New York: McGrawHill; 2008.

The total of active learning classes

Lectures: 30	**Practical classes:** 15
Research work:	**Other forms of teaching:**

Teaching methods:

Lectures, case studies, laboratory practice, Moodle (e-learning platform).

Grading system

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

Other activities		

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY – MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy – Medical Biochemistry

Course title: Biochemistry of sport

Teachers: Violeta B. Dopsaj, Maja A. Tomic, Brizita I. Djordjevic, Ana R. Ninic, Andjelija M. Malenovic

Course status: Elective

Semester: IX	**Year of studies:** V
ECTS points: 4	**Course code:** B5I4

Requirements:

Course aims:

Acquiring knowledge from biochemistry of sport as a part of physiology of exercise and sports medicine, a multidisciplinary approach to the study of sports science in general. Knowledge of biochemical and haematological changes in the body that are created under the influence of physical exercise, the use of medicines, dietary supplements and prohibited substances and methods in sports.

Course outcomes:

To enable the student to evaluate the reactions of the body under the influence of stress caused by physical exercisse in the conditions of training and recreational exercise, prohibited pharmacologically active substances, dietary supplements and methods. Understanding techniques in detecting the use of doping agents in biological fluids and the application of antidoping.

Course contents:

Lectures

The influence of physical exercise on the physiological systems of the organism. Metabolic pathways that provide energy in conditions of anaerobic and aerobic muscular work. Oxygen deficit and oxygen debt. Determination of maximum oxygen consumption, determination of lactate threshold and acid-base status. The influence of physical exercise on biochemical and haematological parameters. Free radicals, antioxidant protection and physical exercise. Anemia in athletes, blood doping, a biological passport. Adaptation of the body to physical activity. The role and importance of pharmacists and biochemists in antidoping. Methods in detecting the use of doping agents. Pharmacologically active substances and methods prohibited before and after competition. The influence of drugs on biochemical and haematological parameters. The pharmacological effect of drugs that can be used in doping. Rational use of dietary supplements in sports.

Practical classes

Defining the characteristics of the lactate curve, determining the body structure by bioimpedance, testing contractile muscle characteristics, examination of haematological status in athletes, analysis of methods used to control doping.Visiting laboratory for testing athletes.

Recommended literature:

1. Katch VL, McArdle WD, Katch FI. Essentials of exercise physiology, 4th ed. Lippincott Williams & Wilkins 2011.
2. Viru M. Biochemical monitoring of sport training. Human Kinetics Publishers, Inc, 2001.
3. Stephen Reed. Essential Physiologycal biochemistry. Wiley-Blackwell 2009.
4. Paul David. A guide to the world Anti-doping Code. Cambrige University Press 2008.
5. Vasilis Klisuras. Osnovi sportske fiziologije (prevod: Vassilis Klissouras. Fundamentals of Sports Physiology). USMS 2013.

The total of active learning classes

Lectures: 30	**Practical classes:** 15
Research work:	**Other forms of teaching:**

Teaching methods:

Lectures, interactive teaching, practical work in the laboratory, analysis of cases from practice

Grading system

Exam prerequisites	Points	Final exam	Points
Active participation in lectures	10	Practical	
Practical classes	20	Written	70

Workshops		Oral	
Colloquia			
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY – MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy – Medical Biochemistry

Course title: Laboratory management and quality assurance

Teachers: Ignjatović D. Svetlana

Course status: Elective

Semester: IX	**Year of studies:** V
ECTS points: 4	**Course code:** B5I5

Requirements: Medical biochemistry

Course aims:

Introduction to the basic principles of laboratory management and leadership of the laboratory. Using the quality management system (QMS) based on the preparation of the strategic and business plan. Knowledge of the preparation of the budget of the laboratory and the financial plan, based on the principles of good laboratory practice.

Course outcomes:

Application of knowledge and skills to perform a good laboratory organization and work efficiency, evaluate the quality of total testing process in clinical laboratory, improve productivity, implement the principles of occupational safety, enforce legal and ethical regulations and familiarize with the principles of accreditation according to the requirements of the ISO standard series: ISO 9000, ISO 17025 and ISO 15189.

Course contents:

Lectures

Laboratory organization and quality management. Selection of work procedures, planning in the laboratory, selection of equipment and methods. Quality assessment in the laboratory. Improving productivity and efficiency in the laboratory. Laboratory Technology Management. Application of standards and norms in the laboratory. Point-of-Care Testing. Data management: medical informatics, data transfer, telecommunications, presentation and handling of laboratory data (selection of units, appearance and content of the report). Educating laboratory staff and writing and maintaining QMS procedures. Application of legal and ethical regulations: implementation in the laboratory, ethical aspects and conventions in the preparation, interpretation, reporting and use of medical-laboratory data. Knowledge of ISO standards and principles of accreditation: introduction to the laboratory, maintenance of QMS. Pre-analytical, analytical and post-analytical process of the medical laboratory according to the requirements of ISO 15189.

Practical classes

Practical work in a clinical laboratory: Laboratory arrangement according to the requirements of standard SRPS ISO 15189: 2008. Getting to know the hierarchy of QMS documents. Creation of communication forms - presentation modes. Preparation of QMS documents - instruction, procedure, record. Introduction to the requirements of organization and management (quality management system: document management, contract review, referral laboratories, external services and procurement, advisory services, complaints handling, identification and control of nonconformities, corrective measures, preventive measures, continuous improvement, quality and technical records, internal checks, leadership reviews) and technical requirements (staff, accommodation and environment conditions and laboratory equipment).

Recommended literature:

1. Carl A. Burtis, Edward R. Ashwood, David E. Bruns: Tietz Textbook of Clinical Chemistry and Molecular Diagnostics, Elsevier 2012.

2. Мајкић-Сингх Н. Медицинска биохемија, ДМБСЦГ, Београд, 2006.

3. Burnett D. A practical guide to accreditation. ACB Venture Publications. 2002.

4. ISO 9001:2000 Quality management systems – Guidelines for performance improvements.

5. SRPS ISO 15189:2008.

The total of active learning classes

Lectures: 30	**Practical classes:** 15
Research work:	**Other forms of teaching:**

Teaching methods:

Lectures, interactive classes and workshops, practical classes - work in a clinical laboratory, seminar paper, discussions and

practical cases analysis, problem based learning, internet and library use, e-learning			
Grading system			
Exam prerequisites	**Points**	**Final exam**	**Points**
Active participation in lectures	10	Practical	
Practical classes	10	Written	70
Workshops	10	Oral	
Colloquia			
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY – MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy – Medical Biochemistry

Course title: Modern Methods in Medical Biochemistry

Teachers: Kotur-Stevuljevic M. Jelena, Bogavac-Stanojevic B. Nataša, Aleksandra R. Zeljković, Stefanović Ž. Aleksandra, Jelena Z. Vekić, Ana R. Ninić

Course status: elective

Semester: IX	**Year of studies:** V
ECTS points: 4	**Course code:** B5I6

Requirements: clinical chemistry with molecular diagnostics 1

Course aims:

Theoretical ground and new biochemical and molecular biology methods and procedures implementation; practical aplication of the methods and results analysis.

Course outcomes:

Apropriate selection and aplication of the complex analytical methods. Estimation of the possibilities and limitations of the methods and use basic terms for data analysis.

Course contents:

Lectures

Theoretical ground for isolation – ultracentrifugation, DNA and RNA isolation. Biomolecules quantification methods: gas chromatography, gradient gel electrophoresis, imunochemical methods. DNA and RNA analysis. Flow citometry. Analytical approach from the diagnostics aspects.

Practical classes

Demonstrative methods in laboratory – LDL and HDL particles subclasses separation by gradient gel electrophoresis, biomolecules concentration determination with ELISA techiques, DNA and RNA isolation, gene polymorphism, gene expression by rtPCR method.

Multimedial presentation of the distinct method – HDL subclasses separation by ultracentrifugation method, lipid component determination by gas chromatography, microparticles determination by flow citimetry

Recommended literature:

Practical skills in biomolecular sciences, RH Reed, JDB Weyers, AM Jones, Addison Wesley Longman Ltd 2nd ed , 2003.

The total of active learning classes

Lectures: 30	**Practical classes:** 15
Research work:	**Other forms of teaching:**

Teaching methods:

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

Grading system

Exam prerequisites	Points	Final exam	Points
Active participation in lectures	10	Practical	
Practical classes	20	Written	40
Workshops	20	Oral	
Colloquia	10		
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY – MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy – Medical Biochemistry

Course title: Objects for General Use Safety Control

Teachers: Slađana S. Šobajic, Ivan M. Stanković, Brižita I. Đorđević. Ivana D. Đuričić, Bojana B. Vidović

Course status: Elective

Semester: X	**Year of studies:** V
ECTS points: 4	**Course code:** B5I8

Requirements: Food Safety Control 1

Course aims:

Introduction to the classification and main features of objects for general use. Specificity of analysis of objects for general use. Main contaminants and legislation.

Course outcomes:

Upon completion of the course student is trained to provide information on the importance of the quality and safety of objects for general use, as well as classes of contaminanats present. Student should be able to conduct basic chemical analyses and to interprete the results acorrding to the actual legislation.

Course contents:

Lectures

Basic data on hazard enalysis and safety of objects for general use; classification and main features of objects for general use; types of contamination and classes of contaminants present. Tobacco. Toys. Co-smetics. Food packaging matherials. EU and national legislation.

Practical classes

Basic techniques and methods used in analysis of objects for general use, determination of certain

contaminants. Rate of migration in model solutions. Assesment on uptake fn certain contaminants; crea-ting analytical reports. Seminars.

Recommended literature:

1. M. Mirić; S. Šobajić. Zdravstvena ispravnost namirnica., Beograd, 2002.
2. EU and national legislation
3. Gordon L. Robrertson. Food packiging methrials. CRS Press. Francis &Taylor. Boca Raton, FL. 2013.
4. Handouts.

The total of active learning classes

Lectures: 30	**Practical classes:** 15
Research work:	**Other forms of teaching:**

Teaching methods:

lectures, laboratory practice, seminars, other activities

Grading system

Exam prerequisites	Points	Final exam	Points
Active participation in lectures	0-7	Practical	
Practical classes	9-18	Written	33-65
Workshops		Oral	
Colloquia	6-10		
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY – MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy – Medical Biochemistry

Course title: Laboratory Diagnostics of the Disorders in Paediatric Population

Teachers: Spasojević-Kalimanovska V. Vesna, Bogavac-Stanojević B. Nataša, Zeljković R. Aleksandra, Stefanović Ž. Aleksandra, Vekić Z. Jelena, Sopić D. Miron

Course status: elective

Semester: X	**Year of studies:** V
ECTS points: 4	**Course code:** B5I9

Requirements: Medical Biochemistry

Course aims:

Broadening of students' knowledge and skills in the area of laboratory diagnostics of various conditions and diseases in paediatric population.

Course outcomes:

Students will understand the specificity of paediatric patients in relation to adult patients (metabolic processes in newborns and children, frequency of diseases in paediatric population, different reference intervals), know how to perform correct sampling of biological material and understand the importance of pre-analytical and analytical variations and possible interferences on the validity of laboratory results. Students will know how to perform analytical methods for diagnosis and monitoring of the diseases in paediatric population. Proper interpretation of the results of neonatal screening tests and tests for the detection of inborn errors of metabolism. Accurate calculation and application of the reference values and interpretation of the obtained results.

Course contents:

Lectures

Biological material and pre-analytical variations in paediatrics. Metabolic processes in newborns and in childhood. Neonatal screening and laboratory diagnostics in neonatology. Laboratory testing of inborn errors of metabolism. Reference values in paediatrics. Laboratory diagnostics of the disorders of carbohydrate and lipid metabolism, liver dysfunction, gastrointestinal tract and kidney diseases in paediatric patients. Laboratory examination of endocrine disorders in paediatric patients. Urgent laboratory diagnostics in paediatrics.

Practical classes

Sampling of biological material and pre-analytical errors in paediatric patients. Laboratory methods for the examination of inborn errors of metabolism and other hereditary diseases. Laboratory diagnostics and monitoring of metabolic disorders in children.

Recommended literature:

1. Burtis CA, Ashwood ER, Bruns DE (editors). Tietz Textbook of Clinical Chemistry and Molecular Diagnostics, 5th Edition. St. Louis, MO: Elsevier, 2012.

2. Spasić S, Jelić-Ivanović Z, Spasojević-Kalimanovska V. Medicinska biohemija, Beograd, 2004.

3. Kliegman RM, Stanton BF, St Geme III JW, Schor NF. Nelson Textbook of Pediatrics. 20th ed. Philadelphia: Elsevier; 2016.

4. Hay WW Jr, Thureen PJ (editors). Neonatal Nutrition and Metabolism, 2nd edition. New York, NY: Cambridge University Press, 2006.

5. Additional literature: review articles from scientific journals

The total of active learning classes

Lectures: 30	**Practical classes:** 15
Research work:	**Other forms of teaching:**

Teaching methods:

lectures, interactive classes, workshops, problem based learning, practical cases analysis, seminars, e-learning.

Grading system

Exam prerequisites	Points	Final exam	Points
Active participation in lectures	10	Practical	
Practical classes	15	Written	40

Workshops	15	Oral	
Colloquia	20		
Seminars			
Other activities			

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY – MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy – Medical Biochemistry

Course title: Professional Practice

Teachers: Ignjatović D.Svetlana, Topić S. Aleksandra

Course status: Mandatory

Semester: X	**Year of studies:** V
ECTS points: 10	**Course code:** BSP

Requirements: the fifth year of study enrolled

Course aims:

Acquiring skills for handling instruments and equipment, performing analyzes in a medical-biochemical laboratory, for the safe handling of chemicals, biological materials and medical waste, for identifying and troubleshooting problems, for independent and team work in the laboratory and with other healthcare professionals.

Course outcomes:

Training students for the application of previously acquired theoretical and practical skills for solving specific problems within a selected laboratory and for independent professional work. Introduction to students with the activities of the selected laboratory, the way of work, management and the place and role of medical biochemists in their organizational structures.

Course contents:

Lectures

Selection and application of analytical methods performed in medical-biochemical laboratories in accordance with good laboratory practice. Application of standards in the laboratory. Handling of medical waste and its disposal. Introduction to diagnostic characteristics of laboratory tests and analytical characteristics of methods used in laboratories. Provision of quality control system achieved through a continuous process of checking and evaluating the results of measurement procedures in order to provide a reliable finding and medical relevant information.

Practical classes

Recommended literature:

The total of active learning classes	
Lectures: 0	**Practical classes:** 300
Research work:	**Other forms of teaching:**

Teaching methods:

Inclusion in the process of work of the medical-biochemical laboratory. Consultations and writing a professional practice diary in which the student describes activities and jobs they performed during professional practice.

The verification a diary of professional practice by responsible teachers and mentors from practice confirms that the student has successfully completed the professional practice. After completing the professional practice, the student takes a written exam consisting of multiple choice questions.

Grading system

Exam prerequisites	Points	Final exam	Points
Active participation in lectures		Practical	
Practical classes	10	Written	70
Workshops		Oral	
Colloquia			
Seminars	20		
Other activities			

University of Belgrade Faculty of Pharmacy	Specialized academic study **PHARMACY – MEDICAL BIOCHEMISTRY**	

Study programme: Pharmacy – Medical Biochemistry

Course title: Final Work

Teachers:

Course status:

Semester: X	**Year of studies:** V
ECTS points: 10	**Course code:**

Requirements: finished all courses of the study programme, in the total of 290 ECTS

Course aims:

Student is capable to apply basic, theoretically methodological, scientific and professional and professionally applicative knowledge and methods for solution of specific problems relative to the selected topic of the final work. Through the preparation of the final work the student, by studying representative references or by conducting experiments, studies specific problem, its structure and complexity, and based on the performed analysis makes conclusions on possible methods of its solution. Furthermore, student is trained on how to write the final work, present in the specified time frame, and discuss on the matter with the experts.

Course outcomes:

Student has gained competencies to, based on the knowledge and skills gained during the studies, conduct experiments or bibliographic analysis of the references, write the work and present it in front of the competent commission.

Course contents:

Lectures

Final work represents research activities of the student enabling therefore introduction to the methodology of research in all fields related to pharmacy. Final work topic can be either experimental or bibliographic. Upon conduction of the research, student prepares the final work that contains the following elements: introduction, theoretical part, experimental part (if the final work is experimental), results and discussion, conclusion and references. Defense of the final work consists of the oral presentation of the work by the student, followed by interrogation and discussion with the competent commission.

Practical classes

Recommended literature:

The total of active learning classes

Lectures: 0	**Practical classes:** 0
Research work:	**Other forms of teaching:**

Teaching methods:

During preparation of the final work, mentor provides the necessary instructions to student, directs him to the specific references, helps with the selection of the research method, analyses and elaboration of the obtained results, and drawing of the appropriate conclusions. In this stage of the preparation of the final work, student can have additional consultations with the mentor or other teachers dealing with the topics related to the final work, if necessary. If the final work requires conduction of experiments, mentor introduces the student to the work in the laboratory, selection of chemicals, protection measures, handling with instruments, etc.

Grading system

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