






University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Methodology of scientific research			
Teachers: Savić M. Miroslav, Krajnović M. Dušanka, Kotur-Stevuljević M. Jelena, Bogavac-Stanojević B. Nataša			
Course status: Mandatory common, module: Doctoral academic studies			
Semester: I		Year of studies: I	
ECTS points: 5		Course code: D1031	
Requirements: none			
Course aims: The aim of this course is to provide participants with general scientific skills in order to formulate a scientific problem and plan the experiment, as well as to understand the complete process of preparation and publication of scientific research results			
Course outcomes: By the end of this course participants will be able to summarize and apply the principles of the methodology of scientific-research work and scientific writing			
Course contents: Science and scientific method. Problem and scientific problem. Hypothesis. Hypothesis verification: scientific observation and scientific experiment. Common methodology of scientific research in biomedicine. Classification of research. Experimental research in laboratory. Animal experiments. Types of studies in epidemiological investigations. Ethics and biomedical investigations. Ethical codex of scientific-research work. Generation of biomedical information. Communications. Networks. Internet. Internet search engines. Authorship/co-authorship. Role and duties of principal investigator. Protection of intellectual property. Classification of scientific work. Writing of scientific and professional papers. Literature citing. Review process. Oral presentation of scientific work (adaptation to audience and situation). Designing PowerPoint slides for a scientific presentation. Introduction to writing of project proposals. Master's thesis and doctoral dissertation.			
Recommended literature: 1 Cargill, M, O'Connor P. Writing scientific research articles: Strategy and steps. John Wiley & Sons, 2013. 2. Baumgartner TA, Hensley LD. Conducting and Reading Research in Health and Human performance. Mc Graw Hill, Boston, 2006 3. Machin D, Campbell MJ. Design of studies for medical research. John Wiley & Sons, Hoboken, 2005. 4. Peat J, Elliot E, Baur L, Keena V. Scientific writing – easy when you know how. BMJ Books, London, 2002. 5. Albert T. The A-Z of medical writing. BMJ Books, London, 2000. 6. Hudson Jones A, McLeallan F. Ethical Issues in Biomedical Publication. Baltimore: John Hopkins University Press, 2000.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures and study-research work			
Grading system: Seminar: 30 points; written exam: 70 points			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Statistics in research			
Teachers: Bogavac-Stanojević B. Nataša, Kotur-Stevuljević M. Jelena			
Course status: Mandatory common, module: Doctoral academic studies			
Semester: I		Year of studies: I	
ECTS points: 5		Course code: D1032	
Requirements: One semester of undergraduate studies in mathematics and statistics pharmaceutical / medical biochemistry / medicine			
Course aims: Understanding advanced statistical methods. Applying advanced statistical analyses in scientific research.			
Course outcomes: After completing the course students will be trained to: <ul style="list-style-type: none">- Recognizing the type of statistical analysis- Interpret the significance of the obtained statistical indicators and discuss the results,- Understand the importance of the application of statistical methods in the scientific research,- Use statistical software in the data analysis			
Course contents: One-way analysis of variance (ANOVA). Two-way analysis of variance. ANOVA with replication. Post-hoc tests. Simple linear regression analysis. Multiple regression analyses. Logistic regression. Analysis of covariance. Nonparametric analysis of variance. Nonparametric correlation. Chi-square test. Confidence interval. Student’s research: Solving different statistical problems and tasks.			
Recommended literature: 1. Sheskin DJ. Handbook of parametric and nonparametric statistical procedures Chapman & Hall/CRC, Washington, D.C., 2000. 2. Vittingoff E, Shiboski SC, Glidden DV, McCulloch CE. Regression Methods in Biostatistics, Springer Science + Business Media, New York, 2005. 3. Selvin S. Statistica Analysis of Epidemiological Data, Oxfor University Press, Oxford, 1996. 4. Tamhane AJ, Dunlop DD. Statistics and Data Analysis, Prentice Hall, Upper Saddle River, NJ, 2000.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures, computer exercises, solving practical problems			
Grading system: The presence at lectures: 30 points; Written Exam: 70 points.			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Seminar 1			
Teachers: Ivanović P. Darko, Zečević L. Mira, Malenović M. Anđelija, Stojanović S. Biljana, Miletić Đ. Ivanka, Šobajić S. Slađana, Stanković M. Ivan, Đorđević I. Brižita, Vuleta M. Gordana, Milić R. Jela, Primorac M. Marija, Savić D. Snežana, Vasiljević D. Dragana, Krajišnik R. Danina, Đekić M. Ljiljana, Spasić M. Slavica, Jelić-Ivanović D. Zorana, Spasojević-Kalimanovska V. Vesna, Stojanov D. Marina, Ignjatović D. Svetlana, Topić S. Aleksandra, Dopsaj B. Violeta, Bogavac-Stanojević B. Nataša, Kotur-Stevuljević M. Jelena, Tasić M. Ljiljana, Marinković D. Valentina, Krajnović M. Dušanka, Miljković R. Branislava, Vezmar Kovačević D. Sandra, Vučićević M. Katarina, Kovačević N. Nada, Petrović D. Silvana, Maksimović A. Zoran, Kundaković D. Tatjana, Drobac M. Milica, Ugrešić D. Nenad, Stepanović-Petrović M. Radica, Savić M. Miroslav, Ilić V. Katarina, Novaković N. Aleksandra, Tomić A. Maja, Leposavić M. Gordana, Arsenović-Ranin M. Nevena, Stojić-Vukanić M. Zorica, Plečaš-Solarović A. Bosiljka, Pešić P. Vesna, Nedeljković S. Miodrag, Milenković T. Marina, Antić Stanković A. Jelena, Parojčić V. Jelena, Ibrić R. Svetlana, Đuriš D. Jelena, Grbić V. Sandra, Đurić R. Zorica, Vladimirov M. Sote, Agbaba D. Danica, Bulat L. Zorica, Matović J. Vesna, Antonijević M. Biljana, Vujanović L. Dragana, Đukić M. Mirjana			
Course status: Mandatory common, module: Doctoral academic studies			
Semester: I		Year of studies: I	
ECTS points: 5		Course code: D1033	
Requirements: none			
Course aims: This course aims to enable the participant to: search the scientific literature effectively and thoroughly; perform a critical analysis of publications relevant for his/her study field; apply the principles of making a successful oral presentation in English.			
Course outcomes: By the end of this course participants will be able to: search the scientific literature effectively and thoroughly; perform a critical analysis of publications relevant for his/her study field; apply the principles of making a successful oral presentation in English			
Course contents: Collection of pertinent literature (by use of bibliographic databases, web sites of publishers, general search engines). Preparation of personal databases. Contextual analysis of key publications in a field. Preparation and presentation of the published results.			
Recommended literature: 1. Alley M. The craft of scientific presentations. Critical steps to succeed and critical errors to avoid. Springer-Verlag New York, Inc., 2003. 2. Original scientific papers and review articles in the field of the participant's research activity.			
The total of active learning classes	Lectures: 30		
	Individual research work: 60		
Teaching methods: Study-research work			
Grading system: Seminar: 70 points; written exam: 30 points			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Seminar 2			
Teachers: Ivanović P. Darko, Zečević L. Mira, Malenović M. Anđelija, Stojanović S. Biljana, Miletić Đ. Ivanka, Šobajić S. Slađana, Stanković M. Ivan, Đorđević I. Brižita, Vuleta M. Gordana, Milić R. Jela, Primorac M. Marija, Savić D. Snežana, Vasiljević D. Dragana, Krajišnik R. Danina, Đekić M. Ljiljana, Spasić M. Slavica, Jelić-Ivanović D. Zorana, Spasojević-Kalimanovska V. Vesna, Stojanov D. Marina, Ignjatović D. Svetlana, Topić S. Aleksandra, Dopsaj B. Violeta, Bogavac-Stanojević B. Nataša, Kotur-Stevuljević M. Jelena, Tasić M. Ljiljana, Marinković D. Valentina, Krajnović M. Dušanka, Miljković R. Branislava, Vezmar Kovačević D. Sandra, Vučićević M. Katarina, Kovačević N. Nada, Petrović D. Silvana, Maksimović A. Zoran, Kundaković D. Tatjana, Drobac M. Milica, Ugrešić D. Nenad, Stepanović-Petrović M. Radica, Savić M. Miroslav, Ilić V. Katarina, Novaković N. Aleksandra, Tomić A. Maja, Leposavić M. Gordana, Arsenović-Ranin M. Nevena, Stojić-Vukanić M. Zorica, Plečaš-Solarović A. Bosiljka, Pešić P. Vesna, Nedeljković S. Miodrag, Milenković T. Marina, Antić Stanković A. Jelena, Parojčić V. Jelena, Ibrić R. Svetlana, Đuriš D. Jelena, Grbić V. Sandra, Đurić R. Zorica, Vujić B. Zorica, Čudina A. Olivera, Bulat L. Zorica, Matović J. Vesna, Antonijević M. Biljana, Vujanović L. Dragana, Đukić M. Mirjana			
Course status: Mandatory common, module: Doctoral academic studies			
Semester: II		Year of studies: I	
ECTS points: 5		Course code: D1034	
Requirements: none			
Course aims: This course aims to enable the participant to: search the scientific literature effectively and thoroughly; perform a critical analysis of publications relevant for his/her study field; upgrade his/her capacities for giving a successful oral presentation in English.			
Course outcomes: By the end of this course participants will be able to: search the scientific literature effectively and thoroughly; perform a critical analysis of publications relevant for his/her study field; apply the principles of making a successful oral presentation in English			
Course contents: Collection of pertinent literature (by use of bibliographic databases, web sites of publishers, general search engines). Preparation of personal databases. Contextual analysis of key publications in a field. Preparation and presentation of the published results.			
Recommended literature: 1. Alley M. The craft of scientific presentations. Critical steps to succeed and critical errors to avoid. Springer-Verlag New York, Inc., 2003. 2. Original scientific papers and review articles in the field of the participant's research activity.			
The total of active learning classes	Lectures: 30		
	Individual research work: 60		
Teaching methods: Study-research work			
Grading system: Seminar: 70 points; written exam: 30 points			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Seminar 3			
Teachers: Ivanović P. Darko, Zečević L. Mira, Malenović M. Anđelija, Stojanović S. Biljana, Miletić Đ. Ivanka, Šobajić S. Slađana, Stanković M. Ivan, Đorđević I. Brižita, Vuleta M. Gordana, Milić R. Jela, Primorac M. Marija, Savić D. Snežana, Vasiljević D. Dragana, Krajišnik R. Danina, Đekić M. Ljiljana, Spasić M. Slavica, Jelić-Ivanović D. Zorana, Spasojević-Kalimanovska V. Vesna, Stojanov D. Marina, Ignjatović D. Svetlana, Topić S. Aleksandra, Dopsaj B. Violeta, Bogavac-Stanojević B. Nataša, Kotur-Stevuljević M. Jelena, Tasić M. Ljiljana, Marinković D. Valentina, Krajnović M. Dušanka, Miljković R. Branislava, Vezmar Kovačević D. Sandra, Vučićević M. Katarina, Kovačević N. Nada, Petrović D. Silvana, Maksimović A. Zoran, Kundaković D. Tatjana, Drobac M. Milica, Ugrešić D. Nenad, Stepanović-Petrović M. Radica, Savić M. Miroslav, Ilić V. Katarina, Novaković N. Aleksandra, Tomić A. Maja, Leposavić M. Gordana, Arsenović-Ranin M. Nevena, Stojić-Vukanić M. Zorica, Plečaš-Solarović A. Bosiljka, Pešić P. Vesna, Nedeljković S. Miodrag, Milenković T. Marina, Antić Stanković A. Jelena, Parojčić V. Jelena, Ibrić R. Svetlana, Đuriš D. Jelena, Grbić V. Sandra, Đurić R. Zorica, Vujić B. Zorica, Čudina A. Olivera, Bulat L. Zorica, Matović J. Vesna, Antonijević M. Biljana, Vujanović L. Dragana, Đukić M. Mirjana			
Course status: Mandatory common, module: Doctoral academic studies			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: D2031	
Requirements: none			
Course aims: This course aims to enable the participant to: search the scientific literature effectively and thoroughly; perform a critical analysis of publications relevant for his/her study field; upgrade his/her capacities for giving a successful oral presentation of results of personal research activities			
Course outcomes: By the end of this course participants will be able to: search the scientific literature effectively and thoroughly; perform a critical analysis of publications relevant for his/her study field; apply the principles of making a successful oral presentation in English			
Course contents: Collection of pertinent literature (by use of bibliographic databases, web sites of publishers, general search engines). Preparation of personal databases. Contextual analysis of key publications in a field. Preparation and presentation of the published results.			
Recommended literature: 1. Alley M. The craft of scientific presentations. Critical steps to succeed and critical errors to avoid. Springer-Verlag New York, Inc., 2003. 2. Original scientific papers and review articles in the field of the participant's research activity.			
The total of active learning classes	Lectures: 30		
	Individual research work: 60		
Teaching methods: Study-research work			
Grading system: Seminar: 70 points; written exam: 30 points			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Seminar 4			
Teachers: Ivanović P. Darko, Zečević L. Mira, Malenović M. Anđelija, Stojanović S. Biljana, Miletić Đ. Ivanka, Šobajić S. Slađana, Stanković M. Ivan, Đorđević I. Brižita, Vuleta M. Gordana, Milić R. Jela, Primorac M. Marija, Savić D. Snežana, Vasiljević D. Dragana, Krajišnik R. Danina, Đekić M. Ljiljana, Spasić M. Slavica, Jelić-Ivanović D. Zorana, Spasojević-Kalimanovska V. Vesna, Stojanov D. Marina, Ignjatović D. Svetlana, Topić S. Aleksandra, Dopsaj B. Violeta, Bogavac-Stanojević B. Nataša, Kotur-Stevuljević M. Jelena, Tasić M. Ljiljana, Marinković D. Valentina, Krajnović M. Dušanka, Miljković R. Branislava, Vezmar Kovačević D. Sandra, Vučićević M. Katarina, Kovačević N. Nada, Petrović D. Silvana, Maksimović A. Zoran, Kundaković D. Tatjana, Drobac M. Milica, Ugrešić D. Nenad, Stepanović-Petrović M. Radica, Savić M. Miroslav, Ilić V. Katarina, Novaković N. Aleksandra, Tomić A. Maja, Leposavić M. Gordana, Arsenović-Ranin M. Nevena, Stojić-Vukanić M. Zorica, Plečaš-Solarović A. Bosiljka, Pešić P. Vesna, Nedeljković S. Miodrag, Milenković T. Marina, Antić Stanković A. Jelena, Parojčić V. Jelena, Ibrić R. Svetlana, Đuriš D. Jelena, Grbić V. Sandra, Đurić R. Zorica, Vujić B. Zorica, Čudina A. Olivera, Bulat L. Zorica, Matović J. Vesna, Antonijević M. Biljana, Vujanović L. Dragana, Đukić M. Mirjana			
Course status: Mandatory common, module: Doctoral academic studies			
Semester: IV		Year of studies: II	
ECTS points: 5		Course code: D2032	
Requirements: none			
Course aims: This course aims to enable the participant to: search the scientific literature effectively and thoroughly; perform a critical analysis of publications relevant for his/her study field; upgrade his/her capacities for giving a successful oral presentation of results of personal reserch activities; prepare publications containing the results obtained in the performed personal investigation			
Course outcomes: By the end of this course participants will be able to: search the scientific literature effectively and thoroughly; perform a critical analysis of publications relevant for his/her study field; apply the principles of making a successful oral presentation and preparing publications containing the personal results			
Course contents: Collecction of pertinent literature (by use of bibliographic databases, web sites of publishers, general search engines). Preparation of personal databases. Contextual analysis of key publications in a field. Preparation and oral and written presentation of the personal results.			
Recommended literature: 1. Alley M. The craft of scientific presentations. Critical steps to succeed and critical errors to avoid. Springer-Verlag New York, Inc., 2003. 2. Original scientific papers and review articles in the field of the participant's research activity.			
The total of active learning classes	Lectures: 30		
	Individual research work: 60		
Teaching methods: Study-research work			
Grading system: Seminar: 70 points; written exam: 30 points			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Principles of Modern Pharmaceutical Analysis			
Teachers: Darko P. Ivanović, Mira L. Zečević, Anđelija M. Malenović, Biljana S. Stojanović			
Course status: Mandatory modules, module: Drug Analysis			
Semester: I		Year of studies: I	
ECTS points: 10		Course code: ДАЛ10М1	
Requirements: no			
Course aims: Acquiring knowledge in the field of pharmaceutical analysis necessary for characterization of the medicine, from the pharmaceutical substance until final dosage form.			
Course outcomes: Knowledge of all types of tests for pharmaceutical substances and dosage forms which characterize their quality, as well as knowledge of appropriate methods that are used to for quality control.			
Course contents: Analysis of physicochemical properties of pharmaceutical substances (solid state analysis, polymorphism, pKa values, solubility in different media, molecular stereochemistry, etc.) important for quality assessment of the substance. Methods for monitoring the physical and chemical stability of the pharmaceutical substances. Study of relationship between the chemical structure of substances and the development and implementation of new methods in the analysis of the tested compounds, as well as their related substances. Modern methods in testing of the potential drug related substance. The origin of residual solvents in pharmaceutical substances, procedures for testing and determination of the limits of residual solvents. Methods for determination and monitoring the water content in the pharmaceutical substance. Targeted degradation study, isolation and identification of the impurities. Modern methods for impurity structure confirmation. Chemical and safety aspects of impurity testing. The origin and qualification of impurities. Genotoxic impurities - classification, assessment of genotoxic potential; characteristics of methods for monitoring and analysis of genotoxic impurities. Forced degradation studies, methodology, performance conditions and ways of interpreting the results. Degradation mechanisms and analysis of degradation pathways of different structures. Drug degradation profile view. Determination of the kinetics of a chemical reaction. Active pharmaceutical substance testing. Pharmacopoeia and compendial tests. Quality assessment of the dosage form during development and preformulation studies. Testing of the final dosage form. The scientific aspect of method validation. Evaluation and interpretation of obtained results. Verification of compendial methods. Transfer of compendial methods.			
Recommended literature: 1. Ahuja, S. Scipynski, S., Editors: Handbook of Modern Pharmaceutical Analysis. Academic Press, San Diego, 2001. 2. Ermer, J., McB. Miller, J. H., Editors: Method Validation in Pharmaceutical Analysis, WILEY–VCH Verlag GmbH & Co. KGaA, Weinheim, 2005. 3. Ohannesian, L, Streeter, A. J. Editors: Handbook of Pharmaceutical Analysis, Marcel Dekker, Inc., New York, USA 2002. 4. Pedersen, O.: Pharmaceutical Chemical Analysis: Methods for Identification and Limit Tests, Taylor & Francis Group, LLC 2006. 5. Ahuja, S.: Impurities Evaluation of Pharmaceuticals, Marcel Dekker, Inc., New York, 1998. 6. Yoshioka, S., Stella, V. J.: Stability of drugs and dosage forms, Cluwer, Academic publishers, New York, 2002.			
The total of active learning classes	Lectures: 60		
	Individual research work: 60		
Teaching methods: Lectures, workshops, seminars, interactive teaching and internet			
Grading system: Pre-exam engagements: 30 points Final exam: 70 points			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Chemometrics in Drug Analysis			
Teachers: Darko P. Ivanović, Mira L. Zečević, Anđelija M. Malenović, Biljana S. Stojanović			
Course status: Mandatory modules, module: Drug Analysis			
Semester: I		Year of studies: I	
ECTS points: 5		Course code: ДАЛ10М2	
Requirements: no			
Course aims: Acquiring knowledge about different chemometrical approaches important for application in different area of drug analysis.			
Course outcomes: Success in defining nature of problem and proper selection of experimental design. Interpretation of experimental results and presentation of relevant conclusion.			
Course contents: Chemometrics – theoretical principles. Chemometrics approach in analysis of experiments – significance. Analysis of experiments with one factor. Analysis of experiments with multiple factors. Application of experimental design in screening experiments. Design choosing and interpretation of obtained results. Analysis of full factorial and fractional factorial design. Solving problems with highly fractionated designs. response surface methodology and interpretation of obtained results. Central composite design, Box–Behnken design and full factorial design in method optimization. Qualitative and quantitative factors analysis by applying D optimal design. Multicriterion and multifactors optimization. Deringer desirability function and sensitivity analysis. Robustness testing in method development and optimization. Calculation of partial and total robustness criterion. Experimental design (Plackett–Burman design and fractional factorial design in robustness testing with suitable statistical analysis (Dong algorithm and analysis of non-significance interval for significance factors) followed by appropriate graphical evaluation (Pareto charts, half-normal probability and normal probability plots). Process improvement by application of central experimental design. Visualisation of obtained results (3-D graphs, 2-D graphs, etc). Estimation of model adequacy. Model validation. Estimation of scientific significance of experimental design application. Problem solving – case study with analysis. Presentation of the best solution and discussion.			
Recommended literature: 1. Deming, S. N., Morgan, S. L.: Experimental design: a chemometric approach, Elsevier, Amsterdam, Netherlands, 1993. 2. Brereton, R. G.: Chemometrics: Data Analysis for the Laboratory and Chemical Plant, John Wiley & Sons, Chichester, England 2003. 3. Mason, R. L, Gunst, R. F., Hess, J. L.: Statistical Design and Analysis of Experiments, John Wiley & Sons, New Jersey, USA 2003. 4. Hinkelmann, K., Kempthorne, O.: Design and Analysis of Experiments, John Wiley & Sons, New Jersey, USA 2005. 5. Vander Heyden, Y., Nijhuis, A., Smeyers–Verbeke, J., Vandeginste, B.G.M., Massart, D.L.: Guidance for Robustness/Ruggedness Tests in Method Validation, J. Pharm. Biomed. Anal., 24, 723–753, 2001.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures, workshops, seminars, interactive teaching and internet			
Grading system: Pre-exam engagements: 30 points Final exam: 70 points			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Separation Methods in Drug Analysis			
Teachers: Darko P. Ivanović, Mira L. Zečević, Anđelija M. Malenović, Biljana S. Stojanović			
Course status: Mandatory modules, module: Drug Analysis			
Semester: II		Year of studies: I	
ECTS points: 10		Course code: ДАЛ10М3	
Requirements: no			
Course aims: Acquiring knowledge of the different types of separation methods and exploring the possibilities of their application in drug analysis.			
Course outcomes: Successful implementation of the acquired knowledge to solve specific problems in drug analysis.			
Course contents: Liquid chromatography, advantages, disadvantages, and application in drug analysis. Separation mechanisms for different types of chromatography (adsorption, partition, gel, ion-exchange and affinity chromatography). The chromatographic parameters and criteria to assess the quality of the chromatographic separation. The elementary and global separation criteria. The chromatographic response functions for the interpretation of the chromatographic analysis quality. The assessment and analysis of the acceptability of the chromatographic separation. The analysis of the Van Deemter 's equation coefficients. Fitting of the retention data in localized and non-localized adsorption models. The characteristics of the stationary phase: geometry of the particles, stationary phase chemistry, chemical modifications, and the hybrid and the polymeric stationary phase. The mobile phase modifications (ion-pair chromatography, ion suppression). The micellar and mikroemulziona liquid chromatography and improvement of the method selectivity. Hydrophilic interaction chromatography, advantages, limitations, and application in drug analysis. Hydrophobic interaction chromatography, advantages, limitations, and application in drug analysis. Ultra High Performance Liquid Chromatography - UHPLC, characteristics and analytical application in drug analysis. Hyphenated techniques - liquid/mass, liquid/mass/mass (LC -MS, LC-MS/MS) and their application in drug analysis. Development of liquid chromatographic method compatible with mass spectrometry. Preparative liquid chromatography and its importance in the isolation of impurities and degradation products. Gas chromatography and gas chromatography/mass analysis of the genotoxic impurities and residual solvents .			
Recommended literature: 1. Snyder, L. R., Kirkland, J. J., Dolan, J. W.: Introduction to modern liquid chromatography. Third Edition, John Wiley & Sons, Inc., New York,USA 2010. 2. Ahuja, S.: Chromatography and separation science. Volume 4 of Separation science and technology, Academic Press, San Diego, USA 2003. 3. Ed. Kazakevich, Y., Lobrutto, R.: HPLC for pharmaceutical scientist. John Wiley & Sons, Inc., New York,USA 2007. 4. Scott, R. P. W.: Liquid chromatography column theory, John Wiley & Sons, Inc., Chcihester, England 1991. 5. Kromidas, S.: HPLC made to measure. John Wiley & Sons, Inc., New York,USA 2006. 6. Fowlis, I. A.: Gas Chromatography, Second Ed., John Wiley & Sons, Inc., Chichester, England, 1995.			
The total of active learning classes	Lectures: 60		
	Individual research work: 60		
Teaching methods: Lectures, workshops, seminars, interactive teaching and internet			
Grading system: Pre-exam engagements: 30 points Final exam: 70 points			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Multivariate Analysis in Drug Analysis			
Teachers: Biljana S. Stojanović, Vladimir R. Vasić			
Course status: elective, module: Drug Analysis			
Semester: II		Year of studies: I	
ECTS points: 5		Course code: ДАЛ1И1	
Requirements: no			
Course aims: Gaining knowledge of multivariate analysis that is applicable in different areas of pharmaceutical analysis.			
Course outcomes: Ability to independently apply multivariate analysis for obtaining results of high quality in pharmaceutical analysis, then ability to apply statistical models for statistical inference, as well as ability to create statistical models for real life problems along with appropriate assessment of suitability of their application.			
Course contents: Introduction to multivariate analysis. Multivariate statistical analysis techniques. Multiple linear regression and appliances. Generalized linear models. Factor analysis (identification of factors, types of factor analysis, model of factor analysis, a method of performing factor analysis and the use of different statistical tools for factor analysis). Principal Component Analysis (concept, number of key components, algorithms for key components, evaluation and diagnosis, complementary methods). Principal component analysis in the evaluation of the results obtained by spectroscopic methods. Calibration (concept, characteristic of regression models). Robust regression. The method of partial least squares. Classification (linear classification methods, tree of classification, artificial neuron networks, vector machine, evaluation of methods, etc.). Cluster Analysis and basic methods. Appliance of cluster analysis in separation methods. Pattern recognition and appliance for the characterization of chromatographic analysis. The application of multivariate analysis techniques for screening and quantification in complex samples. Interpretation and presentation of obtained results. Mastering the different software tools for multivariate analysis. Creation of statistical models for particular situations with a presentation and critical analysis of the obtained models.			
Recommended literature: 1. Filzmoser, P. Varmuza, K: Multivariate Statistical Analysis in Chemometrics, CRC Press, Taylor and Francis Group, New York, USA, 2008. 2. Harrell, F.E. Jr. Regression Modeling Strategies with Applications to Linear Models, Logistic Regression and Survival Analysis, Springer, New York, 2001. 3. Basilevsky, A. Statistical Factor Analysis and Related Models: Theory and Applications, Wiley Interscience, New York, 1994. 4. Kvalheim, O. M., Chan, H., Benzie, I. F. F., Szeto, Y., Tzang, A. H., Mok, D. K., Chau, F: Chromatographic profiling and multivariate analysis for screening and quantifying contributions from individual components to the bioactive signature in natural products. Chemom. Intell. Lab. Syst. 107 (2011) 98–105. 5. Tabachnick, B, Fidell, L.: Using Multivariate Statistics (5. izdanje), Boston: PEARSON, 2007			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Theoretical lectures, workshops, seminars, interactive classes and internet.			
Grading system: Pre-exam activities: 30 points Final exam: 70 points			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Quantitative Structure–Retention Relationships			
Teachers: Darko P. Ivanović, Mira L. Zečević, Anđelija M. Malenović, Biljana S. Stojanović			
Course status: elective, module: Drug Analysis			
Semester: II		Year of studies: I	
ECTS points: 5		Course code: ДАЛ1И2	
Requirements: no			
Course aims: Acquisition of knowledge in the field of Quantitative Structure–Retention Relationships in different chromatographic systems.			
Course outcomes: Ability of standalone analysis of Quantitative Structure–Retention Relationships of active pharmaceutical ingredients, as well as adequate selection of the most suitable separation system for the analysis.			
Course contents: Basic structural descriptors and their calculation. Thermodynamic basis of Quantitative Structure–Retention Relationships. The methods of determination of a molecule lipophilicity and its significance. The determination of log P values using experimental and computational methods. Estimation of the lipophilicity of xenobiotics. Various methodologies in the analysis of Quantitative Structure–Retention Relationships (chemometrics, multiple regression analysis, artificial neural networks, etc.). Estimation of retention prediction on the basis of created mathematical models or artificial neural networks. Application of various types of chromatography in the determination of the retention behavior of the analytes (reversed–phase liquid chromatography, normal–phase liquid chromatography, hydrophilic interaction liquid chromatography, micellar liquid chromatography). Analysis of Quantitative Structure–Retention Relationships in isocratic and gradient elution. Characterization of the stationary phases and appropriate selection of the stationary phase type for the chromatographic analysis of the specific molecules. Application of Quantitative Structure–Retention Relationships in proteomics Quantitative Structure–Retention Relationships of enantiomers and the specificity of its determination. The creation of quantitative relationship between retention behavior of the analyte and its biological effect.			
Recommended literature: 1. Kaliszan, R.: QSRR: Quantitative Structure–(Chromatographic) Retention Relationship. Chem Rev. 2007 (107) 3212–23246. 2. Put, R. Vander Heyden, Y.: Review on Modelling aspects in Reversed–Phase Liquid Chromatographic Quantitative Structure–retention Relationship. Anal. Chim. Acta 2007 (602) 164–172. 3. Heberg, K.: Quantitative Structure–(Chromatographic) Retention Relationships. J. Chromatogr. A 2007 (1158) 273–305.			
The total of active learning classes		Lectures: 30	
		Individual research work: 30	
Teaching methods: Theoretical lectures, workshops, seminars, interactive classes and internet.			
Grading system: Pre-exam activities: 30 points Final exam: 70 points			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Biological Material for Biopharmaceutical Testing			
Teachers: Mira L. Zečević, Anđelija M. Malenović			
Course status: elective, module: Drug Analysis			
Semester: II		Year of studies: I	
ECTS points: 5		Course code: ДАЛ1И3	
Requirements: no			
Course aims: Acquiring the knowledge required for the successful preparation of biological samples for biopharmaceutical studies			
Course outcomes: The selection and application of the appropriate procedure for the preparation of biological samples, and the ability to assess the adequacy of the chosen method.			
Course contents: The analysis of the problems that might occur during the testing of the pharmaceutical compounds and their metabolites in samples of biological material. The modes of collection and storage of biological material samples (plasma, serum, urine, saliva, etc.), their impact on the process of analysis, as well as the reliability of the results. Methods and procedures for the preparation of samples for bioanalytical testing; selection of the appropriate procedure depending on the type of biological material sample, instrumental methods that might be applied for the testing and the characteristics of the analyte. The extraction of drug metabolites from the biological material. The basic principles of solid-phase extraction and liquid-liquid extraction, and their appropriate modifications. The types of solid-phase extractions, various adsorbents and solvents that might be used as eluents, factors affecting the extraction, the automation of the process. The optimization of solid-phase and liquid-liquid extraction. Quality assurance and quality control during sample preparation. The sample collection using the Dry Matrix Spots - DMS method, critical steps that might affect the reliability of the analysis and storage of these samples. Preparation and analysis of DMS samples.			
Recommended literature: 1. Mitra, S. (Editor): Sample Preparation Techniques in Analytical Chemistry. John Wiley & Sons, New Jersey, USA, 2003. 2. Kataoka, H.: Recent Advances in Solid–Phase Microextraction and Related Techniques for Pharmaceutical and Biomedical Analysis. Curr. Pharm. Anal 2005 (1) 65–84. 3. Wells, D.: High Throughput Bioanalytical Sample Preparation, Elsevier, Amsterdam, 2003.			
The total of active learning classes		Lectures: 30	
		Individual research work: 30	
Teaching methods: Theoretical lectures, consultations, seminars, interactive teaching.			
Grading system: Pre-exam activities: 30 points Final exam: 70 points			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Chiral Drug Analysis			
Teachers: Mira L. Zečević, Anđelija M. Malenović, Biljana S. Stojanović			
Course status: elective, module: Drug Analysis			
Semester: II		Year of studies: I	
ECTS points: 5		Course code: ДАЛ1И4	
Requirements: no			
Course aims: Acquiring additional knowledge about the investigation of physicochemical properties of chiral compounds and the methods that can be applied for identification and assay of pharmacologically active chiral compounds.			
Course outcomes: Acquired knowledge application to the selection of the appropriate approach and method which should be applied to the chiral compounds analysis.			
Course contents: Importance of chirality in pharmaceutical research and development, and therapeutical application as well. Evaluation of physicochemical properties of chiral compounds (solubility, specific optical rotation, polymorphism and pseudopolymorphism, racemization, etc). Determination of composition of chiral compounds by means of solid state analysis methods. Chiral compounds analysis by means of high performance liquid chromatography. Direct and indirect enantiomeric analysis. Stationary phase chemistry (Brush type stationary phases, etc). Types and properties of mobile phase chiral modifiers. Evaluation of the quality of chromatographic enantiomeric separation. Specificity of development and optimization of the chromatographic methods for enantiomeric analysis. Determination of enantiomers in biological material by means of liquid chromatography. Other separation methods that can be applied to chiral compounds analysis: gas chromatography, supercritical fluid chromatography – SFC, capillary electrophoresis – CE), capillary electrochromatography – CEC). Selection of the appropriate approach and method which should be applied to the analysis of the specific chiral compounds. Method development for qualitative and quantitative pharmaceutical analysis of chiral compounds.			
Recommended literature: 1. Buch, K. W., Buch, M. A.: Chiral Analysis, Elsevier, San Diego, USA 2006. 2. Subramanian, G.: Chiral Separation Techniques, Third Edition, WILEY–VCH Verlag GmbH & Co., Germany 2007. 3. Ahuja, S., Rasmussen, H.: HPLC Method Development for Pharmaceuticals, Volume 8 of Separation Science and Technology, Academic Press, San Diego, USA 2003.			
The total of active learning classes		Lectures: 30	
		Individual research work: 30	
Teaching methods: Lectures, workshops, seminars, interactive teaching and internet.			
Grading system: Pre-exam engagements: 30 points Final exam: 70 points			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Conducting Research in the Analysis of Medical Devices			
Teachers: Anđelija M. Malenović			
Course status: elective, module: Drug Analysis			
Semester: II		Year of studies: I	
ECTS points: 5		Course code: ДАЛ1И5	
Requirements: no			
Course aims: Acquiring the knowledge related to the assessment of the quality and safety of medical devices, as well as the introduction to the most important methods and procedures used for quality control and evaluation of the reliability of medical devices.			
Course outcomes: Application of acquired knowledge in assessment of the adequacy of the data on the characteristics, safety and quality of medical devices.			
Course contents: The analysis of the requirements that medical devices, in vitro diagnostic medical devices and active implantable medical devices must meet in terms of quality and safety. Factors affecting quality and safety. Classification rules for medical devices and their implementation. The types and characteristics of the materials used for medical devices production; special emphasis on biomaterials. The characterization of biomaterials by dynamic mechanical analysis, differential scanning calorimetry and differential thermal analysis / thermogravimetric analysis. Safety assessment of medical devices by testing cytotoxicity, sensitization, irritability, acute and subchronic toxicity, genotoxicity and hemocompatibility. Analytical testing of medical devices:testing of materials, known impurities and agents used during production, testing of the extractables. The examination of degradation products and impurities that may arise under the action of the immune system, or of the intracellular and extracellular biological fluids. Calculation of the patient exposure upper theoretical limit. Defining the principles for the appropriate test selection and conduction of medical device testing. The application of risk management to medical devices. Basic requirements for conformity assessment of medical devices.			
Recommended literature: 1. Directive 90/385/EECof the European parliament and of the council on active implantable medical devices. 2. Directive 98/79/EC of the European parliament and of the council on in vitro diagnostic medical devices. 3. Directive 93/42/EEC of the European parliament and of the council concerning medical devices 4. Richard, F.: Reliable design of medical devices. Second edition. Taylor & Francis Group, Boca Raton, Florida, USA, 2006. 5. Nicholson, J.W.: The chemistry of medical and dental materials. The Royal Society of Chemistry, Cambridge, UK, 2002. 6. Shayne, C. G., McCord, M.G.: Safety Evaluation in the Development of Medical Devices and Combination Products. Third Edition, Informa Healthcare USA, Inc., New York, USA, 2008. 7. ISO 14971:2000(E), Medical Devices – Application of Risk Management to Medical Devices.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods:			
Grading system: Pre-exam activities: 30 points Final exam: 70 points			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Spectroscopic Methods in Drug Analysis			
Teachers: Mirjana B. Medenica, Mara M. Aleksić			
Course status: elective, module: Drug Analysis			
Semester: II		Year of studies: I	
ECTS points: 5		Course code: ДАЛ1И6	
Requirements: no			
Course aims: Acquirement of additional knowledge of different spectroscopic methods in the analysis of small molecules and macromolecules.			
Course outcomes: Knowledge of the theory and application of modern spectroscopic methods. The ability to choose the adequate spectroscopic method for the corresponding pharmaceutical analysis. Successful implementation of the acquired knowledge to solve specific problems in drug analysis.			
Course contents: Introduction to different spectroscopic methods. Quantitative analysis of multicomponent mixtures by using UV/VIS spectrophotometry - mathematical correction techniques and their analysis. The application of IR (Infrared Spectroscopy), NIR (Near Infrared Spectroscopy), and Raman spectroscopy: qualitative analysis, solid-state analysis, analysis of traces of various foreign contaminations, analysis of biopharmaceutical products, etc. Atomic absorption spectrometry for the analysis of metals in different pharmaceutical products, as well as for the purity degree analysis. Detection and analysis of metal traces in various samples (active pharmaceutical substance, pharmaceutical product, biological material) using the inductively coupled plasma spectrometry - ICP with the theoretical principles of the method. The application of nuclear magnetic resonance - NMR for the confirmation of chemical structure, in the qualitative and quantitative analysis of pharmaceutical substances and products with the theoretical principles. One-dimensional (1D) and two dimensional (2D) NMR spectra. Theoretical principles of mass spectrometry. Types of ionization (chemical ionization, electron ionization, electrospray ionization, chemical ionization at atmospheric pressure). Types and characteristics of the mass analyzer. Types of ions in the mass spectra and the characteristics of the mass spectra. Hyphenated methods with mass detector and their application in drug analysis. Other hyphenated techniques, so-called hybrid methods (ICP-MS, GC-AAS, GC-ICP, GC-MS, HPLC-ICP).			
Recommended literature: 1. Lee, D. C., Webb, M. (Editors): Pharmaceutical Analysis, Blackwell Publishing Ltd., CRC Press, Boca Raton, USA, 2003. 2. Hoffman, E., Stroobant, V.: Mass spectrometry: Principles and Applications. Wiley, New York, 2007. 3. Watson, D. G.: Pharmaceutical Analysis, Second edition, Elsevier, Edinburg, 2005. 4. Vandecasteele, C., Block, C. B.: Modern Methods for Trace Element Determination, John Wiley and Sons, New York, 1995. 5. Siuzdak, G.: The Expanding Role of Mass Spectrometry in Biotechnology, Second edition, MCC Press, England, 2006. 6. Skoog, D. A., Holler, F. J. and Nieman, T. A.: Principles of Instrumental Analysis, Fifth edition, Saunders College Publishing, Philadelphia, 1998. 7. Keeler, J.: Understanding NMR spectroscopy, Second edition, Wiley, New York, 2010.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Theoretical lectures, workshops, seminars, interactive classes and internet.			
Grading system: Pre-exam activities: 50 points Final exam: 50 points			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Thermal Analysis Methods in Drug Analysis			
Teachers: Mira L. Zečević, Anđelija M. Malenović, Aleksandra S. Daković			
Course status: elective, module: Drug Analysis			
Semester: II		Year of studies: I	
ECTS points: 5		Course code: ДАЛ1И7	
Requirements: no			
Course aims: Gaining the knowledge about the examination of physical characteristics and physical stability of pharmaceutical substances using methods of thermal analysis, as well as the possibilities of applying these methods in the development of pharmaceutical dosage forms and their quality control.			
Course outcomes: The application of acquired knowledge in order to select the appropriate method of thermal analysis to examine the physical characteristics and monitoring physical stability of pharmaceutical substances. Critical evaluation of the possibilities of application of these methods in process control of pharmaceutical dosage forms.			
Course contents: The principles and theoretical foundations of thermal analysis. The most commonly used thermal analysis methods in the pharmaceutical field : thermogravimetry - TG), derivative thermogravimetry - DTG , thermogravimetric analysis - TGA, differential thermal analysis - DTA and differential scanning calorimetry - DSC. The basic principles of TG, TGA and DTA. The effect of the sample carrier, gas type, gas pressure and gas flow rate on the analysis. Preparation of sample for thermogravimetric analysis. The types of scale to be used in the TGA apparatus. Advantages and disadvantages of the application of TGA in analytics drugs. Interpretation of the thermogram . The application of TGA on pharmaceutical substances stability evaluation, hydrate characterization, characterization of creams, tablets, and controlled-release tablets. Principles and types of differential scanning calorimetry. Practical problems in the application of DSC. Calibration of DSC apparatus. Interpretations of the results. The examination of the polymorphic forms, hydrates, solvates, amorphous forms, the glass transition; the interpretation of the results. Confirmation, clarification and replenishment of the results obtained by different methods of thermal analysis.			
Recommended literature: 1. Craig, D. Q. M., Reading, M.: Thermal Analysis of Pharmaceuticals. CRC Press is an imprint of Taylor & Francis Group, an Informa business, Boca Raton, USA, 2007. 2. Ed. Haines, P. J.: Principles of Thermal Analysis and Calorimetry. RSC, Cambridge, UK 2002. 3. Ed. Gabbott P.: Principles and Applications of Thermal Analysis, Blackwell Publishing Ltd ,Oxford, UK 2008.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Theoretical lectures, consultations, seminars, interactive teaching.			
Grading system: Pre-exam activities: 30 points Final exam: 70 points			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Method Development Strategy for Drug Analysis			
Teachers: Darko P. Ivanović, Mira L. Zečević, Anđelija M. Malenović, Biljana S. Stojanović			
Course status: Mandatory modules, module: Drug Analysis			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: ДАЛ2ОМ1	
Requirements: no			
Course aims: Acquiring necessary knowledge for the successful method development and establishment and for drug analysis involving scientific approach in definition of critical steps.			
Course outcomes: Successful acquired knowledge application in evaluation of critical phases in method development and establishment, as well as ability to resolve defined problems with adequate risk assessment.			
Course contents: Development of liquid chromatographic method for the determination of purity level of starting material for active pharmaceutical substance synthesis. Development of liquid chromatographic method for the drug concentration analysis in in process samples, and for the evaluation of purity level of intermediers. Development of liquid chromatographic method for the for the finalised drug product with special reflection to the achiral and chiral compounds analysis. Considerations related to the quality and method characteristics (nature of the sample to be analysed, type of the detectors, solution stability, stationary phase selection and mobile phase selection, etc. development of other methods involved in drug quality assessment (spectroscopic methods, titrimetric methods, etc.). The actions involved in embedding of quality into method with the assistance of design – QbD (eng. Quality by Design), as well as the ways of applied method adequacy assessment. Development of alternative method. Method robustness and ruggedness assessment. The choice of optimal method that satisfies in advance assigned criteria and the ways how to asses risk in method application. Defining critical method parameters. Special aspects of method development which involve analysis of impurities of different origin with particular reference to genotoxic impurities. Development of separation methods which are compatible with mass detection for the analysis of genotoxic impurities. Development of Stability Indicating methods. Drug stability evaluation, obtained results interpretation. The recommendation for the application of appropriate method for the analysis in relation to the nature of samples.			
Recommended literature: 1. Juran, J. M., Blanton Godfrey, A. 5th edition: Juran’s quality handbok, McGraw–Hill, New York, USA, 1999. 2. Ed. Kazakevich, Y., Lofbrutto, R.: HPLC for pharmaceutical scientist. John Wiley & Sons, Inc., New York,USA 2007. 3. Freitag, R. (Ed.): Moder Advances in Chromatography. Springer, Berlin, Nemačka, 2002. 4. Vogt, F.G., Kord, A.S.: Development of Quality-by-Design Analytical Methods. J. Pharm. Sci. 2011 (100) 797–812. 5. Cimarosti, Z., Bravo, F., Stonestreet, P., Tinazzi, F., Vecchi, O., Camurri, G.: Application of Quality by Design Principles to Support Development of a Control Strategy for the Control of Genotoxic Impurities in the Manufacturing Process of a Drug Substance, Org. Process. Res. Dev. 2010 (14) 993–998.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures, workshops, seminars, interactive teaching and internet.			
Grading system: Pre-exam engagements: 30 points Final exam: 70 points			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Artificial Neural Networks			
Teachers: Mira L. Zečević, Anđelija M. Malenović, Biljana S. Stojanović			
Course status: elective, module: Drug Analysis			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: ДАЛ2И1	
Requirements: no			
Course aims: Gaining knowledge about artificial intelligence in aim to solve different problems in drug analysis.			
Course outcomes: Ability to solve problems through choice of appropriate neural network, than network testing and dinal validation of results. Showing and interpretation of obtained results.			
Course contents: Basic principles of artificial neural networks. Analogy artificial neurons with biological neurons. Compounds of artificial neurons and basic characteristics of all compounds. Types of artificial neural networks and possibilities for application (prediction, classification, grouping of results, etc.) Methods for network training. Creation of plan of experiments suitable for application of artificial neural networks by applying experimental design methodology. Networks with one layer. Multiple layer perceptron networks. Self-organizing maps. Other types of artificial neural networks. Algorithms for networks training (Back Propagation, Conjugate Gradient descent, Quick Propagation and Quasi Newton, etc). Error function. Optimization of artificial neural networks. Confirmation of successful application of neural networks for certain problem. Application of artificial neural networks for solving different problems in drug analysis (optimization of chromatographic methods, modeling of chromatographic behavior, prediction of retention behavior). Comparing application of artificial neural networks and multiple regression analysis in quantitative relationship between molecular structure and retention behavior. Application of artificial neural networks in prediction of drug substance behavior during period of storage and expiration date. Application of different statistical programs in creation and testing of artificial neural networks and estimation of obtained results.			
Recommended literature: 1. Bishop, C. M.: Neural networks for pattern recognition. Oxford, University press, Great Britain 1994. 2. Medsker, L. R., Jain, L. C.: Recurrent neural networks: Design and Application. CRC Press, Washington, USA 2001. 3. Arbib, M. A.: Brain Theory and Neural Networks, 2nd, Massachusetts Institute of Technology, 2003, Madison, USA. 4. Freeman, J. A., Skapura, D. M.: Neural Networks: Algorithms, Applications and Programming Techniques. Addison-Wesley Publishing Company, 1991, New York, USA. 5. Ed. Kwon, S. J.:Artificial Neural Networks, Nova Publishers, 2011.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Theoretical lectures, workshops, seminars, interactive classes and internet.			
Grading system: Pre-exam activities: 30 points Final exam: 70 points			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Evolutionary Algorithms in Drug Analysis			
Teachers: Biljana S. Stojanović, Zorica V. Stanimirović			
Course status: elective, module: Drug Analysis			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: ДАЛ2И2	
Requirements: no			
Course aims: Training of the candidate to recognize, model and resolve complex problems of optimization in Drug Analysis by applying evolutionary and other algorithms.			
Course outcomes: The ability of clear definition of complex systems and processes, creation of appropriate mathematical models and successful application of evolutionary and other algorithms for obtaining optimal and high quality problem solutions.			
Course contents: Elementary problems of mathematical modeling, problem definition and presentation of mathematical formulation. The complexity of mathematical model and its interpretation. Basis of exact and heuristic optimization methods which could be successfully applied in resolving of optimization problems in drug analysis. Elementary and advanced concept of evolutionary algorithms. Presentation of solutions and different forms of coding function. Generation of initial population, resolving of problems of incorrect individuals. Definition of fitness function. Evolutionary operations of selection, recombination and mutation – elementary and advanced operation types and their modifications. Other aspects of evolutionary algorithms, strategies for prevention of premature convergence and preservation of genetic material diversity. Creation of evolutionary algorithm concept which is adjusted to the problem that should be resolved. Hybridization with exact and heuristic methods aiming to improve the efficiency of algorithm and solution quality. Examples and the possibility of evolutionary algorithms application in drug analysis. Development and optimization of complex chromatographic methods applying evolutionary algorithms. Resolving of different problems in spectroscopic methods applying evolutionary algorithms. Evaluation of problems solutions and data interpretation. Individual resolving and analysis of defined problems.			
Recommended literature: 1. Leardi, R.: Geneticalgorithmsinchemistry. J. Chromatogr. A 2007 (1158) 226–233. 2. Haupt, R. L., Haupt, S. E.: PracticalGeneticAlgorithms. WILEY–INTERSCIENCE, AJohn Wiley & Sons, Inc. Publication, New Yersey, U. S. A. 2004. 3. Leardi, R. Ed.: Natureinspiredmethodsinschemometrics: geneticalgorithmsandartificialneuralnetworks. Elsevier, Amsterdam, 2003. 4. Coley, D.: AnIntroductiontoGeneticAlgorithmsforScientistsandEngineers, WorldScentific, Singapore/New Jersey/London/HongKong, 2003. 5. Glover, F., KochenbergerG.: HandbookofMetaheuristics, KluwerAcademicPublishers, Boston/ Dordrecht/London, 2003. 6. Michalewicz, Z., Fogel, D.B.: How tosolveit: modernheuristics, Springer 2004.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Theoretical lectures, workshops, seminars, interactive classes and internet.			
Grading system: Pre-exam activities: 30 points Final exam: 70 points			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Proteomic, Metabolomic and (Pharmaco)metabonomic Analysis			
Teachers: Mira L. Zečević, Anđelija M. Malenović, Biljana S. Stojanović			
Course status: elective, module: Drug Analysis			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: ДАЛ2ИЗ	
Requirements: no			
Course aims: Understanding of modern pharmaceutical analysis principles in the field of peptide and protein, proteomic, metabolomic and (pharmaco)metabonomic analysis.			
Course outcomes: Basic knowledge needed for metabolomic profiling and establishing a relationship between phenotype or phenotype response and genetic or nutritional disorder, in order to give the right treatment regimen.			
Course contents: Pharmacometabolomics (or pharmacometabonomics) are a part of the scientific field Metabolomics and refer to quantification of metabolites, originated after the application of specific active pharmaceutical substance. Interpretation of the obtained results may provide an evidence of the influence of the applied substance to metabolic pathway. On the other hand, metabolites may be monitored during the research and development phase in order to predict and estimate the metabolism of the pharmaceutical substances. Both approaches include the use of appropriate bioanalytical methods for metabolic profiling in tissues and biological liquids (blood, plasma, urine, etc.). Most applicable methods are liquid chromatography and gas chromatography combined with mass spectrometry and nuclear magnetic resonance. Obtained data are most adequately analyzed by means of chemometrics, because it allows individual patient’s response prediction. Metabolomic profiling and establishing a relationship between phenotype or phenotype response and genetic or nutritional disorder enables giving of the right treatment regimen. The main goal of pharmacometabolomics and complementary scientific areas like pharmacogenomics is to provide therapy individualization by treatment results predicting in terms of efficiency and safety.			
Recommended literature: 1. Weckwerth, W.: Metabolomics, Methods and Protocols. Humana Press, New Jersey, 2007. 2. Evans, G.: A Handbook of Bioanalysis and Drug Metabolism., CRC Press, New York 2004. 3. Lovrić, J.: Introducing Proteomics: From Concepts to Sample Separation, Mass Spectrometry and Data Analysis, John Wiley–Blackwell, New Jersey 2011. 4. Assfalg, M., Bertini, I., Colangiuli, D., Luchinat, C., Schäfer, H., Schütz, B. Spraul, M.: PNAS 2011 (105) 1420–1424. 5. Lindon, J. C., Holmes, E., Nicholson, J. K.: Pharm. Res. 2006 (23) 1075–1088.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures, workshops, seminars, interactive teaching and internet.			
Grading system: Pre-exam engagements: 30 points Final exam: 70 points			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Pharmacological Profile of the Drug			
Teachers: Miroslav S. Savić			
Course status: elective, module: Drug Analysis			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: ДАЛ2И4	
Requirements: no			
Course aims: Acquiring knowledge for understanding the basic characteristics of drugs based on in vitro and in vivo data obtained from preclinical studies.			
Course outcomes: Ability to independently interpret the results obtained during preclinical investigation of drugs. Ability for critical appraisal of the completeness of the available pharmacological profile of a drug. Appraisal of preclinical research data in the context of the findings of research in humans.			
Course contents: The process of drug discovery. Strategy for investigation and development of new drugs. Drug target sites. Integration of multi-celled organism. Interaction drug – mechanism of biological regulation. Biological membranes and the effect of the drug. Receptors, ion channels, enzymes, transporters. In vitro investigation of drug affinity and efficacy. Efficacy and potency. Agonists, inverse agonists, antagonists. Relationship between dose and effect. Tolerance and resistance. Principles of investigation on animals. Legislation and ethical issues in relation to work with experimental animals. Methods of genetic engineering in assessment of pharmacological profile of drug. Primary pharmacodynamic investigations. Secondary pharmacodynamic investigations. Safety pharmacology. Pharmacokinetic profile of drug. Toxicological profile of drug. Acute toxicity. Repeated dose toxicity. Mutagenicity. Teratogenicity. Carcinogenicity. Interpretation of the results obtained from toxicological studies and data extrapolation on humans. Estimation of efficacy and safety of drugs. Preclinical profile of biological drugs. Planning of clinical investigations of drugs. Phases in clinical investigation. Pharmacoepidemiological investigation. Pharmacological profile in special populations (children, pregnancy, lactation, elderly, patients with excretory organ disease).			
Recommended literature: 1. Rang, H. P.: Drug discovery and development. Churchill Livingstone, Edinburgh, 2006. 2. Kenakin T. A Pharmacology Primer: Theory, Applications and Methods, 2nd edition. Academic Press, London, 2006. 3. Hacker M, Bachmann K, Messer W. Pharmacology Principles and Practice. Academic Press, Amsterdam, 2009. 4. Rang, H. P., Dale, M. M., Ritter, J. M., Flower, R. J., Henderson, G. Rang and Dale's Pharmacology, 7th ed. Elsevier Churchill Livingstone, Edinburgh, 2011. 5. Brunton, L., Chabner, B. A., Knollman, B. Goodman and Gilman's The Pharmacological Basis of Therapeutics, 12 ed. McGraw–Hill, New York, 2010.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures and study-research work			
Grading system: Seminar: 30 points; written exam: 70 points			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Advanced Pharmaceutical Dosage Forms			
Teachers: Snežana D. Savić, Svetlana R. Ibrić			
Course status: elective, module: Drug Analysis			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: ДАЛ2И5	
Requirements: no			
Course aims: Acquiring knowledge in the field of formulation development and control of conventional and modern pharmaceutical dosage forms.			
Course outcomes: Dealing with development approaches and recognizing of formulation difference between conventional and modern pharmaceutical dosage forms: preformulation (phisicochemical and biopharmaceutical characterization of active pharmaceutical ingredient, excipients selection) and formulation consideration of conventional and modern pharmaceutical dosage forms intended for different administration routes; acquiring knowledge about the techniques of preparation/obtaining and common methods for characterization/control of conventional and modern pharmaceutical dosage forms during the development phase in laboratory; getting familiar with technological producing processes of conventional and some modern pharmaceutical dosage forms and methods for their pharmacotechnological examination. Knowledge about manufacture methods, development and formulation of biotechnological drugs.			
Course contents: Selection of excipients for the formulation of conventional and modern pharmaceutical dosage forms. Formulation and control of the dosage forms intended for per oral administration. Formulation and control of the sterile dosage forms: parenteral administration and ophthalmic preparations. Pharmaceutical preparations for dermal application and specific administration routes. Formulation and control of modified-release preparations. Formulation and techniques of preparation of microparticle drug delivery systems. Preformulation and formulation considerations, preparation techniques and characterization of colloidal carriers: micellar systems, microemulsions, liquid crystal phases, liposomes, nanoparticle systems. Properties of biotechnological drugs. Development of biotechnological drugs. Prokaryotic and eukaryotic cells in biotechnological drug production. Production of biotechnological drugs from plants. Development of industrial production process and production process. Formulations with proteins and peptides. Scientific, technological and economic aspects of vaccine development, including DNA vaccines also. Inhaled preparations based on biomacromolecules. Proteins and phospholipids (injectable forms, formulation and preparation, characteristics of the products). Polymeric systems for per os administration of proteins and peptides. Characterization of the recombinant proteins as drugs. Biogeneric drugs.			
Recommended literature: 1. Gibson, M.: Pharmaceutical preformulation and formulation, 2nd ed. Informa healthcare, New York–London, 2009. 2. Rathbone, M. J., Hadgraft, J., Roberts, M. S., Lane, M. E.: Modified Release Drug Delivery Technology, Second Edition, Volume 1, Informa healthcare, New York–London, 2008. 3. Rathbone, M. J., Hadgraft J., Roberts M. S., Lane M. E.: Modified–Release Drug Delivery Technology, Second Edition, Volume 2, Informa healthcare, New York–London, 2008. 4. Bauer, K. H., Fröming, K. H., Führer, C.: Lehrbuch der Pharmazeutischen Technologie. 8th ed., Nova Stuttgart, 2006. 5. Ed.:Kayser, O., Müller, R. H.: Pharmaceutical Biotechnology, Drug Discovery and Clinical Application. Wiley-VCH Verlag GmbH&Co. KgaA, Weinheim, Nemačka, 2004. 6. Walsh, G: Pharmaceutical Biotechnology, Concept and Application. Wiley & Sons Ltd., Chichester, England, 2007. 7. Groves, M.J.: Pharmaceutical Biotechnology, Taylor & Francis Group, CRC Press, Boca Raton, U. S. A. 2006.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures, workshops, seminars, interactive teaching and internet.			
Grading system: Pre-exam engagements: 30 points Final exam: 70 points			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Biological Drug Analysis			
Teachers: Biljana S. Stojanović, Nevena M. Arsenović Ranin, Zorica M. Stojić Vukanić			
Course status: elective, module: Drug Analysis			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: ДАЛ2И6	
Requirements: no			
Course aims: Acquiring knowledge about the characteristics of methods used for biological drug analysis.			
Course outcomes: Ability to select an adequate method for biological drugs analysis.			
Course contents: Protein structure and properties. Properties and classification of biological drugs. Immunogenicity of biological drugs. Biosimilars, properties and comparison to generic drugs. Biotechnological drug development. Chromatography and other techniques used for protein purification. Chromatographic methods used for the analysis of biological drugs, i.e. proteins and peptides (size-exclusion chromatography, ion-exchange chromatography, reversed-phase chromatography, hydrophilic interaction liquid chromatography and affinity chromatography). Development of chromatographic methods used for biological drug analysis. Mass spectrometry methods used for protein characterization (electrospray ionization, matrix-assisted laser desorption/ionization). Benefits from hyphenation with „time of flight“– TOF detector. Determination of protein molecular mass. Protein characterization by means of mass spectrometry. Characterization of drug-protein interactions by means of affinity HPLC/MS. Microwaves application in protein and peptide analysis. Application of electrophoresis and multidimensional chromatography in protein analysis. Comparison of methods used for biological and conventional drug analysis. Comparison of biological and conventional drugs. Regulatory requirements concerning quality of biological drugs. Monitoring of biological drug quality assurance. Stability of biological drugs and protocols of stability studies for biological methods. Literature overview about specific biological drug analysis, presentation and critical review on the proposed procedure.			
Recommended literature: 1. Groves, M.J.: Pharmaceutical Biotechnology, Taylor&Francis Group, CRC Press, Boca Raton, U. S. A. 2006. 2. Ed. Kazakevich, Y., Lobrutto, R.: HPLC for pharmaceutical scientist. John Wiley & Sons, Inc., New York,USA 2007. 3. Quality of Biotechnological Products:Stability Testing of Biotechnological/Biological Products, ICH Q5C Guideline, 1995. 4. Pramanik, B. N., Mirza, U. A., Ing, Y. H., Liu, Y. H., Bartner, P. L., Weber, P. C., Bose, A. K.: Microwave-enhanced enzyme reaction for protein mapping by mass spectrometry: A new approach to protein digestion in minutes, Protein Science 11 (2002), 2676–2687. 5. Walsh, G: Pharmaceutical Biotechnology, Concept and Application. Wiley & Sons Ltd., Chichester, England, 2007.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures, workshops, seminars, interactive teaching and internet.			
Grading system: Pre-exam engagements: 30 points Final exam: 70 points			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Drug analysis in Pharmacokinetics Investigation			
Teachers: Miljković P. Branislava, Vezmar Kovačević D. Sandra, Vučićević M. Katarina			
Course status: elective, module: Drug Analysis			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: ДАЛ2И7	
Requirements: no			
Course aims: The aim of the course is to provide students with relevant tools needed for planning, conducting and interpreting the results of bioanalytics methods during pharmacokinetic studies.			
Course outcomes: On completion of the course, the student will be able independently to account for the need of bioanalytical methods within pharmacokinetic studies, to plan and carry out optimal techniques, and interpret, critically appraise and present the results of bioanalytical analysis during pharmacokinetic studies.			
Course contents: Significance of pharmacokinetics in drug development. Biological materials used in pharmacokinetic investigation. Planning the process of biological samples preparation and analysis methodology for pharmacokinetic studies. Methods for biological samples preparation and optimization of the separation methods. Optimization of drugs' and metabolites' analysis in biological samples. Parameters of bioanalytical analysis validation in pharmacokinetic studies according to the regulatory authorities. Representation of validation parameters. Preparing the report as a part of pharmacokinetic clinical studies. Bioanalytical aspects of bioavailability and bioequivalence studies. Calculation of pharmacokinetic parameters of interest for the bioequivalence studies. Bioanalytical aspects in therapeutic drug monitoring. Factors that contribute to pharmacokinetic variability, and interpretation of measured drug levels. Pharmacokinetic analysis of measured drug concentrations. Interpretation of measured drug concentration during therapeutic drug monitoring. Critical appraisal of pharmacokinetic and studies of bioequivalence based on the results. Adjustment of dosing regimen based on the measured drug concentration levels.			
Recommended literature: 1. Xu A.Q, Madden T. Analytical Methods for Therapeutic Drug Monitoring and Toxicology. Wiley, 1st ed. 2011. 2. Burton M.E. (Editors): Shaw L.M, Schentag J.M, Evans W.E. Applied Pharmacokinetics and Pharmacodynamics: Principles of Therapeutic Drug Monitoring. Lippincott Williams & Wilkins; 4th ed, 2005. 3. Chow S.C, Liu J. Design and Analysis of Bioavailability and Bioequivalence Studies. CRC Press, New York, 3rd ed, 2009. 4. Rowland M, Tozer T.N. Clinical Pharmacokinetics and Pharmacodynamics: Concept and Applications, Lippincott Williams & Wilkins, 4th ed, 2011.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Theoretical lectures, workshops, seminars, interactive classes and internet.			
Grading system: Pre-exam activities: 30 points Final exam: 70 points			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Food Chemistry I			
Teachers: Šobajić S. Slađana, Stanković M. Ivan, Đordjević I. Brižita			
Course status: Mandatory modules, module: Bromatology			
Semester: I		Year of studies: I	
ECTS points: 10		Course code: ДБР1ОМ1	
Requirements: no			
Course aims: Course provides students with knowledge on the chemical constituents of food, their chemical structure and physiological function			
Course outcomes: Student will be able to independently evaluate nutritive end energy value of foods and their roles within daily diet or specific dietary regimen			
Course contents: Food Chemitry as a science, connections with other scientific disciplines; Definitions of diet, food, nutrients. Factors that have effect on food choice; Energy value of foods; Macro- and micronutrients - chemistry and basic physiological roles; Dietary reference Intakes, adequate intake, safe upper level of nutrients; Role of food and food groups in daily diet			
Recommended literature: 1. Introduction to Human Nutrition. Second Edition. Editors Michael J. Gibney, Susan A. Lanham-New, Aedin Cassidy, Hester H. Vorster. Willey Blackwell Publ., 2009; 2. Belitz HD, Grosch W, Scieberle P. Food Chemistry. Springer, 2004			
The total of active learning classes	Lectures: 60		
	Individual research work: 60		
Teaching methods: Lectures; consultations; laboratory work; an individual written report on selected topics; quiz tests; preparing individual Power point presentation on selected topics			
Grading system: Continuous assessments: 30; Final exam: 70			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Food Analysis			
Teachers: Šobajić S. Slađana, Stanković M. Ivan, Đordjević I. Brižita			
Course status: Mandatory modules, module: Bromatology			
Semester: I		Year of studies: I	
ECTS points: 5		Course code: ДБР10М2	
Requirements: no			
Course aims: Course provides students with knowledge on the basic methods and techniques used in food analysis.			
Course outcomes: Student will be able to indipendently analyse food composition and use methods in determination of certain food characteristics.			
Course contents: Theoretical and practical priciples of basic laboratory techniques used in food analyses (gravimetry, volumetry, spectrophotometry, refractometry, polarimetry, gas chromatography, thin-layer chromatography, HPLC etc); Principles of method validation; Basic food analysis: water, proteins, fats, carbohydrates, vitamins, minerals, food additives.			
Recommended literature: 1. AOAC Methods; 2. Handbookof Food Analytical Chemistry. Editors RE Wrostand, TE Acree, EA Decker i sar., Wiley&Sons Inc., New Jersey, 2005			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures; consultations; laboratory work; an individual written report on selected topics.			
Grading system: Continuous assessments: 50; Final exam: 50			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Food Chemistry II			
Teachers: Šobajić S. Slađana, Stanković M. Ivan, Đordjević I. Brižita			
Course status: Mandatory modules, module: Bromatology			
Semester: II		Year of studies: I	
ECTS points: 10		Course code: ДБР10М3	
Requirements: no			
Course aims: Course provides students with knowledge on the chemical constituents of food, their chemical structure and their physiological function or function in foods			
Course outcomes: Student will be able to indipendently evaluate biological value of foods and their role within specific dietary regimen, as well as to evaluate quality and composition of water			
Course contents: Biologically active non-nutritive food compounds and their role in helath and disease; Water as part of regular diet and as a product; interactions of nutrients, Interactions of nutrients and drugs; Information on food labels			
Recommended literature: 1. Belitz HD, Grosch W, Scieberle P. Food Chemistry. Springer, 2004; WHO Guidelines for Drinkig Water Quality. Geneve, 2011; 3. Handbook of Food-Drug Interactions. Editors BJ McCabe, EH frankel, JJ Wolfe. CRC Press, London. 2003.			
The total of active learning classes	Lectures: 60		
	Individual research work: 60		
Teaching methods: Lectures; consultations; laboratory work; an individual written report on selected topics; quiz tests; preparing individual Power point presentation on selected topics			
Grading system: Continuous assessments: 30; Final exam: 70			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Dietetics			
Teachers: Šobajić S. Slađana, Stanković M. Ivan, Đordjević I. Brižita			
Course status: Mandatory modules, module: Bromatology			
Semester: II		Year of studies: I	
ECTS points: 5		Course code: ДБР1ОМ4	
Requirements: no			
Course aims: Course provides students with knowledge for applying the principles of optimal nutrition.			
Course outcomes: Student will be able to implement principles of rational and optimal nutrition in health and disease.			
Course contents: Basic principles of rational and optimal nutrition, and role of nutrition in health and disease; Methods for the evaluation of nutritive status; Nutrition throughout life cycle; Dietary products and dietary supplements; Basic principles of enteral and parenteral nutrition; Nutrition in prevention and risk management in chronic diseases; Food-drug interactions; Food allergies and food intolerances.			
Recommended literature: 1. Mahan LK, Escott-Stump S. Krause’s Food & Nutrition Therapy. Elsevier, St. Louis, 2008.; 2. Mery E. Barasi. Human Nutrition – A health perspective. 2003. Hodder Arnold Publ.; 3. Introduction to Human Nutrition. Second Edition. Editors Michael J. Gibney, Susan A. Lanham-New, Aedin Cassidy, Hester H. Vorster. Willey Blackwell Publ., 2009			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures; consultations; laboratory work; an individual written report on selected topics, quiz tests; preparing individual Power point presentation on selected topics			
Grading system: Continuous assessments: 30; Final exam: 70			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Food Safety			
Teachers: Šobajić S. Slađana, Stanković M. Ivan, Đordjević I. Brižita			
Course status: Mandatory modules, module: Bromatology			
Semester: III		Year of studies: II	
ECTS points: 10		Course code: ДБР2ОМ1	
Requirements: no			
Course aims: Course provides students with knowledge on the principles of food safety and food risk analysis, as well as the characteristics of major food hazards.			
Course outcomes: Student will be able to understand the risk of food constituents (nutrients, contaminants, additives) and to indipendently analyse their presence in food and water.			
Course contents: Definitions and principles of food risk analysis (hazard identification, risk assessment, risk communication, risk management); International legislative on food safety; Food additives; Natural food toxins; Residues of chemical contaminants in food and water; Effects of food thermal processing; Materials in contact with foods.			
Recommended literature: 1. Food toxicology, editori W. Helferich, C.K. Winter, CRC Press, London, 2001.; 2. Food Additives. Editori A. Larry Branen; P. Michael Davidson. CRC Press, Boca Raton, 2001.; 3. Chemical Migration and Food Contact Materials. Editors KA Barnes, CR Sinclair, DH Watson. Woodhead Publishing Limited, Cambridge, 2007.			
The total of active learning classes	Lectures: 60		
	Individual research work: 60		
Teaching methods: Lectures; consultations; laboratory work; an individual written report on selected topics, quiz tests; preparing individual Power point presentation on selected topics			
Grading system: Continuous assessments: 30; Final exam: 70			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Selected chapters of Organic Chemistry			
Teachers: Savić M. Vladimir, Tokić-Vujošević N. Zorana			
Course status: elective, module: Bromatology			
Semester: II		Year of studies: I	
ECTS points: 2,5		Course code: ДБР1И1	
Requirements: no			
Course aims: Understanding the properties and reactivity of biomolecules at the molecular level, learning about the impact of stereochemical properties of biomolecules and their function			
Course outcomes: Understanding and predicting the chemical properties of biomolecules, understanding of the stereochemical features and their importance in the function of biomolecules.			
Course contents: The structure and reactivity of biomolecules, basic stereochemical terms, stereochemical aspects of the properties of biomolecules.			
Recommended literature: 1. Organic Chemistry: Structure and function, 5th edition, K.P.Vollhardt and Neil E. Shore 2. Essentials of Organic Chemistry P. M. Dewick 3. original scientific research papers			
The total of active learning classes		Lectures: 15	
		Individual research work: 15	
Teaching methods: Consultations, seminars.			
Grading system: commitments before the exam - seminar: 50 points; exam: 50 points.			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Physiology - Selected chapters			
Teachers: Bosiljka A. Plećaš-Solarović, Vesna R. Pešić			
Course status: elective, module: Bromatology			
Semester: II		Year of studies: I	
ECTS points: 2,5		Course code: ДБР1И2	
Requirements: no			
Course aims: Introduction to physiological processes necessary for understanding the study program.			
Course outcomes: Acquaintance with medical terminology; Basic knowledge of organ, system and whole body function.			
Course contents: Homeostasis, Blood, Cardiovascular system, Respiratory system, Digesttive system, Urinary system, Endocrine sistem.			
Recommended literature: B. Plećaš: Physiology Lectures			
The total of active learning classes	Lectures: 15		
	Individual research work: 15		
Teaching methods: Consultations and individual study			
Grading system: pre-exam: 30 poens; oral exam: 70 poens.			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Selected Instrumental Methods			
Teachers: Vesna S. KuntiĆ, Slavica M. BlagojeviĆ			
Course status: elective, module: Bromatology			
Semester: II		Year of studies: I	
ECTS points: 2,5		Course code: ДБР1И3	
Requirements: no			
Course aims: To acquire knowledge about basic principles of spectrophotometric and chromatographic methods widely applied in food analysis , as well as basic principles of mass spectrometry. Through this course, student will complete his/her theoretical knowledge for instrumental analysis and he/she will be trained to apply these method for required task in research.			
Course outcomes: Student grasps the concept of theoretical principals of optical and chromatographic methods and comprehends fundamentals of mass spectroscopy. Student is capable to apply particularly instrumental method in his/her own scientific research for food analysis.			
Course contents: Selected spectroscopic methods. UV-VIS spectroscopy: theoretical principles, UV-VIS spectrophotometer, spectra of proteins. Atomic absorption spectrophotometry: theoretical principles, AAS instrument, techniques with and without flame-graphite furnace technique, preparation (digestion) of the sample. Selected chromatographic techniques. Liquid chromatography, RP-HPLC, selection of mobile and stationary phase. HPLC in protein analysis. Gas chromatography, detectors in gas chromatography. Application of GC in food analysis. Fundamentals of mass spectroscopy. Ionisation modes: electron impact, chemical ionisation, fast atom bombardment, plasma desorption ionisation, electrospray ionisation, ion spray ionisation, matrix-assisted laser desorption ionisation. Mass analyser: magnetic sector field, quadrupole, ion trap, time-of-flight. Ion detectors. Mass spectrum. Mass spectroscopy in food analysis.			
Recommended literature: Lawrence A. Kaplan, Amadeo J.Pesce, Clinical chemistry: theory, analysis, correlation, 1996. Skoog, D., Holler, F., Nieman, T.: Principles of Instrumental Analysis, Saunders College Publishing, Philadelphia 1998. DavidSheehan: Physical Biochemistry: Principles and Applications, Wiley, 1997.			
The total of active learning classes	Lectures: 15		
	Individual research work: 15		
Teaching methods: Individual lectures, literature survey.			
Grading system: Pre-examination activities (seminar): 50 points Exame (oral): 50 points			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Nutritional biochemistry			
Teachers: Spasojević-Kalimanovska V. Vesna			
Course status: elective, module: Bromatology			
Semester: II		Year of studies: I	
ECTS points: 2,5		Course code: ДБР1И4	
Requirements: no			
Course aims: The student has to accomplish, understand and comprehend the knowledge of basic anabolic and catabolic pathways in human organism and their regulation. Nutrition and metabolism in specific physiological and pathophysiological states.			
Course outcomes: After the course the student will be able to interpret the energy requirements and specific metabolism in various nutritional and hormonal states.			
Course contents: Basic principles of bioenergetic. Digestion and absorption of diet constitutes. Catabolism and anabolism of carbohydrates, lipids and nitrogen compounds. Metabolism in different physiology and pathophysiology states. Metabolic interrelationships and hormonal control. Metabolism in starvation, digestion and absorption disorders. Metabolism and vitamin and microelement deficiency. Effect of diet on lipoprotein metabolism and atherogenic risk. Metabolic pathways in adipose tissue. Insulin resistance and obesity. Aerobic and anaerobic exercise and specific metabolism in skeletal muscle. Metabolic changes in different diets.			
Recommended literature: 1. Devlin, T.M. Textbook of Biochemistry with clinical correlation. John Wiley&Sons. 2011. Cox MM. Lehninger Principles of Biochemistry 5th Edition, W.H. Freeman & Company, 2008. 3. Broddy T. Nutritional biochemistry, Second edition, Academic Press, 1999. 4. Rozenthal MD, Glew RH. Medical Biochemistry. Human metabolism in health and disease. John Wiley & Sons, New York, 2009. 2. Nelson DL,			
The total of active learning classes	Lectures: 15		
	Individual research work: 15		
Teaching methods: Interactive theoretical lectures; student practical work, seminars; case problem study e-learning.			
Grading system: 60 poens pre-exam; final exam: 40 poens			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Biologically Active Food Compounds			
Teachers: Sobajić S. Slađana, Stankovic M. Ivan, Đordjević I. Brižita			
Course status: elective, module: Bromatology			
Semester: III		Year of studies: II	
ECTS points: 2,5		Course code: ДБР2И1	
Requirements: no			
Course aims: Course provides students with knowledge of biological non-nutritive functions of certain food constituents.			
Course outcomes: Student will be able to understand the possibilities of selected food compounds in health protection and nutrition therapy.			
Course contents: Categories of food active compounds; Nutritive and non-nutritive food active compounds; Phytonutrients; Microorganism cultures; Dietary sources; Fortified foods; Dietary supplements; Dietary interventions with active food compounds; Health claims and food labelling.			
Recommended literature: 1. Phytochemicals in Health and Disease edited by:Yong Ping Bao, Roger Fenwick, Marcel Dekker, Inc.New York, Basel, 2004.; 2. Preventive Nutrition. The Comprehensive Guide For Health Professionals. Third Edition. Byadrianne Bendich, Richard J.Deckelbaum, Humana Press, New Jersey, 2005.			
The total of active learning classes	Lectures: 15		
	Individual research work: 15		
Teaching methods: Lectures; consultations; an individual written report on selected topics, quiz tests; preparing individual Power point presentation on selected topics			
Grading system: Continuous assessments: 50; Final exam: 50			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Food intolerances and nutritive metabolic disorders			
Teachers: Šobajić S. Slađana, Stanković M. Ivan, Đordjević I. Brižita, Miletić D. Ivanka			
Course status: elective, module: Bromatology			
Semester: III		Year of studies: II	
ECTS points: 2,5		Course code: ДБР2И2	
Requirements: no			
Course aims: Course provides students with knowledge of major nutritive metabolic disorders and food intolerances and nutritive strategies in their therapy.			
Course outcomes: Student will be able to understand the possibilities of selected food compounds in triggering clinical symptoms and to implement dietary measures in prevention and therapy of these disorders.			
Course contents: Metabolic disorders; Food allergy; Food intolerances; The role of dietary products in the diet of population with these disorders; Safety of these products.			
Recommended literature: 1. Food Allergy. Editori JM James, W Burks, PA Figenmann. Elsevier Inc., London, 2012.; 2. Food Allergy: Adverse reactions to foods and food additives. editori DD Metcalfe, HA Sampson, RA Simon. Blackwell Publishing, Malden, 2008.			
The total of active learning classes	Lectures: 15		
	Individual research work: 15		
Teaching methods: Lectures; consultations; an individual written report on selected topics, quiz tests; preparing individual Power point presentation on selected topics			
Grading system: Continuous assessments: 50; Final exam: 50			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Food lipids			
Teachers: Šobajić S. Slađana, Stanković M. Ivan, Đordjević I. Brižita, Miletić D. Ivanka			
Course status: elective, module: Bromatology			
Semester: III		Year of studies: II	
ECTS points: 2,5		Course code: ДБР2И3	
Requirements: no			
Course aims: Course provides students with knowledge of the characteristics of food lipids and their role in foods and in nutrition.			
Course outcomes: Student will be able to analyse fatty acid composition of foods and to use lipids in dietary interventions and in designing fortified and functional foods.			
Course contents: Food lipids; Chemistry of food lipids; Dietary sources; Essential fatty acids; Omega-9, omega-6, and omega-3 fatty acids; Cholesterol and phytosterols; Lipid oxidation; Role of lipids in health and disease.			
Recommended literature: 1. Gurr MI: Lipids in nutrition and health: A reappraisal., PJ Barnes&Associates, Bridgwater, 2009.; 2. Belitz HD, Grosch W, Schieberle P. Food Chemistry. Springer, 2004.			
The total of active learning classes	Lectures: 15		
	Individual research work: 15		
Teaching methods: Lectures; consultations; an individual written report on selected topics, quiz tests; preparing individual Power point presentation on selected topics			
Grading system: Continuous assessments: 50; Final exam: 50			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Effects of processing on food quality and safety			
Teachers: Šobajić S. Slađana, Stanković M. Ivan, Đordjević I. Brižita, Miletić D. Ivanka			
Course status: elective, module: Bromatology			
Semester: III		Year of studies: II	
ECTS points: 2,5		Course code: ДБР2И4	
Requirements: no			
Course aims: Course provides students with knowledge on the principles of the food thermal processing and the effects, positive and negative, of these processes.			
Course outcomes: Student will be able to understand the possibilities of food processing in improving food quality and safety, as well as the risks of food processing.			
Course contents: Food processing methods; Thermal food processing and its influence on nutrients and non-nutritive constituents; Toxicological risks of food processing: Maillard reaction.			
Recommended literature: 1. Process-induced Food Toxicants. Editori RH Stadler, DR Lineback.Wiley^Sons Inc, New Jersey, 2009.; 2. Thermal Technologies in Food Processing. Editor P Richardson. Woodhead Publishing limited, Vambridge, 2011			
The total of active learning classes	Lectures: 15		
	Individual research work: 15		
Teaching methods: Lectures; consultations; an individual written report on selected topics, quiz tests; preparing individual Power point presentation on selected topics			
Grading system: Continuous assessments: 50; Final exam: 50			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Cosmetic ingredients			
Teachers: Vuleta M. Gordana, Milić R. Jela, Savić D. Snežana, Petrović D. Silvana, Drobac M. Milica			
Course status: Mandatory modules, module: Cosmetology			
Semester: I		Year of studies: I	
ECTS points: 10		Course code: ДКО10М1	
Requirements: one-semester undergraduate course in Cosmetology			
Course aims: To introduce the candidate with different groups of cosmetic ingredients, along with their properties, application, efficacy and safety aspects.			
Course outcomes: The candidate is able to independently make a selection of suitable cosmetic ingredients based on the assessment of their characteristics, according to the requirements set by the formulation process of a specific cosmetic product.			
Course contents: National legislation relating to cosmetic products; Regulatory requirements on cosmetic products in European Union; Cosmetics Directive 76/768/EEC and Annexes; 6th and 7th Amendment of the Cosmetic Directive 76/768/EEC; Regulation No 1223/2009 of the European Parliament and of the Council on cosmetic products and its amendments; Good Manufacturing Practice in cosmetic industry; Classification of cosmetic ingredients according to origin: natural (plant, mineral or animal origin), synthetic and semi-synthetic; Cosmetic actives of different type: plant extracts in cosmetic preparations, proteins, peptides, glycosaminoglycans, vitamins, alpha-hydroxy acids, beta-hydroxy acids, etc; Lipid materials: fatty acids, fatty alcohols, waxes, ceramides, vegetable oils, hydrocarbons, synthetic lipids; Surface active materials; Surfactant-type emulsifiers, polymeric emulsifiers; Humectants; Polymers (thickeners, rheology modifiers and gelling agents); Preservatives and complexants; Antioxidants; Colours and pigments; UV-filters (chemical and physical); Nanomaterials; Various types of colloidal carriers for cosmetic actives: liposomes, nanosomes, microparticles, microspheres, microcapsules, nanoparticles (polymeric and solid lipid ones), oleosomes, micelles.			
Recommended literature: 1. Rieger MM. Harry's Cosmetology. 8th edition, New York: Chemical Publishing Co Inc, 2000. 2. De Polo KF. A Short Textbook of Cosmetology. Ausburg: Verlag Fur Chemishe Industrie, H. Ziokowski GmbH, 1998. 3. Vasiljević D, Savić S, Đorđević Lj, Krajišnik D. Priručnik iz kozmetologije. Beograd: Nauka, 2009. 4. Schlossman ML. Chemistry and Manufacture of Cosmetics: Cosmetic Specialties and Ingredients, Illinois: Allured Publishing Co, 2010. 5. Seifen, Öle, Fette, Wachse (journal specialized for cosmetology in EU - selected articles). 6. INCI Dictionaries. 7. Regulation (EC) No 1223/2009 of the European Parliament and of the Council of 30 November 2009 on cosmetic products. 8. COSMOS-standard: Cosmetic organic and natural standard, Version 1.1– 31st January 2011, COSMOS-standard AISBL, Brussels, Belgium (www.cosmos-standard.org).			
The total of active learning classes	Lectures: 60		
	Individual research work: 60		
Teaching methods: Lectures, seminars, interactive methods, laboratory work.			
Grading system: Pre-exam assignments: 50 points; exam (oral): 50 points.			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Theoretical aspects of cosmetic emulsions and gels			
Teachers: Vuleta M. Gordana, Milić R. Jela, Savić D. Snežana, Vasiljević D. Dragana			
Course status: Mandatory modules, module: Cosmetology			
Semester: I		Year of studies: I	
ECTS points: 5		Course code: ДКО10М2	
Requirements: one semester undergraduate course in Cosmetology; course: Cosmetic ingredients (first semester of doctoral studies).			
Course aims: Introduction to theoretical background of colloidal systems; Getting acquainted with stabilization mechanisms of emulsion systems with different consistencies and purposes; Introduction to formation and structure of gels with different gelling agents, factors important for emulsion and gel preparation; The possibilities of the application of theoretical premises in formulation of cosmetic emulsions and gels .			
Course outcomes: Application of the acquired knowledge in independently review and selection of a dispersion system in accordance with the purpose of cosmetic products, selection and characteristics of the necessary emulsifiers. The student is also able to predict possible preparation techniques and methods of characterization of the formulated products.			
Course contents: Cosmetic emulsions - characteristics, types, contents, classification criteria and classification; Principles of emulsion preparation and stabilization; The choice of raw materials/ingredients for preparation of cosmetic emulsions of liquid and semi-solid consistencies (lotions and creams); Principles of stabilization and preparation/production methods of cosmetic emulsions - theoretical and practical aspects; Equipment for preparation/manufacture and principles; Good manufacturing practices (GMP) in preparation/production of cosmetic emulsions; Investigation of quality of emulsions of liquid and semi-solid consistencies; Cosmetic gels - characteristics, composition (formula), types, classification; Factors important for formulation, stability and application characteristics of gels; Choice and quality of cosmetic ingredients/raw materials for gel preparation; Methods of preparation/production of cosmetic gels - theoretical and practical aspects; Assessment of cosmetic gels quality.			
Recommended literature: 1) Colloids in Cosmetics and Personal Care, Volume 4 (ed T. F. Tadros), Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim, Germany. doi: 10.1002/9783527631131. 2) Rieger MM. Harry s Cosmeticology. 8 th edition, New York chemical Publishing Co Inc. 2000 3) De Polo KF, A Short Text book of Cosmetology, Ausburg: Verlag Fur Chemishe Industrie, H. Ziokowski GmbH, 1998. 4) International Cosmetic Ingredient Dictionary and Handbook, 14th ed. The Personal Care Products Council, 2012. 5) Vasiljević D., Savić S., Đorđević Lj., Krajišnik D., Priručnik iz kozmetologije, Nauka, Beograd, 2007. 6) Rosen R.M, Delivery System Handbook for personal Care and Cosmetic Products, Tehnology, Applications and Formulations, Norwich, New York: William Andrew Publishing, 2005. 7) Seifen, Ole, Fette, Wachse Journal 8) Cosmetics & Toiletries magazine 9) Actifs et additifs en cosmetologie, edit. Martini M.C., Seiller M., Edition Tec & Dac, Paris, 1999.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures, interactive sessions, practical classes and seminars.			
Grading system: Pre-exam assignments: 50 points; exam (oral): 50 points.			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Formulation and characterization of cosmetic emulsions and gels			
Teachers: Milić R. Jela, Savić D. Snežana, Vasiljević D. Dragana, Krajišnik D. Danina			
Course status: Mandatory modules, module: Cosmetology			
Semester: II		Year of studies: I	
ECTS points: 10		Course code: ДКО10М3	
Requirements: one semester undergraduate course in Cosmetology; courses: Cosmetic ingredients (first semester of doctoral studies) and Theoretical aspects of cosmetic emulsions and gels (first semester of doctoral studies).			
Course aims: Theoretical and practical learning that will qualify student for an individual work in development of formulation and preparation techniques of cosmetic emulsions (lotions and creams) and cosmetic gels for different purposes.			
Course outcomes: Independence in approach to formulation and preparation of cosmetic emulsions (lotions and creams) and cosmetic gels for different purposes. The student is able to apply appropriate characterization techniques of these systems, their properties and physicochemical stability, aesthetic and application properties.			
Course contents: Preformulation, determination of the optimal composition and preparation method of cosmetic emulsions and creams; Selection of appropriate active substances and excipients (emulsifiers, oil phase ingredients, rheology modifiers) for formulation of oil/water and water/oil emulsions and creams, multiple emulsions, nanoemulsions, microemulsions, liposomes dispersions and nanoparticles prepared by emulsification methods; Formulation of emulsions and creams in order to achieve optimal sensorial characteristics accomplished with appropriate effects on skin as well as product stability; Methods of preparation and production equipment for preparation/manufacture of emulsions and creams; Characterization of cosmetic emulsions (liquid and semi-solid consistency) for various purposes - theoretical and practical aspects: use of different microscopic techniques, rheological measurement, thermal techniques, X-ray diffraction, photon correlation spectroscopy, Raman microscopic spectroscopy, laser diffractometry;The product stability considerations and potential skin effects; The types, characteristics and quality of gelling agents; Determination of the optimal composition and preparation methods of cosmetic gels; Preparation and characterization of cosmetic gels for various purposes - theoretical and practical aspects; The quality assessment and stability of cosmetic gels.			
Recommended literature: 1. Colloids in Cosmetics and Personal Care, Volume 4 (ed T. F. Tadros), Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim, Germany. doi: 10.1002/9783527631131. 2. Rieger MM. Harry s Cosmeticology. 8 th edition, New York chemical Publishing Co Inc. 2000. 3. Kemper FH, Luepke P, Umbach W. Blue List cosmetic ingridients. Aulendorf: Editio Cantor Verlag, 2000. 4. Vasiljević D., Savić S., Đorđević Lj., Krajišnik D., Priručnik iz kozmetologije, Nauka, Beograd, 2009. 5. Rosen R.M, Delivery System Handbook for personal Care and Cosmetic Products, Tehnology, Applications and Formulations, Norwich, New York: William Andrew Publishing, 2005. 6. Schlossman ML, Chemistry and Manufacture of Cosmetics: Cosmetic Specialties and Ingredients, Allured Publishing Co., Illinois 2010. 7. Seifen, Ole, Fette, Wachse Journal. 8. Cosmetics & Toiletries magazine.			
The total of active learning classes	Lectures: 60		
	Individual research work: 60		
Teaching methods: Lectures, interactive sessions, practical classes and seminars.			
Grading system: Pre-exam assignments: 50 points; exam (oral): 50 points.			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Physiological aspects of skin aging			
Teachers: Plečaš-Solarović A. Bosiljka			
Course status: elective, module: Cosmetology			
Semester: II		Year of studies: I	
ECTS points: 5		Course code: ДКО1И1	
Requirements: Faculty of Pharmacy diploma; for candidates without diploma from medicinal group of faculties: passed exam from the selected chapters of skin hystology and physiology according to program of undergraduate pharmacy studies.			
Course aims: The aim of the course is to provide the participant with novel scientific data from the field of structure, function and skin aging which will enable following and understanding of some pathological skin conditions, as well as some fundamentals of preparation procedures and skin effects of cosmetic and dermatological drug products.			
Course outcomes: By the end of this course participant should have the ability of following the actual trends in formulation of cosmetic products intended for prevention and treatment of photoaged skin, based on knowledge of skin aging mechanism.			
Course contents: Skin as dynamic structure; Keratinocytes proliferation and role of cytokines; Epidermal response on skin barrier disruption and response mediators; Keratinocytes forming and arrangement; Synthesis, extrusion and rearrangement of intracellular lipids and desquamation. Factors affecting the skin structure and function; Free radicals – reactive oxygen species (ROS); UV irradiation; Skin aging; The role of ROS in skin aging – the influence on the cell structure, metabolism and genetic material; Enzymatic and vitamin antioxidants; Mechanisms of collagen, elastin and extracellular dermal matrix degradation; The role of matrix metalloproteinase (MMP) and tissue inhibitors of MMP; Melanogenesis and mechanisms of skin hyperpigmentation; Histological changes at epidermal and dermal level during skin aging; Clinical presentation of skin aging at epidermal and dermal level – mechanisms of appearing skin lines and skin texture changes.			
Recommended literature: 1. P.T. Pugliese: Physiology of the Skin, Allured Publishing Corporation, Caroll Stream, Illinois, USA, 2001. 2. Bailey A.J.: Molecular mechanisms of ageing in connective tissues. Mech. Ageing Dev. 122: 735–755, 2001. 3. Werner S., Smola H.: Paracrine regulation of keratinocyte proliferation and differentiation. Trends Cell Biol. 11: 143-146, 2001. 4. Rigel DS, Weiss RA, Lim HW, Dover JS. Photoaging. Marcel Dekker, Inc. New York, Basel, 2004. 5. Timiras PS. Physiological Basis of Aging and Geriatrics, 4th edition. Informa Healthcare, USA, 2007.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures, interactive learning and study-research work.			
Grading system: Pre-exam assignments: 30 points; exam (oral): maximal 70 points.			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Preformulation of cosmetic products			
Teachers: Milić R. Jela, Primorac M. Marija, Krajišnik R. Danina, Đekić M. Ljiljana			
Course status: elective, module: Cosmetology			
Semester: II		Year of studies: I	
ECTS points: 5		Course code: ДКО1И2	
Requirements: undergraduate course in Cosmetology; courses: Cosmetic ingredients (semester I of doctoral studies) and Formulation and characterization of cosmetic emulsions and gels (II semester of doctoral studies).			
Course aims: Knowledge and ability for individual evaluation of preformulation factors relevant for formulation of cosmetic products.			
Course outcomes: The students are qualified for preformulation, formulation, manufacturing and assesment of cosmetic products in accordance with current requirements for quality, safety and efficacy.			
Course contents: Physicochemical characteristics (solubility, pH value, viscosity, particle size etc.) of cosmetic ingredients and "active substances"; Evaluation of compatibility of cosmetic ingredients and cosmetic active substances; Benefits considerations for selected cosmetic ingredients in cosmetic products - physicochemical and physiological aspects; Stability of cosmetic ingredients and "active substances"; Considerations on compatibility between cosmetic ingredients (active and auxiliary substances) and packaging materials; Overview of approaches for protection of labile active substances (thermolability, oxidability, light induced degradation) by encapsulation in colloidal carriers such as: liposomes, niosomes, nanosomes, microparticles, nanoparticles, micelles.			
Recommended literature: 1. Rieger MM. Harry s Cosmetology. 8th edition, New York chemical Publishing Co Inc. 2000. 2. De Polo KF, A Short Text book of Cosmetology, Ausburg: Verlag Fur Chemishe Industrie, H. Ziokowski GmbH, 1998. 3. Regulation (EC) No 1223/2009 Of The European Parliament and of the Concil of 30 November 2009. on cosmetic products, Official Journal of the European Union, L342/59- L342/209. 4. Vasiljević D, Savić S, Đorđević Lj, Krajišnik D. Priručnik iz kozmetologije, Nauka, Beograd, 2009. 5. Rosen RM. Delivery System Handbook for personal Care and Cosmetic Products, Tehnology, Applications and Formulations, Norwich, New York: William Andrew Publishing, 2005. 6. Schlossman ML. Chemistry and Manufacture of Cosmetics: Cosmetic Specialties and Ingredients, Allured Publishing Co., Illinois, 2010. 7. International Cosmetic Ingredients Dictionary and Handbook, 14th ed. The Personal Care Products Council, 2012. 8. Reviewws and original scientific papers published in relevant national and international journals: Arhiv za farmaciju, International Journal of Cosmetic Science, Cosmetic&Toiletries, SÖFW Journal, Journal of Cosmetic Dermatology, Skin Research&Technology.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures, consultations, and seminars.			
Grading system: Pre-exam assignments: 30 points; exam (written): 70 points.			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Preparation and application of plant extracts in cosmetic products			
Teachers: Petrović D. Silvana, Drobac M. Milica			
Course status: elective, module: Cosmetology			
Semester: II		Year of studies: I	
ECTS points: 5		Course code: ДКО1И3	
Requirements: undergraduate studies in subjects Pharmacognosy and Cosmetology			
Course aims: Providing information and increasing knowledge on preparation, active principles and activity of plant extracts.			
Course outcomes: The candidate knows the preparation procedure, application and effects of the principal plant extracts in formulations of cosmetic products. The candidate is able to independently produce these extracts, assess quality and formulate cosmetic products for certain use.			
Course contents: Production and quality of raw plant materials; Choice of extraction methods and solvents; Types of plant extracts; Standardization and quantification of plant extracts; Labelling of plant extracts; Active principles of plant extracts: various classes of polyphenols (flavonoids, anthocyanins, tannins, phenol-carbonic acids), phenol glycosides, coumarins, essential oils, sesquiterpenes, triterpenes, saponins, purine derivatives (purine alkaloids, allantoin); Quality control of plant extracts: identification and quantification of active principles (characterization of plant extracts); Purification of plant extracts and isolation of the active principles; Application of plant extracts in cosmetic products; Application of active plant principles in cosmetic products; Characterization of cosmetic products containing plant extracts; Estimation of stability.			
Recommended literature: 1. Blumenthal M, Busse WR, Goldberg A, Gruenwald J, Hall T, Riggins CW, Rister RS. The Complete German Commission E Monographs. Austin: American Botanical Council, 1998. 2. Blumenthal M, Goldberg A, Brinckmann J. Herbal Medicine. Expanded Commission E Monographs. Austin: American Botanical Council, 2000. 3. Schulz V, Hänsel R, Tyler VE. Rational Phytotherapy. Berlin: Springer-Verlag, 2001. 5. Blumenthal M, Hall T, Goldberg A, Kunz T, Dinda, K. The ABC Clinical Guide to Herbs. Austin: American Botanical Council, 2003. 6. Dingermann T, Loew D. Phytopharmakologie. Experimentelle und klinische Pharmakologie pflanzlicher Arzneimittel. Stuttgart: Wissenschaftliche Verlagsgesellschaft mbH, 2003. 7. ESCOP Monographs. Stuttgart: Georg Thieme Verlag, 2003. 8. PDR for Herbal Medicines. Montvale: Thomson PDR, 2004. 9. Committee of Experts on Cosmetic Products with the collaboration of Patri F and Silano V. Plants in cosmetics. Plants and plant preparations used as ingredients for cosmetic products. Volume I. Strasbourg: Council of Europe Publishing, 2002. 10. Kovačević N. Osnovi farmakognozije. Beograd: Srpska školska knjiga, 2004.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: lectures, seminars.			
Grading system: Pre-exam assignments: 30 pt; exam (oral): 70 pt.			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Analytics and quality control of cosmetic products			
Teachers: Zečević L. Mira			
Course status: elective, module: Cosmetology			
Semester: II		Year of studies: I	
ECTS points: 5		Course code: ДКО1И4	
Requirements: Undergraduate course from Drug analytics; previous courses from Cosmetic ingredients (I semester of doctoral studies) and Formulation and testing of cosmetic emulsions and gels (II semester of doctoral studies).			
Course aims: The aim of the course is to introduce and enable the participant to choose and apply the most feasible method for quality control of cosmetic ingredients/products.			
Course outcomes: The candidate is able to independently choose and apply the most feasible method for quality control of cosmetic ingredients/raw materials and cosmetic products.			
Course contents: Analytics and quality control of officinal and non-officinal cosmetic ingredients/raw materials; Quality control of cosmetic products; Identification and quantification of active and auxiliary substances; Investigation of stability and purity of substances for cosmetic products; Employing of UV-VIS spectrophotometric methods in analytics and investigation of cosmetic products purity; Spectrofluorometric studies in analytics of cosmetic products; Novel IR techniques: FTIR and ATR use in analytics of cosmetic products; HPLC methods in cosmetology; Cosmetic colors: investigation of stability and purity using TLC and HPLC methods; Micellar and ion-pair liquid chromatography and gas chromatography in analytics of cosmetic products; Titrimetric methods in analytics of cosmetic products containing metal ions (Mg, Ca, Al in salt form); Types of detectors in analytics of cosmetic products; Validation of methods for investigation and quality control of cosmetic products; Types and significance of extraction in analytics of cosmetic products.			
Recommended literature: 1. Rieger MM. Harry s Cosmetology. 8 th edition, New York Chemical Publishing Co Inc.2000. 2. Handbook of modern pharmaceutical analysis,Satinder Ahuja and Stephen Scypinski, Academic Press, 2001. 3. Method validation in pharmaceutical analysis, J. Ermer and H. McB Miller, Wiley-VCH, 2000. 4. Spectrofluorimetric method for determination of panthenol in cosmetic and pharmaceutical formulations. Shehata, Mostafa A. M.; Sultan, Maha A.; Tawakkol, Shereen M.; Abdel Fattah, Laila E. Saudi Pharmaceutical Journal (2004), 12(1), 29-34. 5. Studies for analyzing the prohibited ingredients such as tetracaine hydrochloride in cosmetics. Tokunaga, Hiroshi; Takeuchi, Orie; Uchino, Tadashi; Ando, Masanori.Kokuritsu Iyakuhin Shokuhin Eisei Kenkyusho Hokoku (2004), 122 30-33. 6. TLC and HPLC study of new 9-phenylxanthene dyes. Konstantinova, Temenushka Neicheva; Neicheva, Anastasia Shopova; Venkova, Alexandrina Yoncheva: Journal of Planar Chromatography--Modern TLC (2004), 17(5), 369-371.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures, seminars, laboratory work.			
Grading system: Pre-exam assignments: 30 points; exam (written): 70 points.			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Selected chapters of dermatology			
Teachers: Vesić A. Sonja			
Course status: elective, module: Cosmetology			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: ДКО2И1	
Requirements: Undergraduate course from Physiology.			
Course aims: The aim of the course is providing the participant with comprehension and knowledge of some important symptoms of most common dermatoses interesting for formulator of cosmetic and dermocosmetic products.			
Course outcomes: The candidate is able to independently recognize some dermatoses and to evaluate the skin condition that is important during cosmetic/dermocosmetic product formulation development, its evaluation and application, as well as to competently collaborate with dermatologist.			
Course contents: Morphology of basic skin changes; Clinical and pathohistological presentation of skin efflorescence: erythema, puerperal angioma, telangiectasia, papule, vesicle, bullae, crust, tuber, nodes, atrophy, erosion, ulceration, eschara, rhagas, fissure, fistula; Deseborrheic dermatoses – Acne vulgaris, skin Seborrhoe , Rosacea, Acne rosacea, Eczema dysseboroicum, Pityriasis sicca et oleosa capilitii; Verrucosus skin changes: Verruca senilis, Verruca seborrhoica, Verruca plajuvenilis; Nevuses and hemangiomas; Skin pigmentation disorders – skin pigments, mechanisms of skin pigmentation, skin dyschromias (hyperchromia, hypochromia and achromia); Trichosis – hypertrichosis (hirsutism), hypotrichosis (alopecia). Photodermatoses; Skin types from cosmetologist point of view; Effects of physical therapy to the skin; Allergenic skin changes caused by cosmetic preparations; Epicutaneous allergological testing.			
Recommended literature: 1. Kozmetička dermatologija. Načela i praksa. Leslie Baumann (the first edition in Croatian). Interpreta, Zagreb 2011. 2. T.Forster, Cosmetic lipids and the skin barrier, Cosmetic science and Technology series, M.Dekker, New York, vol. 24, 2002. 3. Loden M., Maibach HT, Dry Skin and Moisturisers: Chemisty and Function Boea Raton CPC Press, 2000. 4. Karadaglić Đ., Dermatologija, Vojnoizdavački zavod and Versalpress, Beograd, 2000. 5. Journal of American Academy of Dermatology (JAAD).			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures, seminars, laboratory work.			
Grading system: Pre-exam assignments: 30 points; exam (oral): 70 points.			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Dermocosmetic preparations			
Teachers: Savić D. Snežana			
Course status: elective, module: Cosmetology			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: ДКО2И2	
Requirements: One-semester undergraduate course in Cosmetology; lectures in courses: Cosmetic ingredients (first semester of doctoral studies) and Formulation and characterization of cosmetic emulsions and gels (second semester of doctoral studies).			
Course aims: The candidate is acquainted with the composition and properties of novel categories of cosmetic products that are developed and characterized by pharmacists in collaboration with dermatologists. Introduction to methodologies and techniques for efficacy and safety evaluation of dermocosmetic products, with the aim to enable the candidate to independently conduct experiments in scope of his/her doctoral dissertation.			
Course outcomes: The candidate is able to assess the formulation composition, expected effects and provide suitable critical opinion on the function, purpose and mode of application of dermocosmetic preparations.			
Course contents: Definition of dermocosmetic preparations/cosmeceuticals; Regulatory requirements relating to dermocosmetic preparations on a global level; Similarities and differences between a dermatological drug and a dermocosmetic preparation; Active substances in dermocosmetic preparations; Cosmeceuticals and barrier function of the skin; Physiological lipids for skin barrier regeneration and dry skin treatment; Dermocosmetic preparations used in atopic dermatitis skin: skin washing, cleaning, care and protection; Dermocosmetic preparations for acne treatment; Dermocosmetic preparations for rosacea skin; Dermocosmetic anti-age preparations: formulations for prevention of signs of premature skin aging vs. formulations for treatment of photo-aged skin; Dermocosmetic preparations for skin protection from sun exposure; Dermocosmetic preparations for babies and children; Application of in vitro media in evaluation of active substances efficacy in dermocosmetic preparations; Principles of dermocosmetic preparations formulation development; Efficacy assessment of dermocosmetic preparations – clinical trials; Application of in vitro media in safety evaluation of cosmeceuticals; In vivo studies for evaluation of dermocosmetic preparations safety profiles; Novel approaches in the research of dermocosmetic preparations.			
Recommended literature: 1. Baumann L. Cosmetic dermatology: Principles and Practice (1st edition in Croatian). Zagreb: Interpret, 2011. 2. Draelos ZD. Cosmeceuticals. 1st ed., Philadelphia: Elsevier Saunders, 2005. 3. Lodén M, Maibach HI. Dry skin and moisturizers. 1st ed., Boca Raton: CRC Press, 2000. 4. Čajkovac M. Kozmetologija. Zagreb: Naklada Slap, 2000 (selected chapters). 5. Rieger MM. Harry's Cosmetology. 8th ed., New York: Chemical Publishing Co. Inc., 2000. 6. Review and original articles from national and international journals: Arhiv za farmaciju, International Journal of Cosmetic Science, Cosmetic&Toiletries, SÖFW Journal, Journal of Cosmetic Dermatology, Skin Research&Technology.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures, seminars.			
Grading system: Pre-exam assignments: 30 points; exam (oral): 70 points.			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Special-purposes cosmetics			
Teachers: Primorac M. Marija, Milić R. Jela, Krajišnik R. Danina, Đekić M. Ljiljana			
Course status: elective, module: Cosmetology			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: ДКО2И3	
Requirements: undergraduate course in Cosmetology; courses: Cosmetic ingredients (semester I of doctoral studies) and Formulation and characterization of cosmetic emulsions and gels (II semester of doctoral studies)			
Course aims: Introduction in formulation and methods of preparation/production and characteristics of cosmetic products for different purposes: anti-perspirants and deodorants, products for care of the teeth, the mouth and the skin, cosmetic products for men, cosmetic products for children, skin-protective cosmetic products, products for tanning without sun, skin-whitening products, make-up products (make-up powders, blushes, lipsticks, eye-shadows, mascaras, nail lacquers).			
Course outcomes: The students know formulation, manufacturing/production and assesment of cosmetic products for special purposes: anti-perspirants and deodorants, products for care of the teeth, the mouth and the skin, cosmetic products for men, cosmetic products for children, skin-protective cosmetic products, products for tanning without sun, skin-whitening products, make-up products (make-up powders, blushes, lipsticks, eye-shadows, mascaras, nail lacquers).			
Course contents: Formulation, manufacturing/production and assesment of cosmetic products for different purposes: anti-perspirants and deodorants, products for care of the teeth, the mouth and the skin, cosmetic products for men, cosmetic products for children, skin-protective cosmetic products, products for tanning without sun, skin-whitening products, make-up products (make-up powders, blushes, lipsticks, eye-shadows, mascaras, nail lacquers); Selection of active and auxiliary ingredients - cosmetic raw materials for specific cosmetic products, regarding their purpose, especially colours and pigments, as well nanomaterials for different purposes; Specificity in production processes and assesment of product characteristics, theri quality and stability; Methods for evaluation of effects and safety of cosmetic products for special purposes.			
Recommended literature: 1. Rosen RM. Delivery System Handbook for Personal Care and Cosmetic Products, Technology, Applications and Formulations. Norwich, New York: William Andrew Publishing, 2005. 2. Vasiljević D, Savić S, Đorđević Lj, Krajišnik D. Priručnik iz kozmetologije, Nauka, Beograd, 2009. 3. International Cosmetic Ingredients Dictionary and Handbook, 14th ed. The Personal Care Products Council, 2012. 4. Čajkovac M, Kozmetologija, Naklada Slap, Zagreb, 2005. 5. Rieger MM, Harry's Cosmeticology., 2000, 8th ed., Chemical Publishing Co., Inc., New York. 6. De Polo KFD. A short textbook of cosmetology. 1998, 1st ed., H. Ziolkowsky GmbH, Augsburg. 7. Schlossman ML. Chemistry and Manufacture of Cosmetics: Cosmetic Specialties and Ingredients, Allured Publishing Co., Illinois 2010.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures, consultations, and seminars.			
Grading system: Pre-exam assignments: 30 points; exam (written): 70 points.			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Cosmetic hair products			
Teachers: Vuleta M. Gordana, Krajišnik R. Danina, Đekić M. Ljiljana			
Course status: elective, module: Cosmetology			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: ДКО2И4	
Requirements: one-semester undergraduate course in Cosmetology; lectures in courses: Cosmetic ingredients (first semester of doctoral studies) and Formulation and characterization of cosmetic emulsions and gels (second semester of doctoral studies).			
Course aims: 1. Introduction to formulation approach and manufacturing of cosmetic hair products (hair washing, care, colouring, waving and straightening); 2. Ability to independently develop a formulation and manufacturing procedure of a specific hair care product.			
Course outcomes: The candidate is capable to independently perform preformulation, formulation, preparation and characterization of cosmetic hair products (hair washing, care, colouring, waving and straightening) that comply with contemporary requirements for quality, safety and efficacy.			
Course contents: Cosmetic products for hair washing and care – properties, types, forms; Formulation, preparation and characterization of products for: washing, care, styling, colouring, waving and straightening of hair – theoretical and practical aspects; Selection of surface active materials for shampoo formulation: surfactants vs. shampoos for everyday use, shampoos for children, anti-dandruff shampoos; Active substances in shampoos and conditioners: specific plant extracts, protein derivatives, surfactants with substantivity, oily components, moisturizers; Selection of other excipients with emphasis on antioxidants, preservatives and colorants; Choice of the containers for shampoos and conditioners; Principles of shampoos and conditioners manufacturing; Investigation of shampoo and conditioner stability, assessment of the following properties: foaming capacity, foam volume, solubilisation/washing properties; Effects exerted on volunteers' hair and skin: hair combing test, evaluation of hair shine, strength and texture, anti-dandruff effect.			
Recommended literature: 1. Rosen RM. Delivery System Handbook for Personal Care and Cosmetic Products, Technology, Applications and Formulations. Norwich, New York: William Andrew Publishing, 2005. 2. Vasiljević D, Savić S, Đorđević Lj, Krajisnik D. Priručnik iz kozmetologije. Beograd: Nauka, 2009. 3. Kempler FH, Luepke P, Umbach W. Blue List Cosmetic Ingredients. Aulendorf: Editio Cantor Verlag, 2000. 4. Čajkovac M. Kozmetologija. Zagreb: Naklada Slap, 2005. 5. Rieger MM. Harry's Cosmeticology. 8th ed., New York: Chemical Publishing Co., Inc., 2000. 6. Schlossman ML. Chemistry and Manufacture of Cosmetics: Cosmetic Specialties and Ingredients, Illinois: Allured Publishing Co., 2010. 7. Review and original articles from national and international journals: Arhiv za farmaciju, International Journal of Cosmetic Science, Cosmetic&Toiletries, SÖFW Journal, Journal of Cosmetic Dermatology, Skin Research&Technology.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures, laboratory work, seminars.			
Grading system: Pre-exam assignments: 30 points; exam (written): 70 points.			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: In vitro/in vivo efficacy and safety studies in cosmetology			
Teachers: Savić D Snežana, Antonijević M. Biljana, Vuleta M. Gordana			
Course status: elective, module: Cosmetology			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: ДКО2И5	
Requirements: one-semester undergraduate course in Cosmetology; lectures in courses: Cosmetic ingredients (first semester of doctoral studies) and Formulation and characterization of cosmetic emulsions and gels (second semester of doctoral studies)			
Course aims: To introduce the candidate to design, theoretical and practical aspects of in vitro and in vivo efficacy and safety studies of cosmetic products for diverse applications, along with the selection of suitable statistical tests for analysis of the obtained results.			
Course outcomes: The candidate is capable to plan and perform in vitro and in vivo studies for efficacy and safety assessment of various cosmetic products, followed by the application of proper statistical tests for analysis of the obtained results.			
Course contents: EEMCO guidelines for the assessment of different skin parameters: skin hydration, transepidermal water loss, skin colour, mechanical properties of the skin; Clinical evaluation and skin bioengineering methodologies; Measurement of electrical properties of the skin; Measurement of transepidermal water loss; Device characteristics and study design; Methodology of the erythema and melanin index assessment; Methodology of skin pH and surface lipids content assessment; Methodology of the evaluation of skin biomechanical properties – skin viscoelasticity; Organization of the studies: short- and long-term studies, double blind, placebo controlled studies; Comparative studies; Statistical analysis of the obtained results: descriptive and analytical statistics; Parametric and non-parametric tests; Approaches of data representation and their discussion with the aim of generating relevant conclusions on the efficacy of a specific cosmetic product.			
Recommended literature: 1. Baumann L. Cosmetic dermatology: Principles and Practice (1st edition in Croatian). Zagreb: Interpret, 2011. 2. Draelos ZD. Cosmeceuticals. 1st ed., Philadelphia: Elsevier Saunders, 2005. 3. Lodén M, Maibach HI. Dry skin and moisturizers. 1st ed., Boca Raton: CRC Press, 2000. 4. Čajkovac M. Kozmetologija. Zagreb: Naklada Slap, 2000 (selected chapters). 5. Rieger MM. Harry's Cosmeticology. 8th ed., New York: Chemical Publishing Co., Inc., 2000. 6. Review and original articles from national and international journals: Arhiv za farmaciju, International Journal of Cosmetic Science, Cosmetic&Toiletries, SÖFW Journal, Journal of Cosmetic Dermatology, Skin Research&Technology.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures, laboratory work, seminars.			
Grading system: Pre-exam assignments: 30 points; exam (written): 70 points.			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Sensory assessment of cosmetic products with the applied statistics			
Teachers: Savić D. Snežana, Vuleta M. Gordana			
Course status: elective, module: Cosmetology			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: ДКО2И6	
Requirements: one-semester undergraduate course in Cosmetology; lectures in courses: Cosmetic ingredients (first semester of doctoral studies) and Formulation and characterization of cosmetic emulsions and gels (second semester of doctoral studies)			
Course aims: 1) Comprehension of the types of sensory studies, sensory attributes and tests used in sensory evaluation of various cosmetic products; 2) Planning and conduct of sensory studies with the application of suitable statistical tests for the analysis of the obtained results.			
Course outcomes: The candidate is able to independently organize and perform sensory tests, as well as to evaluate the obtained results for diverse cosmetic products.			
Course contents: Definition of sensory attributes; Senses and cosmetic products; Descriptive sensory analysis; ASTM standards for the evaluation of various sensory properties; Recruiting panellists (selection tests/criteria for exclusion); Selection of sensory properties and panel training; Statistical analysis: panel variability and reproducibility assessment; Analysis of the results obtained in a sensory study; Development of sensory studies in correlation with instrumental measurements; Statistical tests for correlation of the results obtained through subjective sensory evaluation and physical/instrumental measurements providing parameters relating to sensory characteristics of a cosmetic product (rheological and textural analysis, measurements of the interfacial tension and contact angle a product forms on the skin...); Approaches of sensory data representation and their discussion.			
Recommended literature: 1. Kemp ES, Hollowood T, and Hort J. Sensory Evaluation: A Practical Handbook. Wiley-Blackwell, A John Wiley & Sons, Ltd. Publication, UK, 2009. 2. ASTM Standard Practice for Descriptive Skinfeel Analysis of Creams and Lotions, ASTM International, Philadelphia, 2003. 3. Review and original articles from national and international journals: Journal of Sensory Studies, International Journal of Cosmetic Science, Journal of Texture Studies, Cosmetic&Toiletries, Colloid and Surface B: Biointerface.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures, seminars, laboratory work.			
Grading system: Pre-exam assignments: 30 points; exam (written): 70 points.			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: General Biochemistry			
Teachers: Jelic-Ivanovic D. Zorana, Spasojevic-Kalimanovska V. Vesna, Stojanov D. Marina, Ignjatovic D. Svetlana, Topic S. Aleksandra; Dopsaj B. Violeta, Bogavac-Stanojevic B. Natasa, Kotur-Stevuljevic M. Jelena, Zeljkovic R. Aleksandra, Stefanovic Z. Aleksandra, Vekic Z. Jelena			
Course status: Mandatory modules, module: Medical Biochemistry			
Semester: I, II		Year of studies: I	
ECTS points: 15		Course code: ДМБ1ОМ1	
Requirements: Biology, Organic Chemistry, General Biochemistry (one-semester course at Integrated Academic Studies)			
Course aims: Introduction of structures of biomolecules and types of intercellular communications, metabolic pathways in health organism, as well as in some special physiological conditions, genetics and mechanisms of gene regulation; overview of transfer of genetic information from DNA through RNA to primary protein structure.			
Course outcomes: This course enables students to successfully attend further courses dedicated to learning of disorders of metabolism in different pathophysiological conditions.			
Course contents: Association of protein structure and function. Lipids and lipoproteins. Carbohydrates. Structure of cell membrane. Enzyme kinetics and inhibition. Molecular mechanisms of hormone activity. Molecular basis for cellular growth and differentiation. Molecular basis for extracellular and intracellular communication. Organization of intermediary metabolism: catabolic and anabolic pathways. Energetics of biochemical reactions. Specific pathways in carbohydrates, lipids and proteins metabolism. Metabolic pathways in different organs. Metabolic processes in starving, pregnancy, lactation and stress. Biosynthesis of ribonucleotides and deoxyribonucleotides. Regulation of nucleotides levels in cell. Prokaryotic and eukaryotic DNA structure. DNA replication and transcription. DNA recombination. Translation. Protein biosynthesis and regulation in mitochondria. Posttranslational modifications of proteins.			
Recommended literature: 1. Devlin, TM. Textbook of Biochemistry with Clinical Correlation. John Wiley & Sons. 2010. 2. Voet D, Voet JG, Pratt CW. Fundamentals of Biochemistry:Life at the molecular level. John Wiley&Sons. 2012. 3. Nelson DL, Cox ME. Lehninger Principles of Biochemistry. WH Freeman. 2004. 4. Alberts B, Johnson A, Lewis J, Raff M, Roberts K, Walter P. Molecular biology of the cell, 5th Edition. Garland Science, 2007.			
The total of active learning classes	Lectures: 90		
	Individual research work: 90		
Teaching methods: Lectures, interactive classes, laboratory classes, workshops, seminars, panel discussions			
Grading system: Lectures, seminars: 30 points; Exam: 70 points			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Medical Biochemistry			
Teachers: Jelic-Ivanovic D. Zorana, Spasojevic-Kalimanovska V. Vesna, Stojanov D. Marina, Ignjatovic D. Svetlana, Topic S. Aleksandra; Dopsaj B. Violeta, Bogavac-Stanojevic B. Natasa, Kotur-Stevuljevic M. Jelena, Zeljkovic R. Aleksandra, Stefanovic Z. Aleksandra, Vekic Z. Jelena			
Course status: Mandatory modules, module: Medical Biochemistry			
Semester: I, II		Year of studies: I	
ECTS points: 15		Course code: ДМБ1ОМ2	
Requirements: General Biochemistry, Medical Biochemistry (course at Integrated Academic Studies)			
Course aims: Investigation and measurement of biochemical changes in human diseases.			
Course outcomes: Gaining knowledge in biochemical bases of human diseases, formulation and following of practical procedures in laboratory assessment, evaluation and interpretation of laboratory results.			
Course contents: Electrophoresis. Chromatography. Mass spectrometry. Atomic absorption spectrophotometry. Immunochemistry methods. Biochemistry and hematology analyzers. Flow cytometry. Interferentions in methods for determination of analytes in biological samples. Methods evaluation. Metabolism, disorders of metabolism and clinical significance of determination of carbohydrates, proteins, BUN, aminoacids, lipids, lipoproteins, apolipoproteins, nucleic acids, electrolites, vitamins and microelements in biological samples. Disorders of water homeostasis and acid-base status. Biochemical investigation of functions of kidney, liver, gastrointestinal tract, heart and nervous system.			
Recommended literature: 1. Carl A.Burtis, Edward R. Ashwood, David E.Bruns: Tietz Textbook of Clinical Chemistry and Molecular Diagnosis, W.B.Saunders Company, 2012. 2. Kaplan L.A., Pesce J.P. and Kazmierczak C.K., Clinical Chemistry: Theory, Analysis, Correlation, Mosby, 4th Edition, 2010.			
The total of active learning classes	Lectures: 90		
	Individual research work: 90		
Teaching methods: Lectures, interactive classes, laboratory classes, workshops, seminars, case reports, problem based learning, panel discussions, participation in research projects.			
Grading system: Lectures, seminars: 30 points; Exam: 70 points			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Selected Topics in Medical Biochemistry			
Teachers: Jelic-Ivanovic D. Zorana, Spasojevic-Kalimanovska V. Vesna, Stojanov D. Marina, Ignjatovic D. Svetlana, Topic S. Aleksandra; Dopsaj B. Violeta, Bogavac-Stanojevic B. Natasa, Kotur-Stevuljevic M. Jelena, Zeljkovic R. Aleksandra, Stefanovic Z. Aleksandra, Vekic Z. Jelena			
Course status: Mandatory modules, module: Medical Biochemistry			
Semester: III		Year of studies: II	
ECTS points: 10		Course code: ДМБ2ОМ1	
Requirements: General Biochemistry, Medical Biochemistry (course at Integrated Academic Studies)			
Course aims: Investigation and measurement of biochemical changes in human diseases.			
Course outcomes: Acquirement of biochemical basis for changes in special condition, formulation and following of practical procedures in laboratory assessment, evaluation and interpretation of laboratory results.			
Course contents: Determination of cytokines, tumor markers, enzyme activity. Inborn errors of metabolism. Prenatal diagnostics. Laboratory endocrinology. Laboratory hematology. Biochemical markers in organ transplantation. Changes of biochemical markers in pregnancy and ageing. Biochemical aspects of nutrition. Bone diseases markers.			
Recommended literature: 1. Carl A.Burtis, Edward R. Ashwood, David E.Bruns: Tietz Textbook of Clinical Chemistry and Molecular Diagnosis, W.B.Saunders Company, 2012. 2. Kaplan L.A., Pesce J.P. and Kazmierczak C.K., Clinical Chemistry: Theory, Analysis, Correlation, Mosby, 4th Edition, 2010. 3. McPherson RA, Pincus MR. Henry’s Clinical Diagnosis and Management by Laboratory Methods. Saunders. 2011.			
The total of active learning classes	Lectures: 60		
	Individual research work: 60		
Teaching methods: Lectures, interactive classes, laboratory classes, workshops, seminars, case reports, problem based learning, panel discussions, participation in research projects			
Grading system: Lectures, seminars: 30 points; Exam: 70 points			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Clinical enzymology			
Teachers: Spasojević-Kalimanovska V. Vesna			
Course status: elective, module: Medical biochemistry			
Semester: II		Year of studies: I	
ECTS points: 5		Course code: ДМБ1И1	
Requirements: One semester course of clinical enzymology from the master study			
Course aims: Enzyme distribution in human body. Factors affecting enzyme concentrations in plasma or serum. Enzymes profiles of damaged organs. Diagnostic enzymology and selection of enzyme test. Measuremet of enzyme activity. Enzyme analysis for measurement of substrates.			
Course outcomes: Application of enzyme analysis in disease diagnosis			
Course contents: Enzyme kinetics, Allosteric regulation of enzyme reaction. Inhibition of enzyme activity. Isoenzymes. Enzyme analysis. Measurement of enzyme activity and mass concentration. Separation methods for isoenzymes and isoforms. Methods for determination of enzyme phenotype and genotype. Diagnostic enzymology: pancreatic enzymes, bone enzymes, muscle enzymes, liver enzymes. Erythrocyte enzymes. Diagnostic enzymology in pregnancy. Enzymes as tumor markers.			
Recommended literature: 1. Burtis CA, Ashwood ER, Bruns DE. Tietz Textbook of Clinical Chemistry and Molecular Diagnosis, W.B. Saunders Company, 2012. 2. Moss WD, Rosalki SB. Enzyme Test in Diagnosis, Arnold, London, 1996. 3. Kaplan LA, Pesce AJ, Kazmierczak S. Clinical Chemistry, 5th Edition - Theory, Analysis, Correlation, W.B. Saun-ders Company, 2010.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Interactive theoretical lectures; student practical work, seminars; case problem study			
Grading system: 40 poens pre exam ; final exam: 60 poens			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Laboratory hematology			
Teachers: Violeta B. Dopsaj			
Course status: elective, module: Medical biochemistry			
Semester: I		Year of studies: II	
ECTS points: 5		Course code: ДМБ1И2	
Requirements: Courses in hematology and laboratory methods in hematology from the basic studies			
Course aims: Introducing with special laboratory methods and procedures in hematology.			
Course outcomes: The possibility of applying specific hematology laboratory methods in diagnostic procedures.			
Course contents: The molecular, cellular and immunological basis in hematology. Stem cells and hematopoietic disorders. Anemia. malignancy in hematology. Laboratory procedures in diagnosis of hematology disorders. Morphological analysis of cells in body fluids within the hematology investigations. Haemostasis and thrombosis. Special tests and hematological procedures. Automation in hematology and haemostasis. Quality control in hematology laboratories.			
Recommended literature: 1. Barbara J Bain. Blood cell, a practical guide. Blackwell Publishing 2006. 2. Dacie and Lewis. Practical Haematology. Churchill Livingstone 2006. 3. Shirlyn McKenzie. Clinical Laboratory haematology. Pearson 2010. 4. Hoffman R, Benz E, Furie B, Cochen H. Hematology - Basic principles and practice. Churchill Livingstone 2005. 5. Williams WJ, Beutler E, Erslev AJ, Lichtman. Hematology. McGraw Hill, New York 2001.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures, seminars, practical work in the laboratory .			
Grading system: Seminar articles (2 articles) with presentation: 40 points, oral examination: 60 points			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Selected Topics in Immunochemistry			
Teachers: Nevena M. Arsenović-Ranin, Zorica M. Stojić-Vukanić			
Course status: elective, module: Medical Biochemistry			
Semester: II		Year of studies: I	
ECTS points: 5		Course code: ДМБ1И3	
Requirements: None			
Course aims: Broader knowledge of antigens and immune system activation; better understanding of the structures and biological functions of antibodies, cytokines and complement in immune response.			
Course outcomes: Substantially developed intellectual and professional skills in key areas of immunochemistry.			
Course contents: Regulation of immune processes, relationships between immune system and other biological systems. Immunological specificity, immune recognition. Isolation and characterization of bacterial, viral, parasite, fungal and tissue antigens. Purification of IgG, IgM, IgA, IgE, immunoglobulin chains and fragments. Recombinant DNA technology in immunochemistry. Antigens as reagents. Antibodies as reagents: monoclonal and polyclonal antibodies. Immunochemical characterization of the specificity of monoclonal antibodies. Assessment of antibody affinity for the antigen. Qualitative and quantitative immunochemical tests. Automatization of immunoassays.			
Recommended literature: 1. A K Abbas, A H Lichtman, S Pillai. Basic Immunology, 4th Edition. Elsevier, Saunders, 2012. 2. Richard A. Goldsby, Thomas J. Kindt, Barbara A. Osborne, Janis Kuby: Immunology; W.H. Freeman and Company, 2003. 3. A P Johnstone, MW Turner: Immunochemistry 1 and 2; Oxford University Press, 1997.			
The total of active learning classes		Lectures: 30	
		Individual research work: 30	
Teaching methods: Lectures, seminars, video-presentations, workshops, discussions			
Grading system: Lectures and seminars : 30 points; exam : 70 points			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Biochemical Tests in Prenatal Diagnosis			
Teachers: Ignjatović D. Svetlana			
Course status: elective, module: Medical Biochemistry			
Semester: III		Year of studies: I	
ECTS points: 5		Course code: ДМБ2И1	
Requirements: Course Clinical Chemistry - Integrated academic studies			
Course aims: Introduction to laboratory methods of prenatal diagnosis to be applied in order to detect disorders caused by changes in the level of genes and chromosomes.			
Course outcomes: The knowledge acquired will enable understanding of diagnosis and prevention of genetic diseases.			
Course contents: The function of the fetal-placental-decidual unit. Changes in the concentration of protein (alpha-1-antitrypsin, hemoglobin), polypeptide (hCG, gonadotropin and placental lactogen) and the steroid (progesterone and estrogens) hormones during pregnancy. Assessment of fetal lung maturity. Early diagnosis of neural tube defects and Down 's syndrome. Calculation of risk for some diseases and birth defects. The analysis of the amniotic fluid. Determination of AFP, hCG, unbound estriol and PAPP-A.			
Recommended literature: 1. Carl A.Burtis, Edward R. Ashwood, David E.Bruns: Tietz Textbook of Clinical Chemistry and Molecular Diagnosis, W.B.Saunders Company, 2011. 2. Nicolaides KH, Sebire NJ, Snijders RJM. 11-14 Week Scan: The Diagnosis Of Fetal Abnormalities. Pearl River, New York, 1999.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Theory, computer simulation problems.			
Grading system: Lectures and seminars: 30 points; exam: 70 points.			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Methods in Molecular Biology			
Teachers: Spasojević-Kalimanovska V. Vesna			
Course status: elective, module: Medical biochemistry			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: ДМБ2И2	
Requirements: Biochemistry			
Course aims: Introduction in basic principles of molecular biology, techniques of molecular genetics and their application in disease diagnosis and genetic polymorphisms.			
Course outcomes: Application of different methods for isolation, amplification, separation and detection of nucleic acids. Ability for interpretation of the obtained results in molecular biology.			
Course contents: Genomes and nucleic acid alterations. Replication, transcription and translation. Regulation of gene expression. Human genome. Recombinant DNA. Viral genomes and sequence alterations. Nucleic acid enzymes. Amplification techniques. Polymerase chain reaction. Target amplification. Detection techniques. Visualization of nucleic acids. Labeled probes. Discrimination techniques. Northern and Southern blotting techniques. Hybridisation assays. Real time-PCR and gene expression. Molecular genetics and diagnosis of inherited diseases and other diseases.			
Recommended literature: 1. Devlin, T.M. Textbook of Biochemistry with clinical correlation. John Wiley & Sons. 2010. Voet JGG, Pratt CW. Fundamentals of biochemistry: life at molecular level. John Wiley & Sons. 2012. Introduction to human molecular genetics. Mechanisms of inherited diseases. Wiley-Liss, Ontario, 2005. 2. Voet D, 3. Pasternak JJ. An			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Interactive theoretical lectures; student practical work, seminars; case problem study e-learning.			
Grading system: 30 points pre exam ; final exam: 70 points			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Laboratory Endocrinology			
Teachers: Marina D. Stojanov			
Course status: elective, module: Medical Biochemistry			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: ДМБ2И3	
Requirements: Passed all exams from the 1st year of doctoral studies : Biomolecules and cell signalization; Metabolic pathways in human body; Biosynthesis of nucleic acids and proteins			
Course aims: Investigation of mechanisms by which endocrine system control and coordinate functions of specialized tissues as components of human body.			
Course outcomes: Possibility to explain the endocrine system functioning at molecular level.			
Course contents: Analitical methods for determination of bigenic amines, peptide hormones, steroid hormones, their metabolites and receptors in body fluids. The effect of preanalytical factors on hormon assays. Laboratory diagnosis of adrenal gland disorders. Laboratory tets for investigation of hypothalamus-pituitary axis function. Investigation of thyroid disorder. Laboratory tests for reproductive hormones investigation.			
Recommended literature: 1. Janet E, Hall, Lynette K. Nieman: Handbook of Diagnostic Endocrinology, Humana Press 2010. 2. David Gardner, Dolores Shoback : Greenspan’s Basic & Clinical Endocrinology, 9th Lange Medical Books, 2011. 3. Carl A. Burtis, Edward R. Ashwood, David E. Burns : Tietz Textbook of Clinical Chemistry and Molecular Diagnostics, 5th ed., Elsevier, 2012. 4. Michael T. Johnstone, Aristides Veres : Diabetes and Cardiovascular Disease, 2nd ed., The American Association for Clinical Chemistry, 2005.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures, seminars, video-presentations, work-shops			
Grading system: Lectures and seminars : 30 points; exam : 70 points			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Social Pharmacy			
Teachers: Krajnović M. Dušanka, Tasić M. Ljiljana, Marinković D. Valentina			
Course status: Mandatory modules, module: Social Pharmacy and Pharmacy Practice Research			
Semester: I		Year of studies: I	
ECTS points: 10		Course code: ДСФ10М1	
Requirements: none			
Course aims: Introduction to basic principles of bihevioral apsects of pharmacy and social influences on pharmacy practice. Mastering the research methods of new public-health, socila factors that influence the health or insidence of diseases, use of medicines and behaviours associated with it.			
Course outcomes: Aplication of knowledge from social pharmacy and epidemilogy methods for research in social pharmacy.Capability of critical apprasel of data extracted from national and international data base about health and capability of kondacting knowledge, attitudes and beliefs study associated with health and illness. Critical apprasel in relation to new public health and right to health.			
Course contents: Conceptual framework of pharmacy and society; concept of community, health and individual background. Professional development of pharmacy, aspects of business and healthcare service (clinical, social and economic perspectives). Social relations and social factors in pharmacy. Medicine-patient-pharmacist. People attitudes toward health and illness. Different kind of behavior towards illness. Theoretical concept of health and the most powerful factors associated with health. National and international data base for health as source of information. Health care system and organizational form of delivering health care. Health care on different levels of prevention and focusing on different population groups (women and children, working population, geriatric population, poor and refugees, people with invalidity).Evidence-based healthcare. Knowledge, attitudes and responsibility in the healthcare system (patient, pharmacist, healthcare worker).Principles of healthcare and health rights. Education for health. New public health and responsibility of pharmacy practice. Competences in different professional activities and specific indicators for evaluation of competences. Systematic communication in pharmacy. Pharmaceutical industry and health. Research methods in social pharmacy . Epidemiological studies- importance, participation and interaction with social pharmacy. Different method for assessment of attitudes, beliefs and behavior. Use of survey questionarie and interview as tools for collecting data.			
Recommended literature: 1. Donyai Parastou. Social and Cognitive Pharmacy: Theory and Case Studies. London: Pharmaceutical Press; 2012. 2. Paul Bissell, Janine Morgall Traulsen. Sociology and Pharmacy Practice. London: Pharmaceutical Press; 2005. 3. N Rickles & N Weirtheimer (eds). Social and Behavioural Aspects of Pharmacy Practice. New York: Haworth Press; 2009. 4. Harding G, Nettleton S, Taylor K. Social Pharmacy: Innovation and Development. London: The Pharmaceutical Press; 1994.			
The total of active learning classes	Lectures: 60		
	Individual research work: 60		
Teaching methods: Ex cathedra lectures, practical classes (case studies, workshops, panel discussions, homework, on-line forum and professional practice); Evaluation of Teaching: written-final test and practical exam-verbally.			
Grading system: Final exam (40 points) practical training)(60 points)			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Pharmaceutical administration			
Teachers: Ljiljana M. Tasić, Valentina D. Marinković, Dušanka M. Krajnović			
Course status: Mandatory modules, module: Social Pharmacy and Pharmacy Practice Research			
Semester: I		Year of studies: I	
ECTS points: 5		Course code: ДСФ10М2	
Requirements: none			
Course aims: Acquiring knowledge about pharmaceutical administration and regulatory science. Acquiring method of analysis about pharmaceutical and healthcare systems.			
Course outcomes: Implementation of knowledge about pharmaceutical administration. Ability of critical evaluation of regulatory data in pharmacy and healthcare.			
Course contents: Definition and development of regulatory science. Multidisciplinary approach in healthcare, health policy and drug policy. Development strategy and drug policy management. Health legislation; standards, systems and subsystems in pharmaceutical care. Elements and comparative studies pharmaceutical legislation in Serbia, EU, USA; role of pharma industry in drug policy. International pharmaceutical market and medical devices. Patent legislation and data exclusivity (TRIPS agreement, Bolar declaration). Innovative and generic drugs. Political, social, economic influence in healthcare system regulation; medical reimbursement systems and patient law. Health economy, pharmacoeconomy principles. Basic methods of social systems-conceptual and context studies (qualitative studies).			
Recommended literature: 1 Hedley R. Supply chain management in the drug industry- Delivery Patient Value for Pharmaceuticals and Biologics. New Jersey: John Wiley & Sons Inc 2011. 2. Tasić Lj, Marinković V. Kvalitet u farmaciji -od teorije do prakse. Beograd: Farmaceutski fakultet, 2012. 3. Tasić Lj. Farmaceutski menadžment i marketing. Beograd: Placebo; 2007. 4. Ilić-Stojanović S., Jovanović S., Đorđević S, Tehnološki aspekt zaštite intelektualne svojine za farmaceutske proizvode i postupke. Grafolik: Tehnološki fakultet Leskovac 2005. 5. Bootman J., Townsend R, McGhan W. Principles of Pharmacoeconomics 3rd ed Cincinnati: Harvvey Whitney books company. 2005.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures (ex cathedra) practice: case studies, workshops, panel discussion, home work, on-line forum . Evaluation : written exam- final test and oral practical exam.			
Grading system: Written exam: 40			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Pharmacy Practice			
Teachers: Tasic M. Ljiljana, Krajnovic M. Dusanka, Marinkovic D. Valentina			
Course status: Mandatory modules, module: Social Pharmacy and Pharmacy Practice Research			
Semester: II and III		Year of studies: I and II	
ECTS points: 25		Course code: ДСФ10М3	
Requirements: no			
Course aims: Acquiring knowledge of pharmacy practice of all levels of the health system and the adoption of the principles of research in pharmacy practice. Mastering the methods and tools for analyzing and evaluating the outcomes of pharmaceutical services/intervention. Mastering of the analysis of pharmaceutical systems in the integration of sub-systems and health programs. Creation of the drug list and drug use evaluation.			
Course outcomes: Know and use the scientific knowledge of pharmacy practice research of all levels of the health system. Students will be able to critically analyze health technologies which are used in pharmacy practice as well as being actively involved in the procurement and usage of health technology. Students will be able to make decisions concerning the management of drug safety and the use of drugs. Student will be able to independently design a scientific study and the methodology in the field of pharmacy practice			
Course contents: Health technology assessment and health technology . Scientific review system - Donabedian 's philosophy (structure, process and outcome) of pharmacist interventions in the development of professional practice in the delivery of pharmaceutical care (FZZ). Methods for pharmacy practice research (qualitative and quantitative). Evaluation FZZ to outcomes - clinical, economic and humanistic. FZZ in chronic patients, specific populations. Self-medication. Pharmacist intervention and patient safety. Standards and Quality Assurance of pharmaceutical services. Delivery of clinical services for disease prevention; research and reporting on public health. Pharmacy -based evidence. Commitment to patients' expectations (social marketing). Studies of drug use.			
Recommended literature: 1. Winfield AJ. Pharmaceutical Practice. 3th Ed. Philadelphia: Elsevier Health Science; 2004. 2. Smith MC, Wertheimer AI. Social and behavioral aspects of pharmaceutical care. New York: Pharmaceutical Products Press; 1996. 3. Taylor K, Harding G. Pharmacy Practice. New York: Taylor & Francis; 2001. 4. Kayne SB. Pharmacy business management. New York: Pharmaceutical Products Press; 2005. 5. Remington: Science nad Practice of Pharmacy. 21st Ed. Philadelphia:Lippincott Williams and Wilkins; 2005.			
The total of active learning classes	Lectures: 150		
	Individual research work: 150		
Teaching methods: Ex cathedra, practical work (case studies, workshop, panel discussion, homework, assignment)			
Grading system: final exam (150) and practical exam - oral (150)			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Methodology in social pharmacy and pharmacy practice			
Teachers: Ljiljana M. Tasić, Valentina D. Marinković, Dragana M. Lakić, Dušanka M. Krajnović			
Course status: elective, module: Social Pharmacy and Pharmacy Practice Research			
Semester: II		Year of studies: I	
ECTS points: 5		Course code: ДСФ1И1	
Requirements: no			
Course aims: Knowledge in pharmacoepidemiology and pharmacoeconomics. Application of the methods in pharmacoepidemiology and pharmacoeconomic analysis.			
Course outcomes: Applying knowledge of pharmacoepidemiology and pharmacoeconomics. Ability to critically evaluate information in the field of pharmacoepidemiology and pharmacoeconomics. Knowledge and application of pharmacoepidemiological and pharmacoeconomic methods.			
Course contents: Theoretical - Types of studies dealig with drug use, statig a hypothesis, sampling. Basic principles of pharmacoepidemiological methods of collection, processing and analysis of data related to the use of drugs and other medical products (rational, frequently prescribing medicines and treatment outcome). Methods for detection of adverse and beneficial effects of drugs, including spontaneous reporting, ad- hoc epidemiological studies and the use of databases. Design Study. Cross-sectional studies, observational studies (cohort and case - control studies) and clinical studies. Studies of the drug use. Bias. Perspective in pharmacoeconomic studies, economic and humanistic evaluation methods. Cost of illness (COI), cost minimization analysis (CMA) , cost-effectiveness analysis (CEA), cost-benefit analysis (CBA) , cost-utilty analysis (CUA). Practical - Safety Update Report. Calculating the risk of adverse drug reactions. Critical analysis of studies on adverse drug reaction/medical device Calculating the cost of treatment. Application of CMA, CEA, CBA and CUA.			
Recommended literature: 1. Strom BL. Pharmacoepidemiology. 4th ed. Chichester: John Wiley & Sons; 2005 2. Hartzema AG , Porta M, Tilson HH (editors). Pharmacoepidemiology. An Introduction. 3th ed. Cincinnati: Harvey Whitney Books Company; 1998 3. Gledović Z, Janković S, Jarebinski M, Marković-Denić Lj, Pekmezović T, Šipetić-Grujičić S, Vlajinac H. U: Vlajinac H, Jarebinski M (urednici). Epidemiologija. Beograd: Medicinski fakultet Univerziteta u Beogradu, 2006 4. Drummond M, OBrien B, Stoddart G, Torance G. Methods for the Economic Evaluation of Health Care Programmes. 2nd ed. Oxford: Oxford University Press; 1997 5. Berger ML, Bingefors K, Hedblom EC, Pashos CL, Torrance GW, Smith MD. Troškovi, kvalitet i ishodi zdravstvene zaštite – ISPOR knjiga termina. ISPOR 2003, prevod na srpski, Beograd: ISPOR Serbian chapter; 2012.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Ex cathedra, practical work (case studies, workshop, panel discussion, homework, assignment)			
Grading system: final exam (40) and practical exam - oral (60)			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Integratided communication in pharmacy practice			
Teachers: Dušanka M. Krajnović, Ljiljana M. Tasić, Vojin B. Rakić			
Course status: elective, module: Social Pharmacy and Pharmacy Practice Research			
Semester: II		Year of studies: I	
ECTS points: 5		Course code: ДСФ1И2	
Requirements: none			
Course aims: To acquire knowledge on integrated communications in pharmaceutical practice (scientific public, general public, health care institutions and manufacturers/ suppliers). Introduction to communication styles and information management. Survey on the phenomenon of health information, perception and communication.			
Course outcomes: To apply knowledge on integrated communications in pharmaceutical practice. Introduction and applying of various communication styles and management of information in research. Training for research, analytical thinking and evaluation of various phenomena related to different information, communication and perception.			
Course contents: Information and communication. Internal and external communication. Integrated systems of communication in pharmacy practice. Notion and significance of integrated communication for modern society (three aspects: patients, health system, manufacturers/suppliers). Development of effective integrated communications. Integrated marketing communication. Types of information (health information, social information, drugs and medical devices, classifications, codifications) and different approaches in research. Types of communication (verbal, non-verbal and written verbal communication). Communication channels (mass media, virtual communication, public health sector). Business culture (ethical, cultural, social aspects and pharmaceutical culture). Management of information and communication quality (international and national standards of good pharmacy practices, indicators for monitoring and evaluation). Specific methods, processes and barriers in communication with specific groups (women, children, adolescents, older patients, specific health problems, rare diseases, HIV etc.). Outcomes measurement of integrated communications in pharmacy practice.			
Recommended literature: 1. Tasić LJ.,Krajnović D.,Jocić D., Jović S.Communication in Pharmacy Practice. Belgrade :Faculty of Pharmacy University of Belgrade; 2011. 2. Winfield AJ, Richards RME. (editors). Pharmaceutical Practice. 3rd Ed. Churchill Livingstone; 2004 3. Millares M. Applied Drug Information: Strategies for Information Management, Vancouver: Applied Therapeutics Inc.; 1998. 4. Tasić LJ. Pharmaceutical menagement and marketing. Placebo: Belgrade, 2007. 5. Beardsley SR, Kimberlin LC, Tindall NW. Communication Skills in Pharmacy Practice. 5th Ed. Baltimore: Lippincott Williams & Wilkins; 2008.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Ex cathedra lectures, practical classes (case studies, workshops, panel discussions, homework, on-line forum and professional practice); Evaluation of Teaching: written-final test and practical exam-verbally.			
Grading system: Final exam (40 points) practical training)(60 points)			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Biomedical ethics			
Teachers: Dušanka M. Krajnović, Ljiljana M. Tasić, Vojin B. Rakić			
Course status: elective, module: Social Pharmacy and Pharmacy Practice Research			
Semester: II		Year of studies: I	
ECTS points: 5		Course code: ДСФ1ИЗ	
Requirements: none			
Course aims: Acquiring knowledge about biomedical ethics and application of normative ethical principles in practical situations in pharmaceutical practice. Mastering the methods and tools of ethical analysis and astimating the respect of moral values, duties and rights in providing health care and clinical practice.			
Course outcomes: Application knowlwdge in areas clinical ethical consultation. The ability to critically evaluate ethical problems and moral dilemmas, with a model of ethical analysis. The ability of moral judgement and clinical ethical analysis.			
Course contents: The position and role of ethics in biomedical practice and biomedical sciences. Normative ethical principles. Ethical reasoning in respecting the moral values and patient rights in providing health care and clinical practice. Ethical normatives: types, genesis and structure. The beginning and development of health ethics viewed according to ethical normative. The elements of health ethos in the oaths doctors, pharmacists and other healthcare employees. Not following the codified principles of the ethical normative. The ethical questions connected to public health. The ethical codex of public health. The roll of human rights in public health. The European bioethical agreement whose aim is protection of human rights and dignity in relation to medical research and new health technologies. Bioethical declarations and basic bioethical principles in clinical practice and clinical research. Clinical ethical consultations. Mistakes in health care- moral, professional and legal in health responsibility. Health and pharmaceutical market- behavior of stakeholders and professional ethics.			
Recommended literature: 1. Veatch MR, Haddad MA. Case Studies in Pharmacy Ethics. New York: Oxford University Press; 2008. 2. Parojčić D. The development of ethics in pharmacy: from theory to contemporary practice. Konstisi: Belgrade; 2006. 3. DeGrazia D, Mappes T, Ballard J. Biomedical ethics.McGraw- Hill education; 2010. 4. Parojčić D. Ethics in pharmacy. In: Nikolin et al. Gallery pharmaceutical skills. Belgrade: Placebo; 2005, 301-347. 5. Frkovic A. Bioethics in clinical practice. Pergamena: Zagreb; 2006.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Ex cathedra lectures, practical classes (case studies, workshops, panel discussions, homework, on-line forum and seminar).			
Grading system: test paper(40 points) practical exam- verbally (60 points)			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: History of Pharmacy			
Teachers: Dušanka M. Krajnović			
Course status: elective, module: Social Pharmacy and Pharmacy Practice Research			
Semester: II		Year of studies: I	
ECTS points: 5		Course code: ДСФ1И4	
Requirements: none			
Course aims: To acquire knowledge in the history of health culture and turning points of the evolutionary development of pharmaceutical science and pharmaceutical profession; To overmaster museological and documentative methods in conceptual and contextual analysis.			
Course outcomes: To apply knowledge on the history of A8 museology and preservation of national heritage; To develop the ability of searching and evaluation of historical sources and museum displays in pharmacy and the history of health culture.			
Course contents: Introduction to the history of science with special attention on the history of health culture and the history of pharmacy. Role and significance of pharmacy science since its founding till nowadays. Evolution of pharmaceutical profession. Collaboration with physicians and professional detaching (from physicians). The Edict of Salerno. Introduction to bibliographic research, bibliographic data bases important for pharmacy as well as the methods and ways of searching: profiles and terminology of research. Basis of museology and heritage preservation. Collecting museum displays, preservation and evalutation of collecting funds, depoes and documentation. Museums of pharmacy and medicine. General history of pharmacy. National history of pharmacy. Development of pharmaceutical deontology on the national and regional level. Development of apothecaries and apothecary trade in Serbia and Europe. Development of measurement systems and weights. Drug concept in the history and evolution of certain therapeutic groups of drugs. Development of professional literature and pharmacopoeias. Industrialisation in pharmacy, introduction of machine drug manufacturing and pharmaceutical industry development. Evolution of national, regional and international ethical and law normatives regarding apothecary trade. National, regional and international associations of pharmacists and their influence on the development of pharmaceutical profession.			
Recommended literature: 1. Sonnedecker G. Kremers and Urdang's History of Pharmacy. 4th Ed. Philadelphia: Lippincott; 1976. 2. Lafont O. ed. Dictionnaire d'histoire de la pharmacie, Des origines à la fin du XIXe siècle. Paris: Pharmathèmes; 2003. 3. Helmstaedter A, Hermann J, Wolf E. Leitfaden der Pharmaziegeschichte. Govi-Verlag: Eschborn; 2001. 4. Schmitz R. Geschichte der Pharmazie, band I, Govi-Verlag:Eschborn; 1998. 5. Jonsen RA. A Short History of Medical Ethics. New York: Oxford University Press; 2000.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Ex cathedra lectures, practical classes (workshops, research and discussions of secondary and tertiary sources at History of Pharmacy Museum); homeworks. Evaluation of teaching: written-final test and practical exam-verbally.			
Grading system: written-final test (40 points) practical exam-verbally (60 points)			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Medication management and rational use of medicines			
Teachers: Ljiljana M. Tasić, Vezmar Kovačević D. Sandra			
Course status: elective, module: Social Pharmacy and Pharmacy Practice Research			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: ДСФ2И1	
Requirements: no			
Course aims: Knowledge about the health, social and economic aspects of drug management and rational drug use. Understanding the role of pharmacists in promoting rational use of medicines.			
Course outcomes: The application of knowledge in the effective management of medicines and promotions of rational drug use in primary, secondary and tertiary health care institutions. Ability to critically evaluate and improve the drug management and rational use of medicines.			
Course contents: Essential medicines. Drug List, clinical guidelines, treatment protocols. Quantification of the drugs , the consumption and the morbidity method. The reduction of treatment costs using the VEN system (Vital, Essential and Non- essential drugs), ABC analysis and therapeutic categories analysis. Principles of procurement of drugs and medical devices for public health institutions and impact analysis. Cycle management of drugs (logistics and Supply Chain health system). The roles and responsibilities of the health care team in the management of drug supply. Pharmacovigilance. Planning , implementation and monitoring of the drug use. Clinical, social and economic aspects and outcomes. Use of drugs in an individual patient, the population, institutions and society . The role of pharmacists in rational use of medicines .			
Recommended literature: 1. Hedley Rees. Supply chain management in the drug industry - Delivery Patient Value for Pharmaceutical and Biologics. New Jersey: John Wiley & Sons; 2011. 2. Тасић Љ. Фармацеутски менаџмент и маркетинг. Плацебо: Београд; 2007. 3. Buchbinder S, Shanks NH. Introduction To Health Care Management. 2nd Ed. Burlington: Jones & Bartlett Learning; 2011. 4. World Health Organization. Managing Drug Supply. 2nd ed. Connecticut: Kumarian Press; 1997. 5. Bootman J, Townsend R, McGhan W. Principles of Pharmacoeconomics. 3rd ed. Cincinnati: Harvey Whitney Books Company; 2005.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Ex cathedra, practical work (case studies, workshop, panel discussion, homework, assignment)			
Grading system: final exam (40) and practical exam - oral (60)			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Selected chapter of pharmacotherapy			
Teachers: Tomić A. Maja			
Course status: elective, module: Social Pharmacy and Pharmacy Practice Research			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: ДСФ2И2	
Requirements: no			
Course aims: Acquiring knowledge about the effectiveness, safety about medicines, interactions and adverse drug reactions in the treatment of diseases of the cardiovascular system, central nervous system, endocrine and the musculo-skeletal system. Understanding the importance of reproductive health and disease prevention in women.			
Course outcomes: Applying knowledge of selected fields of pharmacotherapy: cardiovascular diseases, central nervous system, the endocrine and the musculo-skeletal system. Counseling of women about the rational drugs use and disease prevention. Critical evaluation of prescribed pharmacotherapy in patients who suffering from diseases of the cardiovascular system, central nervous system, the endocrine and the musculoskeletal system.			
Course contents: Pharmacotherapy guidelines for the drug use. Frugs for the first and second choice, dosage, pharmacological action, indication, contraindication, interactions and adverse drug reactions of drugs used in the treatment of central nervous system, cardio vascular, endocrine, and musculo - skeletal system. The role of laboratory parameters in assessing the efficacy and safety of the therapy. Specificity of the population of women in reproductive age. Hormonal therapy and reproductive health; hormonal therapy and endocrine diseases. A critical evaluation of clinical studies on the efficacy and safety of drugs. The role of pharmacists in the development of therapeutic guidelines. Counseling patients about the use of medicinal products, the importance of adherence			
Recommended literature: 1. DiPiro J, Talbert RL, Yee G, Matzke G, Wells B, Posey ML. Pharmacotherapy: A Pathophysiologic Approach. 8th Ed.McGraw-Hill Medical; 2011. 2. Brunton L, Chabner B, Knollman B. Goodman and Gilman's The Pharmacological Basis of Therapeutics. 12th Ed. McGraw-Hill Professional; 2010. 3. Schwinghammer T, Koehler J. Pharmacotherapy Casebook: A Patient - Focused Approach. 8th Ed., McGraw-Hill Medical; 2011. 4. Угрешић Н, Степановић-Петровић Р, Савић М. Фармакотерапија за фармацеуте. 1. издање. Београд: Фармацеутски факултет; 2011.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Ex cathedra, practical work (case studies, workshop, panel discussion, homework, assignment)			
Grading system: final exam (40) and practical exam - oral (60)			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Pharmaceutical and Healthcare Quality systems			
Teachers: Ljiljana M. Tasić, Valentina D. Marinković			
Course status: elective, module: Social Pharmacy and Pharmacy Practice Research			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: ДСФ2ИЗ	
Requirements: none			
Course aims: Acquiring knowledge about quality systems concepts. Introduction of basic tools and methods in Pharmaceutical and Healthcare quality systems.			
Course outcomes: Implementation of knowledge about quality management system (QMS) and integrated management system (IMS). Ability of critical evaluation of IMS models and continuous improvement of quality performance.			
Course contents: Quality philosophy, systems subsystems in pharmaceutical lifecycle. Pharmaceutical Quality system. Standardized quality management systems (SMS)-ISO 9001, ISO 22000, ISO 17025, ISO 13845 . Integrated management system about quality, ecology, health & safety. QMS in health industry - Donabedian philosophy. Certification and accreditation in pharmacy and healthcare. Good practices in pharmacy. Pharmaceutical care; analysis of correlation: structure-process-outcome; evaluation and quality assurance of pharmaceutical and healthcare services; development of pharmacy services (project, models), quality performance indicators. New approaches in quality management and business excellence/ clinical excellence)			
Recommended literature: 1.Tasić Lj, Marinković V. Kvalitet u farmaciji -od teorije do prakse. Beograd: Farmaceutski fakultet, 2012. 2. Tasić Lj. Farmaceutski menadžment i marketing. Beograd: Placebo; 2007. 3. Lee TH, Shiba S, Wood R. Integrated management systems- A Practical Approach to transforming organisations. New York: John Wiley & Sons Inc 1999. 4. Hedley R. Supply chain management in the drug industry- Delivery Patient Value for Pharmaceuticals and Biologics. New Jersey: John Wiley & Sons Inc 2011. 5. Filipović J. Menadžment sistema kvaliteta. Beograd FON, 2008.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures (ex cathedra) practice: case studies, workshops, panel discussion, home work, on-line forum . Evaluation : written exam- final test and oral practical exam.			
Grading system: Written exam: 40			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Health outcomes and modelling research			
Teachers: Ljiljana M. Tasić, Valentina D. Marinković, Dragana M. Lakić, Dušanka M. Krajnović			
Course status: elective, module: Social Pharmacy and Pharmacy Practice Research			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: ДСФ2И4	
Requirements: no			
Course aims: The acquisition of knowledge in the field of health outcomes research. Application of the modelling methods.			
Course outcomes: The use of knowledge in health outcomes research. Ability to critically evaluate information in the field of health outcomes research. Knowledge and application of modeling.			
Course contents: Theoretical - Outcomes - clinical, social (humanistic) and economic outcomes. Outcome indicators and design studis (perspective: health policy, and health care programs; patients; health care workers). Studies based on humanistic outcomes - patient related outcome (PRO) and health related quality of lifequestionnaires. Health related quality of life (generic and specific questionnaires), adaptation and validation of the questionnaire. Basic psychometric properties of the questionnaire (validity, reliability, sensitivity). Preferences and preference measurement. Hypotheses and modelling. Modelling systems and subsystems and impact analysis, evaluation of the strength and performance of the system. Modelling in pharmacoepidemiology and pharmacoconomics. Modelling and simulation (Monte Carlo simulation, deterministic analysis, Markov model, stochastic and probabilistic analysis). Practical - The use of questionnaires for quality of life. Content analysis and categorization of the questionnaire. Linguistic adaptation of the questionnaire. Calculation and interpretation of assessment results the basic characteristics of the questionnaire. Development and application of various models. Testing of the model. The effect of changes in the results of base-case analysis. Robustness and sensitivity analysis.			
Recommended literature: 1. Strom BL. Pharmacoepidemiology. 4th ed. Chichester: John Wiley & Sons; 2005 2. Drummond M, OBrien B, Stoddart G, Torance G. Methods for the Economic Evaluation of Health Care Programmes. 2nd ed. Oxford: Oxford University Press; 1997 3. Bootman J, Townsend R, McGhan W. Principles of Pharmacoconomics. 3rd ed. Cincinnati: Harvey Whitney Books Company; 2005			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Ex cathedra, practical work (case studies, workshop, panel discussion, homework, assignment)			
Grading system: final exam (40) and practical exam - oral (60)			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Toxicology-Selected Topics			
Teachers: Matović J. Vesna, Antonijević M. Biljana, Đukić M. Mirjana, Vujanović L. Dragana, Bulat L. Zorica			
Course status: Mandatory modules, module: Toxicology			
Semester: I		Year of studies: I	
ECTS points: 10		Course code: ДТО10М1	
Requirements: none			
Course aims: To gain knowledge (including evaluation) on general principles of toxicology as an introduction for the study of certain groups of poisons and toxicological disciplines as well as to gain knowledge on the most important toxic agents from different fields of toxicology.			
Course outcomes: Gained knowledge on general toxicology and most important toxic agents in different fields of toxicology.			
Course contents: Multidisciplinary character of toxicology. Toxicity concept and toxicological profile. Dose-response. Local and systemic toxic effects. Toxicity tests. Toxicokinetics and toxicodynamics. Genotoxicity. Basis of toxicological and ecotoxicological risk assessment. Regulatory affairs in toxicology. Studying the following groups of toxic agents: gaseous poisons that are of concern in occupational and ecotoxicology and their effects on human health and environment; toxicology of organic solvents and persistent organic pollutants; chronic exposure to toxic metals and consequent therapy; toxicology of pesticides and their effects on human health and pesticides residues; drug poisoning; overdose caused by psychoactive controlled substances.			
Recommended literature: 1. Timbrell JA. Introduction to Toxicology, CRC Press, 2002. 2. Casaret and Doull's Toxicology: The Basic Science of Poisons. Ed.: Curtis D. Klaassen, McGraw-Hill Companies, Inc., USA, 7th Ed, 2008. 3. Marquardt H, Schafer SG, McClellan R, Welsch F: Toxicology. Academic Press, USA, 1999. 4. Manahan SE: Toxicological Chemistry and Biochemistry. Lewis Publishers, USA, 2003. 5. Mulder JG and Dencker L. Pharmaceutical Toxicology Ed.: Mulder JG and Dencker L. Pharmaceutical Press, 2006. 6. Olson KR. Poisoning & Drug Overdose. New York: Lange Medical Books, 4th Ed, 2004. 7. Moffat Ac. Osselton MD, Widop B. Clark's analysis of drugs and poisons in pharmaceutical, body fluids and post-mortem materials. Moffat Ac. Osselton MD, Widop B. Third edition Pharmaceutical Press London 2004.			
The total of active learning classes	Lectures: 60		
	Individual research work: 60		
Teaching methods: Lectures, practical courses , consultations, discussions			
Grading system: pre-exam activities: 30 points; oral exam: 70 points			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Principles of use of animals for scientific purposes			
Teachers: Todorović M. Zoran, Savić M. Miroslav			
Course status: Mandatory modules, module: Toxicology			
Semester: I		Year of studies: I	
ECTS points: 5		Course code: ДТО10М2	
Requirements: none			
Course aims: The aim of this course is to provide participants with knowledge about principles of breeding, handling and use of animals used for scientific purposes, including legislation in Serbia, European Union and world, as well as of anaesthesia and surgery of laboratory animals (wok in vivo).			
Course outcomes: By the end of this course participants will have gained an understanding of legislation and principles of breeding, handling and work with animals used for scientific purposes.			
Course contents: Legislation and ethical questions related to work with animals used for scientific purposes. Priniciples of laboratory experiment. Principles of Good laboratory practice. Breeding and caring for animals used for scientific purposes. Animal welfare. Monitoring the health status and the most common diseases of animals used for scientific purposes. Use of animals in laboratory (routes of treatment application, introduction to anaesthesia and analgesia). Surgical procedures on animals used for scientific purposes. Practical laboratory work.			
Recommended literature: 1. Wolfensohn S, Lloyd M. Handbook of laboratory animal management and welfare. John Wiley & Sons, 2013. 2. Wilking MR (ed). Experimental Therapeutics, Martin Dunitz, Ltd., London, 2003.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures and study-research work			
Grading system: Seminar: 50 points; written exam: 50 points			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Mechanisms of Toxicity			
Teachers: Matović J. Vesna, Antonijević.M. Biljana, Đukić M. Mirjana, Vujanović L. Dragana, Bulat L. Zorica			
Course status: Mandatory modules, module: Toxicology			
Semester: II		Year of studies: I	
ECTS points: 10		Course code: ДТО10М3	
Requirements: none			
Course aims: To gain, analyse and evaluate knowledge on the mechanisms of toxicity.			
Course outcomes: Gained knowledge on the mechanisms of toxicity.			
Course contents: Toxicokinetic and toxicodynamic factors as basic mechanisms of toxicity. Types of toxic responses. Selective toxicity. Cellular transfer and bioaccumulation of toxic agents. Metabolism as the process of bioactivation. Molecular mechanisms of toxicity: covalent binding with endogenous substrates, binding with enzymes and other proteins, oxidative stress (effects of poisons on the parameters of oxidative stress: on reactive oxygen and nitrogen species and on enzymatic and non-enzymatic parameters of antioxidant defense system) apoptosis and necrosis, impairment of cells proliferation and cells repair, effects of poisons on ionic channels, immune system, and on specific receptors. Toxic effects on proteins, lipids and genetic material. Reparative cellular mechanisms. Mechanisms of toxicity of a single toxic agent or a mixture; analysis of these mechanisms of toxicity.			
Recommended literature: 1. Mulder JG and Dencker L. Pharmaceutical Toxicology Ed.: Mulder JG and Dencker L. Pharmaceutical Press, 2006. 1. Plant N. Molecular Toxicology. BIOS Scientific Publishers, London and New York, 2003. 2. Boelsterli UA. Mechanistic Toxicology. Informa Healthcare, New York, USA, 2009. 3. Aldridge WN, Mechanisms and Concepts in Toxicology, Taylor&Francis, London, UK, 1996. 4. Barile FA.Clinical Toxicology Principles and Mechanisms, CRC Press, Boca Raton, USA, 2004. 5. Roberts R, Ed. Apoptosis in Toxicology, Taylor&Francis, , London, UK, 2000.			
The total of active learning classes	Lectures: 60		
	Individual research work: 60		
Teaching methods: Lectures, practical courses , consultations, discussions			
Grading system: pre-exam activities: 30 points; oral exam: 70 points			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Models and Methods in Toxicology			
Teachers: Matović J. Vesna, Antonijević M. Biljana, Đukić M. Mirjana, Vujanović L. Dragana, Bulat L. Zorica			
Course status: Mandatory modules, module: Toxicology			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: DTO2OM1	
Requirements: passed the exams from the first year			
Course aims: To gain, applicate, analyse and evaluate knowledge and skills in the field of models and methods used in toxicology.			
Course outcomes: Gained knowledge and skills will enable a finished PhD student to choose and applicate appropriate models and methods in toxicology, as well to estimate critical assessment and interpretation of the obtained results concerning the character and significance of toxic effect.			
Course contents: Methods in toxicology: in silico, in vitro, in vivo. Theoretical basis of probit analysis in toxicology and tests of acute toxicity (Litchfield and Wilcoxon test, Well test). Quantification of local toxic effects: tests of irritation and sensibilisation. (Draize test, Magnusson and Kligman test). Methods for assessment of genotoxic and mutagenic effects, carcinogenicity, reproductive and developmental toxicity. Quantification of threshold and non threshold effects, hormesis phenomenon. Assessment of no observed adverse effect level (NOAEL) and Benchmark (BMD) dose, advantages and limitations. Models for estimations of (non)genotoxic carcinogenic efect. Linear extrapolation and polinomials application for genotogic carcinogenic effect. Assessment of toxic effect of substance in a mixture and its quantification. Epidemiological studies in toxicology and meta analysis. Toxicokinetic models. Models and methods used for toxicological risk assessment. Deterministic and probabilistic models. Softwers used in toxicology.			
Recommended literature: 1. Greim H, Snyder R.Toxicology and Risk Assessment. John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester, West Sussex PO19 8SQ, England, 2008. 2. Casaret and Doull's Toxicology: The Basic Science of Poisons. Ed.: Curtis D. Klaassen, McGraw-Hill Companies, Inc., USA,7th Ed, 2008. 3. Hayes AW. Principles and Methods of Toxicology. Fourth Edition, Taylor&Fransis, 2001.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures, practical courses , consultations, discussions			
Grading system: pre-exam activities: 30 points; oral exam: 70 points			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Ecotoxicology			
Teachers: Matović J. Vesna, Antonijević.M. Biljana, Đukić M. Mirjana, Vujanović L. Dragana, Bulat L. Zorica			
Course status: elective, module: Toxicology			
Semester: II		Year of studies: I	
ECTS points: 5		Course code: ДТО1И1	
Requirements: Toxicology-Selected Topics, Mechanisms of Toxicity			
Course aims: To gain, analyse and evaluate knowledge in the field of ecotoxicology.			
Course outcomes: Gained knowledge in ecotoxicology that will enable a finished PhD student to be a qualified person in a team competent for environment pollution monitoring and environmental management.			
Course contents: Basic concept of ecotoxicology as a science. Interphase transport and distribution of pollutants in the environment. Bioconcentration, bioaccumulation and biomagnification of pollutants and their entrance into the food chain. Response of a person, population, community and ecosystem to one or more environmental pollutants (molecular, physiological and behavioral approach). Biomonitoring and biomarkers of hazards in the environment. Global effects in the environment: climate changes, depletion of ozone layer in stratosphere, acidification, air, water and soil pollution, waste. The most important pollutants of atmosphere, hydrosphere and lithosphere. Effects of pollution on human health, plants and animals. Ecotoxicological risk assessment. Environmental management and regulatory affairs.			
Recommended literature: 1. Walker CH, Hopkin SP: Principles of Ecotoxicology (2nd edition). Ed.: Walker CH et al. taylor and Francis, USA and Canada, 2001. 2. Newman MC, Unger MA: Fundamentals of Ecotoxicology (2nd edition). Ed.: Lewis publishers. CRC Press LLC, Boca Roton, USA, 2003. 3. Hoffman DJ, Rattner BA, Burton GA, Cairns J. Handbook of ecotoxicology, 2nd edition CRC Press LLC, USA, 2003. 4. Conell D, Lam P, Richardson B and Wu R. Introduction to Ecotoxicology. Blackwell Science, 1999. 5. Paustenbach DJ, Ed. Human and Ecological Risk Assessment, John Wiley and Sons, New York, USA, 2002.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures, practical courses , consultations, discussions			
Grading system: pre-exam activities: 30 points; oral exam: 70 points			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Occupational Toxicology			
Teachers: Matović J. Vesna, Antonijević M. Biljana, Đukić M. Mirjana, Vujanović L. Dragana, Bulat L. Zorica			
Course status: elective, module: Toxicology			
Semester: II		Year of studies: I	
ECTS points: 5		Course code: ДТО1И2	
Requirements: Toxicology-Selected Topics, Mechanisms of Toxicity			
Course aims: To gain, analyse and evaluate knowledge in the field of occupational toxicology.			
Course outcomes: Gained knowledge in occupational toxicology that will enable a finished PhD student to competently participate and manage the affairs in the field of occupational toxicology.			
Course contents: Ambient monitoring (stationary and continuous monitoring, "spot" monitoring, personal monitoring) and biological monitoring (biological markers of exposure and biological markers of effects). Maximal allowed concentrations for air and biological material, and other parameters of concern for toxicological assessment in this field. Selective and non-selective tests of exposure. Biotoxicological parameters in assessment of recent and long-term exposure. The most important agents that are causes of professional intoxications: gasses, organic solvents, metals, pesticides. Toxicokinetics, systemic effects, mechanisms of toxicity, analytics, therapy and prevention. Epidemiological studies. Regulatory affairs.			
Recommended literature: 1. Vidaković A. Medicina rada II, KCS-Institut za medicinu rada i radiološku zaštitu »Dr Dragomir Karajović«, Beograd i Udruženje za medicinu rada Jugoslavije, 1997. 2. Casaret and Doull's Toxicology: The Basic Science of Poisons. Ed.: Curtis D. Klaassen, McGraw-Hill Companies, Inc., USA,7th Ed, 2008. 3. Nordberg GF, Fowler BA, Nordberg M, Friberg LT. Handbook on the Toxicology of Metals, Elsevier, North.Holland Biomedical Press, Holandija 3rd Ed., 2007. 4. Carter RE, Ed. Organic Solvents: Properties, Toxicity, and Industrial Effects, Nova Science Pub Incorporated, 2011.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures, practical courses , consultations, discussions			
Grading system: pre-exam activities: 30 points; oral exam: 70 points			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Analytical toxicology			
Teachers: Matović J. Vesna, Antonijević.M. Biljana, Đukić M. Mirjana, Vujanović L. Dragana, Bulat L. Zorica			
Course status: elective, module: Toxicology			
Semester: II		Year of studies: I	
ECTS points: 5		Course code: ДТО1И3	
Requirements: Toxicology-Selected Topics, Mechanisms of Toxicity			
Course aims: To gain, analyse and evaluate knowledge and skills in the field of analytical toxicology.			
Course outcomes: Gained knowledge in analytical toxicology that will enable a finished PhD student to competently participate and manage the affairs in the field of analytical toxicology.			
Course contents: Samples, sampling, transport and storage of samples. Possible contamination of samples. Current procedure and sampling instruments. Modern procedures for sample preparation in toxicological practice (methods of extraction, mineralisation, etc). Specificity of clinical, forensic and occupational toxicological laboratories. The significance of analytics in monitoring of toxic agents in the environment and occupational ambience. Screening methods. Qualitative and quantitative analysis. Application of different techniques in toxicological practice: HPLC, GC, GC/MS, LC/MS, AAS (flame and flameless) ICP, NAA, RIA, immunoassay methods, etc. Interpretation of the results. Toxicological report. Principles of good laboratory practice. Accreditation of toxicological laboratories.			
Recommended literature: 1. Clarke's Isolation and Identification of drugs in pharmaceuticals, body fluids and post-mortem material. Ed.: Moffat AC, Osseltom MD, Widdop B, Watts J. The Pharmaceutical Press, London, 2011. 2. Flanagan RJ, Taylor A, Watson ID, Whelpton R. Fundamentals of Analytical Toxicology, John Wiley & Sons, England, 2007. 3. Clarke's Analytical Forensic Toxicology, Jickells S, Negrusz A. Eds., Pharmaceutical Press, London, UK, 2008. 4. Skoog DA, Holler FJ, Crouch SR, Principles of instrumental analysis, Brooks/Cole, 2007 5. Popek EP, Sampling And Analysis Of Environmental Chemical Pollutants:A Complete Guide, Academic Press, 2003.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures, practical courses , consultations, discussions			
Grading system: pre-exam activities: 30 points; oral exam: 70 points			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Toxicological Risk Assessment			
Teachers: Matović J. Vesna, Antonijević M. Biljana, Đukić M. Mirjana, Vujanović L. Dragana, Bulat L. Zorica			
Course status: elective, module: Toxicology			
Semester: II		Year of studies: I	
ECTS points: 5		Course code: ДТО1И4	
Requirements: Toxicology-Selected Topics, Mechanisms of Toxicity			
Course aims: To gain, applicate, analyse and evaluate knowledge and skills in the field of toxicological risk assessment.			
Course outcomes: Gained knowledge in toxicological risk assessment will enable a finished PhD student to competently participate in toxicological risk assessment and to analyse and estimate the obtained risk and used methodology.			
Course contents: Basic terms and definitions: risk, hazard, risk assessment, risk management. Significance of toxicological risk assessment. Phases of risk assessment. Identification of hazard: in silico, in vitro, in vivo toxicity tests, epidemiological studies and case reports. Parameters of toxicity in acute and prolonged exposure. Assessment of dose-response relation: threshold effect and no threshold effect, critical toxic effect. Exposure assessment: sources of exposure, route of intake, duration and freguency of exposure, exposed (sub)population. Models of exposure assessment: deterministic and propabilistic models: advantages and restrictions. Risk characterization. Application of biomarkers in risk assessment. Application of toxicokinetic models in risk assessment. Agregative, cummulative and integrative risk assessment. Risk assessment of exposure to low doses and its specificity. Risk assessment of carcinogenic and/or genotoxic substances. Softwers for risk assessment. Risk interpretation: variability and uncertainty. Good evaluation practice. Risk management.			
Recommended literature: 1. Nielsen E, R̂stergaard G, Larsen JC. Toxicological Risk Assessment of Chemicals: A Practical Guide, Informa Healthcare USA, Inc., 2008. 2. Greim H, Snyder R.Toxicology and Risk Assessment. John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester, West Sussex PO19 8SQ, England, 2008. 3. Paustenbach DJ. Human and ecological risk assessment. Ed.: Paustenbach DJ. John Wiley and Sons, Inc., New York, USA, 2002.			
The total of active learning classes		Lectures: 30	
		Individual research work: 30	
Teaching methods: Lectures, practical courses , consultations, discussions			
Grading system: pre-exam activities: 30 points; oral exam: 70 points			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Toxicology of Drugs and Controlled Psychoactive Substances			
Teachers: Matović J. Vesna, Antonijević.M. Biljana, Đukić M. Mirjana, Vujanović L. Dragana, Bulat L. Zorica			
Course status: elective, module: Toxicology			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: ДТО2И1	
Requirements: passed the exams from the first year			
Course aims: To gain, analyse and evaluate knowledge and skills in the field of toxicology of drugs and controlled psychoactive substances.			
Course outcomes: Gained current knowledge in the toxicology of drugs and controlled psychoactive substances will enable a finished PhD student to participate and manage the affairs in this field of toxicology.			
Course contents: Epidemiological data on drug poisonings. Mono- and poly-drug poisonings. Acute and chronic intoxication. Specific groups of drugs- the the most common causes of intoxication: (narcotic and non-narcotic analgetics, antipyretics, sedatives, antipsychotics, anticonvulsants, cardiovascular drugs): toxicokinetics, mechanism of action and toxicity, acute and chronic toxicity, therapy, analytics. Drugs in environment. Ecotoxicological aspects. Medical and pharmaceutical waste. Risk assessment: exposure assessment and risk characterization. Drugs of abuse: alcohol, heroin and other opioids, cocaine, amphetamines, nicotine, caffeine, benzodiazepines, barbiturates, LSD, phencyclidine, cannabinoids, anabolic steroids. Chemical structure and effect. Toxicokinetics, toxicodynamics and mechanisms of toxicity. Tolerance, dependence and withdrawal syndrome. Analytics in biological material. Therapy and preventiopn. Regulatory affairs.			
Recommended literature: 1. Blachford S., Krapp K. (eds.) Drugs and Controlled Substances Information for Students. Thompson Gale, 2002. 2. Emmett D, Nice G. Understanding Street Drugs. Jessica Kingsley Publishers, London, UK, 2006. 3. Olson KR. Poisoning & Drug Overdose. New York: Lange Medical Books, 4th Ed, 2004. 4. Cole MD. The Analysis of Controlled Substances, John Wiley & Sons Ltd., 2003. 5. Barile FA.Clinical Toxicology Principles and Mechanisms, CRC Press, Boca Raton, USA, 2004.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures, practical courses , consultations, discussions			
Grading system: pre-exam activities: 30 points; oral exam: 70 points			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Food Toxicology			
Teachers: Matović J. Vesna, Antonijević.M. Biljana, Đukić M. Mirjana, Vujanović L. Dragana, Bulat L. Zorica			
Course status: elective, module: Toxicology			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: ДТО2И2	
Requirements: passed the exams from the first year			
Course aims: To gain, analyse and evaluate knowledge and skills in the field of food toxicity.			
Course outcomes: Gained current knowledge in food toxicity will enable a finished PhD student to participate and manage the affairs in this field of toxicology.			
Course contents: Toxic substances in food: "natural" origin chemicals, aditives and pollutants. Direct food aditives: colors, antimicrobial agents, antioxidants, enzymes, fumigants, lubricants, sweeteners, etc. Indirect food additives. Unavoidable contamination during growth, storage, or processing: chlorinated organics, heavy metals, mycotoxins, pesticides residues, drugs (for food of animal origin). Toxic substances produced by cooking. Miscellaneous contaminants in food. Regulatory affairs in food toxicology. Risk assessment: assessment of exposure, risk characterization, risk/benefit analysis.			
Recommended literature: 1. Wetzel DLB, Charalambous G., Instrumental Methods in Food and Beverage Analysis, Elsevier science, Amsterdam, The Netherlands, 1998. 2. Helferich W, Winter CK. Food toxicology, Boca Raton, Fla. ;London, CRC Press, 2001. 3. Püssa T. Principles of food toxicology, Boca Raton : CRC Press, 2008. 4. Altug T. Introduction to toxicology and food, Boca Raton, Fla.,CRC Press, 2003.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures, practical courses , consultations, discussions			
Grading system: pre-exam activities: 30 points; oral exam: 70 points			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Toxicology of Metals			
Teachers: Matović J. Vesna, Antonijević M. Biljana, Đukić M. Mirjana, Vujanović L. Dragana, Bulat L. Zorica			
Course status: elective, module: Toxicology			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: ДТО2И3	
Requirements: passed the exams from the first year			
Course aims: To gain, analyse and evaluate knowledge and skills in the field of metal toxicity.			
Course outcomes: Gained current knowledge in toxicology of metals that will enable a finished PhD student to competently participate and manage the affairs in this field of toxicology.			
Course contents: General characteristics of metals, metals redistribution: natural and geological cycles, antropogenic factors; factors influencing toxicity, toxic effect on humans, mechanisms of toxicity. Metals' importance in the field of occupational toxicology and ecotoxicology. Metals as air, water and food pollutants. Organometallic compounds and their toxicological significance. The effect of metals on genetic material. Metals as endocrine disruptors. Biological monitoring and biotoxicological parameters. Therapy-chelating agents. Prophylaxis. Analytics: preparing procedures, methods for qualitative and quantitative analyses, interpretation of the results. Toxicological and ecotoxicological risk assessment. Regulatory affairs.			
Recommended literature: 1. Nordberg GF, Fowler BA, Nordberg M, Friberg LT. Handbook on the Toxicology of Metals, Elsevier, North. Holland Biomedical Press, Holandija 3rd Ed., 2007. 2. Koropatnick DJ, Zalups RK. Molecular biology and toxicology of metals, Taylor & Francis, London, UK, 2000. 3. Sledge EB, Toxicology of metals : biochemical aspects, Springer, London, UK, 2012. 4. Sigel A, Sigel H, Sigel RKO. Metal ions in toxicology : effects, interactions, interdependencies, Cambridge : Royal Society of Chemistry, UK, 2010. 5. Bnfalvi G. Ed. Cellular effects of heavy metals, Springer Dordrecht ; New York, 2011.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures, practical courses , consultations, discussions			
Grading system: pre-exam activities: 30 points; oral exam: 70 points			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Toxicology of Pesticides			
Teachers: Matović J. Vesna, Antonijević M. Biljana, Đukić M. Mirjana, Vujanović L. Dragana, Bulat L. Zorica			
Course status: elective, module: Toxicology			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: ДТО2И4	
Requirements: passed the exams from the first year			
Course aims: To gain, applicate, analyse and evaluate knowledge and skills in the field of pesticides toxicity.			
Course outcomes: Gained current knowledge in toxicology of pesticides that will enable a finished PhD student to assess toxicological characteristics and a risk during the exposure to pesticides.			
Course contents: Pesticides: definition and classes. Toxicological significance of pesticides. Regulatory affairs in biocides and plant protecion products. Insecticides (organochlorine and organophosphorus insecticides, carbamates, piretroides, etc), herbicides (bispiridinium compounds, phenylacetic acid derivatives, dinitrophenols, triazine herbicides, etc), fungicides (organometallic compounds, fungicides of new generation), rodenticides (bromadiolon, brodifakum): toxicokinetic characteristics, metabolism, mechanisms of toxicity, biomarkers of exposure and effect, acute intoxication, chronic intoxication, prolonged exposure to low doses, therapy, analytics in biological material and samples from the environment. Ecotoxicological significance of pesticides. Fate and behavior in the environment. Residues and evaluation of maximum residues levels. Interactions of pesticides. Concept of cumulative risk assessment for organophosphorus and carbamates exposure. Risk assessment: exposure assessment and risk characterization.			
Recommended literature: 1. Costa LG, Galli CL, Murphy SD. Toxicology of Pesticides: Experimental, Clinical and Regulatory Perspectives. Springer London, Limited, 2011. 2. Hayes' Handbook of Pesticide Toxicology. Third edition. Ed., Krieger R, Academic Press, 2010.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures, practical courses , consultations, discussions			
Grading system: pre-exam activities: 30 points; oral exam: 70 points			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Toxicology of Organic Solvents			
Teachers: Matović J. Vesna, Antonijević.M. Biljana, Đukić M. Mirjana, Vujanović L. Dragana, Bulat L. Zorica			
Course status: elective, module: Toxicology			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: ДТО2И5	
Requirements: passed the exams from the first year			
Course aims: To gain, applicate, analyse and evaluate knowledge and skills in the field of toxicology of organic solvents.			
Course outcomes: Gained current knowledge in toxicology of organic solvents that will enable a finished PhD student to participate and manage the affairs in this field of toxicology.			
Course contents: Organic solvents of concern in occupational toxicology. Organic solvents of concern for general population, especially those being cosmetic products ingrediants. Exposure, doses, kinetics of organic solvents. General and specific toxic effects. Mechanisms of toxicity. Aliphatic hydrocarbons (C5-C8); halogenated aliphatic hydrocarbons- methylene chloride, chloroform, carbontetrachloride, methylchloroform, tetrachloroethylen; aromatic hydrocarbons- benzen and its derivatives; aliphatic alcohols/ethanol, methanol, n-buthanol; glycols- diethylene glycol, propylene glycol; glycol ethers; carbon disulfide, etc. Protective measures and therapy. Toxicological risk assessment. Regulatory affairs.			
Recommended literature: 1. Luttrell WE, Jederberg WW, Still KR. Toxicology principles for the industrial hygienist, Fairfax, VA : American Industrial Hygiene Association, 2008. 2. Wypych G. Handbook of solvents, ChemTec Publ, Toronto, Canada, 2001. 3. Toxicological profiles. Public Health Service, Agency for Toxic Substances and Disease Registry. 4. Health Safety Guides, WHO. 5. Environmental Health Criteria, WHO/IPCS.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures, practical courses , consultations, discussions			
Grading system: pre-exam activities: 30 points; oral exam: 70 points			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Toxicology of Persistent Organic Pollutants			
Teachers: Matović J. Vesna, Antonijević M. Biljana, Đukić M. Mirjana, Vujanović L. Dragana, Bulat L. Zorica			
Course status: elective, module: Toxicology			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: ДТО2И6	
Requirements: passed the exams from the first year			
Course aims: To gain, applicate, analyse and evaluate knowledge and skills in the field of toxicology of persistent organic pollutants.			
Course outcomes: Gained current knowledge in toxicology of persistent organic pollutants that will enable a finished PhD student to assess toxicological characteristics and a risk during the exposure to persistent organic pollutants.			
Course contents: Persistent organic pollutants: organochlorine insecticides, polichlorinated biphenyls, polichlorinated dibenzodioxins, polichlorinated dibenzofurans, polibrominated organic compounds. Toxicological and ecotoxicological significance. Fate and behavior in the environment: contamination of water, air and soil, bioaccumulation and biomagnification, entrance into food chain. Toxicokinetic characteristics, mechanisms of action, prolonged exposure to low doses, therapy, analytics in biological material, and samples from the environment. Interactions of persistent organica pollutants with other toxic substnaces. Regulatory affairs. Stockholm's convention. Theoretical concept of cummulative risk assessment, precautions and limitations, critical toxic effect, index substance, toxic equivalent factor. Risk assessment: exposure assessment and risk characterization.			
Recommended literature: 1. Dioxins and Health Including Other Persistent Organic Pollutants and Endocrine disrupters. Edited by Schecter A. John Wiley and Sons Inc., 2012. 2. TOXICOLOGICAL PROFILES. Public Health Service, Agency for Toxic Substances and Disease Registry, USA			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures, practical courses , consultations, discussions			
Grading system: pre-exam activities: 30 points; oral exam: 70 points			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Pharmacokinetics and metabolism during drug development and drug use			
Teachers: Miljković R. Branislava, Vezmar Kovačević D. Sandra, Vučićević M. Katarina			
Course status: Mandatory modules, module: Pharmacokinetics and Clinical Pharmacy			
Semester: I		Year of studies: I	
ECTS points: 10		Course code: ДФК10М1	
Requirements: none			
Course aims: The aim of the course is to provide students with relevant tools needed for understanding the importance of the pharmacokinetics and drug metabolism during drug development, different designs of pharmacokinetic trials depending on the phase of drug development, importance of pharmacokinetic principles in drug therapy and individualization of dosage regimen.			
Course outcomes: On completion of the course, the student will be able to understand and apply drug's pharmacokinetic and metabolism characteristics into the decision-making process related to drug development and individualization of dosing regimen.			
Course contents: Regulatory aspects of the pharmacokinetic studies. Pharmacokinetic study design depending on the phase of drug development. Preclinical in vitro pharmacokinetic and metabolism studies of drug candidate. Preclinical pharmacokinetic studies in experimental animals. In vitro-in vivo correlation of metabolism. Prediction of pharmacokinetic processes, metabolic pathways and parameters values based on physico-chemical characteristics of a drug candidate. Prediction of the pharmacokinetics in humans (allometric approach, physiological models). Clinical pharmacokinetic studies. Assessment of ADME processes of the drug candidate. Izoenzymes CYP450. Induction and inhibition of enzyme systems, extrahepatic drug metabolism. Drug metabolism kinetics. Pharmacological and toxicological significance of drug metabolism. Drug metabolism in vivo. Examination of the drug's potential for pharmacokinetic interactions, and consequently adverse drug effects. Prediction of drug-drug interactions on metabolism level. Calculation of pharmacokinetic parameters using different softwares for pharmacokinetic data analysis. Data interpretation, interpretation of the pharmacokinetic parameters' values. Bioequivalence studies. Correlation between drug's pharmacokinetics and pharmacodynamics. Pharmacokinetic principles in individualization of drug therapy. Application of pharmacokinetic parameters in dosage regimen adjustments.			
Recommended literature: 1. Shargel L, Wu-Pong S, Yu A. Applied Biopharmaceutics & Pharmacokinetics, 6th ed. McGraw-Hill, 2012. 2. Rowland M, Tozer TN. Clinical Pharmacokinetics and Pharmacodynamics: Concepts and Applications, 4th ed. Lippincott Williams & Wilkins, 2011. 3. Krishna R (ed). Applications of Pharmacokinetic Principles in Drug Development, 1st ed. Springer, 2003. 4. Coleman M. Human drug metabolism, 2nd ed. Wiley, 2010. 5. Zhang D, Zhu M, Humphreys WH (eds). Drug Metabolism in Drug Design and Development, 1st ed. Wiley, 2007.			
The total of active learning classes	Lectures: 60		
	Individual research work: 60		
Teaching methods: Theoretical lectures, problem-based learning.			
Grading system: Pre-exam activities - seminar 30 points. Final exam 70 points.			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Selected chapters of clinical pharmacy			
Teachers: Miljković R. Branislava, Vezmar Kovačević D. Sandra, Vučićević M. Katarina			
Course status: Mandatory modules, module: Pharmacokinetics and Clinical Pharmacy			
Semester: I,II		Year of studies: I	
ECTS points: 10		Course code: ДФК10М2	
Requirements: none			
Course aims: The aim of the course is to provide students with relevant tools needed for understanding drug-related problems of patients with various diseases and specific needs as well as drug-related problems of specific patient populations. Student will acquire knowledge about identification and drug-related problem solving in practice as well as monitoring of patient outcomes.			
Course outcomes: On completion of the course, the student will be able to apply the knowledge, identify and solve drug-related problems of patients in practice and monitor patient outcomes.			
Course contents: Types of drug-related problems. Identification of drug-related problems. Interventions for problem solution. Methods of monitoring patient outcomes. Clinical pharmacy in the treatment of diseases of the cardiovascular system, respiratory system, central nervous system, gastrointestinal system, endocrine system and the musculo-skeletal system. Clinical pharmacy in the treatment of infectious diseases and cancers, anemia, and electrolyte abnormalities. Specifics of pharmacotherapy in elderly patients and children. The therapeutic approach to patients with altered renal and/or liver function. Specifics of pharmacotherapy and identification of drug-related problems in pregnant women and nursing mothers. Laboratory parameters to monitor the safety and efficacy of therapy. Analysis of case studies involving the identification of drug-related problems, interventions for problem solving, the assessment of laboratory parameters and outcome monitoring plan for multimorbid patients who receive treatment for diseases of the cardiovascular system, respiratory system, central nervous system, gastrointestinal system, endocrine system, musculo-skeletal system, cancer, infectious diseases, and/or renal and hepatic insufficiency.			
Recommended literature: 1. Dodds L. Drugs in Use. Clinical Case Studies for Pharmacists, Pharmaceutical Press 4th ed, 2009. 2. Walker R, Whittlesea C. Clinical Pharmacy and Therapeutics, Churchill Livingstone 5th ed, 2012. 3. Greene R, Harris N. Pathology and Therapeutics for Pharmacists: a Basis for Clinical Pharmacy Practice, Pharmaceutical Press, 3rd ed, 2008.			
The total of active learning classes	Lectures: 60		
	Individual research work: 60		
Teaching methods: Theoretical lectures, problem-based learning, seminars.			
Grading system: Pre-exam activities - seminar 30 points. Final exam 70 points.			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Planning pharmacokinetic studies			
Teachers: Miljković R. Branislava, Vezmar Kovačević D. Sandra, Vučićević M. Katarina			
Course status: elective, module: Pharmacokinetics and Clinical Pharmacy			
Semester: II		Year of studies: I	
ECTS points: 15		Course code: ДФК1И1	
Requirements: Pharmacokinetics and metabolism during drug development and drug use			
Course aims: The aim of the course is to provide students with relevant tools needed for performing and critical appraisal of pharmacokinetic and bioequivalence studies.			
Course outcomes: On completion of the course, the student will be able to perform and critically appraise (pre)clinical pharmacokinetic and bioequivalence studies.			
Course contents: Regulatory aspects of the pharmacokinetic preclinical and clinical studies. Pharmacokinetic and bioequivalence study design. Preparation of research protocols for conducting pharmacokinetic preclinical and clinical studies according to the regulatory aspects. Preparation of research protocols for bioequivalence studies according to the regulatory aspects. Importance of pharmacokinetics drug profile in the process of planning and conducting pharmacokinetic trials. Implementation of protocols for clinical pharmacokinetic studies. Performing bioavailability and bioequivalence studies. Collection and data analysis during pharmacokinetic (pre)clinical studies. Types of pharmacokinetic data analysis and calculation of the pharmacokinetic parameters. Statistical methods and tests during pharmacokinetic and bioequivalence studies. Interpretation of the (pre)clinical pharmacokinetic studies results. Preparation of a report based on the results of clinical pharmacokinetic studies. Critical appraisal of the results of pharmacokinetic and bioequivalence studies.			
Recommended literature: 1. Chow S-C, Liu J-P. Design and Analysis of Clinical Trials: Concepts and Methodologies, 2nd ed, Wiley-Interscience, 2003. 2. Piantadosi S. Clinical Trials: A Methodologic Perspective 2nd ed, Wiley-Interscience, 2005. 3. Chow S-C, Liu J-P. Design and Analysis of Bioavailability and Bioequivalence Studies, 3rd ed. Chapman and Hall/CRC, 2008. 4. Hauschke D, Steinijans V, Pigeot I. Bioequivalence Studies in Drug Development: Methods and Applications, 1st ed. Wiley, 2007.			
The total of active learning classes	Lectures: 90		
	Individual research work: 90		
Teaching methods: Theoretical lectures, problem-based learning.			
Grading system: Pre-exam activities - seminar 30 points. Final exam 70 points.			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Pharmacokinetic drug variability			
Teachers: Miljković R. Branislava, Vezmar Kovačević D. Sandra, Vučićević M. Katarina			
Course status: elective, module: Pharmacokinetics and Clinical Pharmacy			
Semester: II		Year of studies: I	
ECTS points: 15		Course code: ДФК1И2	
Requirements: Pharmacokinetics and metabolism during drug development and drug use			
Course aims: The aim of the course is to provide students with relevant tools needed for understanding drugs' variability in pharmacokinetic processes, and importance of therapeutic drug monitoring during certain drugs therapy.			
Course outcomes: On completion of the course, the student will be able to access the impact of various factors on the pharmacokinetic drug variability and apply the principles of dosing regimen adjustments of selected drugs based on the data during therapeutic drug monitoring.			
Course contents: Clinically significant sources of pharmacokinetic variability. Physiological factors as a sources of pharmacokinetic variability. Pathological factors as a sources of pharmacokinetic variability. External factors as a sources of pharmacokinetic variability. Requirements for the therapeutic drug monitoring. Preparation of blood sampling protocol as a part of therapeutic drug monitoring process. Therapeutic drug monitoring in specific patients' populations. Initial dosing regimen and its adjustment in obese patients, pregnant women, pediatric and geriatric population of patients, patients with impaired renal, liver function using the principles of clinical pharmacokinetics. Principles of individualization of dosing regimen based on measured drug levels of selected drugs: antibiotics, antiepileptic drugs, immunosuppressive drugs, digoxin, lithium, theophylline. Case studies involving the application of clinical pharmacokinetics principles in of dosing regimen individualization.			
Recommended literature: 1. Bauer L. Applied Clinical Pharmacokinetics, 2nd ed. McGraw-Hill Medical, 2008. 2. Burton ME, Shaw LM, Schentag JJ, Evans WE. Applied Pharmacokinetics and Pharmacodynamics: Principles of Therapeutic Drug Monitoring, 4th ed. Lippincott Williams & Wilkins, 2005. 3. Winter M. Basic Clinical Pharmacokinetics, 5th ed. Lippincott Williams & Wilkins, 2009. 4. Rowland M, Tozer TN. Clinical Pharmacokinetics and Pharmacodynamics: Concepts and Applications, 4th ed. Lippincott Williams & Wilkins, 2011. 5. Murphy JE. Clinical Pharmacokinetics, 5th ed. American Society of Health-System Pharmacists, 2011.			
The total of active learning classes	Lectures: 90		
	Individual research work: 90		
Teaching methods: Theoretical lectures, problem-based learning.			
Grading system: Pre-exam activities - seminar 30 points. Final exam 70 points.			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Drug interactions and adverse outcomes, drug safety and pharmacovigilance			
Teachers: Miljković R. Branislava, Vezmar Kovačević D. Sandra, Vučićević M. Katarina			
Course status: elective, module: Pharmacokinetics and Clinical Pharmacy			
Semester: II		Year of studies: I	
ECTS points: 15		Course code: ДФК1И3	
Requirements: none			
Course aims: The aim of the course is to enable students to acquire knowledge for assessment of clinical importance of drug interactions and adverse drug effects in order to improve treatment safety.			
Course outcomes: On completion of the course, the student will be able to apply the knowledge and assess clinical importance of drug interactions and adverse effects of drugs with the aim of improving treatment safety.			
Course contents: The research of pharmacodynamic and pharmacokinetic drug interactions. Assessment of drug interactions based on the results of laboratory tests. Assessment of clinical importance of drug interactions. Investigation of adverse effects of drugs. Predisposing factors for the occurrence of adverse drug reactions. Methods for monitoring adverse drug reactions. The importance of monitoring adverse drug reactions (pharmacovigilance). Recording and analysis of adverse drug reactions. The role and importance of research in pharmacovigilance. The study of side effects of drugs which are used in the treatment of diseases of the central nervous system, cardiovascular system, respiratory, system gastrointestinal system, endocrine system, malignant and infectious diseases. Safe use of drugs in pregnancy and childhood. Case study analysis - identification and prevention of adverse outcomes of interactions in patients treated for diseases of the cardiovascular system, respiratory system, central nervous system, gastrointestinal system, endocrine system, musculo-skeletal system, cancer, infectious diseases, and/or renal and hepatic insufficiency. Design of clinical studies for investigation of interactions in clinical practice. Critical assessment of published studies of clinically important drug-drug, drug- food and drug- dietary supplement interactions. Critical assessment of published studies on the adverse reactions of drugs.			
Recommended literature: 1. Tatro D. Drug Interaction Facts™: Published by Facts & Comparisons (Drug Interaction Facts), Lippincott Williams & Wilkins; 2012. 2. Baxter K ed. Stockley's Drug Interactions, Pharmaceutical Press, 2012. 3. PDR Guide to Drug Interactions, Side Effects, and Indications, Thomson Healthcare; 62nd ed, 2007.			
The total of active learning classes	Lectures: 90		
	Individual research work: 90		
Teaching methods: Theoretical lectures, problem-based learning, seminars.			
Grading system: Pre-exam activities - seminar 30 points. Final exam 70 points.			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Planning of clinical studies in clinical pharmacy research			
Teachers: Miljković R. Branislava, Vezmar Kovačević D. Sandra, Vučićević M. Katarina			
Course status: elective, module: Pharmacokinetics and Clinical Pharmacy			
Semester: II		Year of studies: I	
ECTS points: 15		Course code: ДФК1И4	
Requirements: none			
Course aims: The aim of the course is to enable students to acquire knowledgde about planning, conducting and critical appraisal of clinical studies in pharmacy and medicine.			
Course outcomes: On completion of the course, the student will be able to apply the knowledge and plan, conduct and critically appraise clinical studies in pharmacy and medicine.			
Course contents: Classification and design of clinical studies. Objectives of health research. Development of methodology to explore specific clinical problems - research setting, the selection of design of clinical studies for conducting research, estimation of the number of subjects and methods of randomization. Setting criteria for inclusion and exclusion of subjects. Research focused on exposure, disease, population. Cohort studies, case - control, cross-sectional studies. Randomized controlled clinical trials. Meta - analysis. The reliability and applicability of the results of clinical studies. Methods of randomization and allocation. Determining the number of participants. Recruitment of participants. Ethics in performing clinical studies. Qualitative Research. The use of questionnaires in health care research, advantages and disadvantages. Health services research, clinical audit, quality assurance services. Pharmacoeconomic analysis. Planning a cost-minimization analysis, cost-benefit analysis, analysis of the cost- utility analysis and cost benefit ratio. The use of techniques for decion making relying on cost/benefit in pharmacoeconomic analyzes. The use of discounting in pharmacoeconomic analyzes. Analysis of results, expected outcomes .			
Recommended literature: 1. Brody T. Clinical Trials: Study Design, Endpoints and Biomarkers, Drug Safety, and FDA and ICH Guidelines. Academic Press; 1st ed. 2011. 2. Chow S-C, Liu JP. Design and Analysis of Clinical Trials: Concepts and Methodologies, Wiley-Interscience; 2 Sub edition, 2003. 3. Bowling A. Research Methods in Health: Investigating Health and Health Services. Open University Press; 3rd ed, 2009. 4. Arnold RJ. Pharmacoeconomics: From Theory to Practice. CRC Press; 1st ed, 2009.			
The total of active learning classes	Lectures: 90		
	Individual research work: 90		
Teaching methods: Theoretical lectures, problem-based learning, seminars.			
Grading system: Pre-exam activities - seminar 30 points. Final exam 70 points.			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Selected chapters of pharmacology			
Teachers: Savić M. Miroslav, Stepanović-Petrović M. Radica			
Course status: elective, module: Pharmacokinetics and Clinical Pharmacy			
Semester: II		Year of studies: I	
ECTS points: 15		Course code: ДФК1И5	
Requirements: none			
Course aims: The aim of this course is to provide participants with knowledge necessary for understanding the basic characteristics of pharmacological profiles of prototype drugs in selected pharmacotherapeutic groups, based on in vitro and in vivo data obtained from preclinical as well as clinical studies.			
Course outcomes: Ability to independently interpret the results of basic preclinical studies of drugs. Ability for critical appraisal of the completeness of the available pharmacological profile of a drug. Appraisal of preclinical research data in the context of the findings of research in humans. Comprehension of benefits and risks of drugs in the selected pharmacotherapeutic group.			
Course contents: Target sites for drug action. Integration of nervous, endocrine and immunological regulation of a multicellular organism. Mechanisms of action of neurotransmitters, hormones and local mediators. Interaction drug-mechanisms of biological regulation. Mechanisms of signal transduction. Receptors, ion channels, enzymes, transporters. In vitro investigation of drug affinity and efficacy. Efficacy and potency. Agonists, inverse agonists, antagonists. Dose-response relationship, quantal and graded. Tolerance and resistance to drug action. Principles of drug investigation on animals. Primary pharmacodynamic investigations. Secondary pharmacodynamic investigations. Safety pharmacology. Toxicological profile of drugs. Acute toxicity. Toxicity of repeated administration. Mutagenicity. Teratogenicity. Carcinogenicity. Interpretation of the results obtained from toxicological studies and data extrapolation on humans. Estimation of efficacy and safety of drugs. Clinical and pharmacoepidemiological studies. Pharmacological profile of the drug. Mechanisms of action, pharmacological effects, therapeutic use and adverse effects of the therapeutic group of research interest for the candidate.			
Recommended literature: 1.Rang HP, Dale MM, Ritter JM, Flower RJ, Henderson G. Rang and Dale’s Pharmacology. 7th edition, Churchill Livingstone Elsevier, 2011. 2. Brunton LL, Chabner BA, Knollmann BC (eds). Goodman&Gliman’s the Pharmacological Basis of Therapeutics, 12th editon. McGraw Hill, 2011. 3. Kenakin T. A Pharmacology Primer: Theory, Applications and Methods, 2nd edition. Academic Press, London, 2006 4. Katzung BG (ed). Basic&Clinical Pharmacology, 12th ed, Lange Medical Books/McGraw-Hill Medical Publishing Division, New York, 2012. 5. Hacker M, Bachmann K, Messer W. Pharmacology Principles and Practice. Academic Press, Amsterdam, 2009.			
The total of active learning classes	Lectures: 90		
	Individual research work: 90		
Teaching methods: Lectures, workshops and seminars			
Grading system: Seminar: 30 points; written exam: 70 points			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Methodology in pharmacokinetic studies and methodological aspects during modelling process			
Teachers: Miljković R. Branislava, Vezmar Kovačević D. Sandra, Vučićević M. Katarina			
Course status: elective, module: Pharmacokinetics and Clinical Pharmacy			
Semester: III		Year of studies: II	
ECTS points: 15		Course code: ДФК2И1	
Requirements: Pharmacokinetics and metabolism during drug development and drug use			
Course aims: The aim of the course is to provide students with relevant tools needed for understanding the methodological issues in pharmacokinetic data analysis.			
Course outcomes: On completion of the course, the student will be able to assess and apply optimal approach pharmacokinetic parameters calculation, and to use pharmacokinetic softwares for data modelling and simulation.			
Course contents: Different approaches in calculating pharmacokinetic parameters that characterize ADME processes of I and 0 order. Noncompartmental pharmacokinetic data analysis. Compartmental pharmacokinetic data analysis. Solving practical assignments and calculation of pharmacokinetic parameters by application of compartmental data analysis using the pharmacokinetic softwares. Solving practical assignments and calculation of pharmacokinetic parameters by application of noncompartmental data analysis using the pharmacokinetic softwares. Interpretation of pharmacokinetic parameters values of biological drugs. Linear, generalized linear and nonlinear models of combined effects. Bayesian modelling of pharmacokinetic data. Methods for parameters estimation in population pharmacokinetic analysis. Physiologically based (perfusion) models for each of ADME process. Pharmacokinetic-pharmacodynamic (PK/PD) modelling. Principles of data simulation. Using different pharmacokinetic softwares for pharmacokinetic parameters' calculation, and sources in pharmacokinetic drug variability. Application of developed pharmacokinetic models in predicting drug's concentration profile following specific dosing regimen. Application of developed pharmacokinetic models in predicting drug's concentration profile and efficacy/safety profile following specific drug's dosing regimen.			
Recommended literature: 1. Rosenbaum S. Basic Pharmacokinetics and Pharmacodynamics: An Integrated Textbook and Computer Simulations, 1st ed. Wiley, 2011. 2. Bonate PL. Pharmacokinetic-Pharmacodynamic Modeling and Simulation, 2nd ed. Springer, 2011. 3. Ette EI, Williams PJ. Pharmacometrics: The Science of Quantitative Pharmacology, 1st ed. Wiley-Interscience, 2007. 4. Gabrielsson J, Weiner D. Pharmacokinetic and Pharmacodynamic Data Analysis: Concepts and Applications, 4th ed. Swedish Pharmaceutical Press, 2007. 5. Peters SA. Physiologically-Based Pharmacokinetic (PBPK) Modeling and Simulations: Principles, Methods, and Applications in the Pharmaceutical Industry, 1st ed. Wiley, 2012.			
The total of active learning classes	Lectures: 90		
	Individual research work: 90		
Teaching methods: Theoretical lectures, problem-based learning.			
Grading system: Pre-exam activities - seminar 30 points. Final exam 70 points.			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Methodology in clinical pharmacy research			
Teachers: Miljković R. Branislava, Vezmar Kovačević D. Sandra, Vučićević M. Katarina			
Course status: elective, module: Pharmacokinetics and Clinical Pharmacy			
Semester: III		Year of studies: II	
ECTS points: 15		Course code: ДФК2И2	
Requirements: Selected chapters of clinical pharmacy			
Course aims: The aim of the course is to enable students to acquire knowledgde about different methodological approaches of clinical pharmacy research.			
Course outcomes: On completion of the course, the student will be able to apply the knowledge and select appropriate methodology for planning and conducting clinical pharmacy research. Moreover, students will be able to perform critical appraisal of the research methodology in clinical pharmacy.			
Course contents: Methodology of research on effectiveness, safety and pharmacoeconomics of treatment. Questionnaires as research methods for the assessment of adherence, quality of life, efficacy and safety of treatment. Semi-structured interview. Creating a questionnaire, contents, types of questions, anonymity, type of response, wording of questions, the order of questions. Assessing the validity, reliability and sensitivity of questionnaire for use in clinical pharmacy research. Tests of significance and correlation. Cronbach α and internal consistency. Factor analysis. The development of questionnaires for the evaluation of adherence, quality of life, safety, and efficacy of treatment for patients suffering from diseases of the cardiovascular system, respiratory system, central nervous system, gastrointestinal system, endocrine system, musculo-skeletal system, cancer, infectious diseases, and/or renal and hepatic insufficiency. The use of questionnaires in clinical practice. Critical assessment of validated questionnaires used in clinical pharmacy research. Development and validation of methods for assesment of drug concentrations, biological markers, and/or laboratory parameters in biological material. Development and validation of pharmacoeconomic studies. One-way and two-way sensitivity analysis. Decision tree and Markov models. Significance and correlation testing of obtained data. Development of methodology for conducting pharmacoeconomic analysis. Critical evaluation of pharmacoeconomic studies in the literature.			
Recommended literature: 1. Fayers P, Machin D. Quality of Life: The Assessment, Analysis and Interpretation of Patient-reported Outcomes. Wiley; 2nd ed, 2007. 2. Jacobsen K. Introduction to Health Research Methods. Jones & Bartlett Learning; 1st ed, 2011. 3. Swartz ME, Krull IS. Handbook of Analytical Validation. CRC Press; 1st ed, 2012. 4. Drummond MF, Sculpher MJ, Torrance GW, O'Brien BJ. Methods for the Economic Evaluation of Health Care Programmes, Oxford University Press; 3rd ed, 2005.			
The total of active learning classes	Lectures: 90		
	Individual research work: 90		
Teaching methods: Theoretical lectures, problem-based learning, seminars.			
Grading system: Pre-exam activities - seminar 30 points. Final exam 70 points.			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Pharmacokinetics of biological drugs			
Teachers: Miljković R. Branislava, Vezmar Kovačević D. Sandra, Vučićević M. Katarina			
Course status: elective, module: Pharmacokinetics and Clinical Pharmacy			
Semester: III		Year of studies: II	
ECTS points: 15		Course code: ДФК2И3	
Requirements: Pharmacokinetics and metabolism during drug development and drug use			
Course aims: The aim of the course is to provide students with relevant tools needed for understanding characteristics and factors that contribute to pharmacokinetics of biological drugs.			
Course outcomes: On completion of the course, the student will be able to understand pharmacokinetic characteristics in development of biological drug, and to individualize dosing regimen based on pharmacokinetic and/or pharmacokinetic-pharmacodynamic studies results.			
Course contents: The importance and place of pharmacokinetics in development of biological drugs. Regulatory aspects in pharmacokinetic studies of biological drugs. Association between pharmacokinetics and technology and pharmacodynamics of biological drugs. Bioanalytical methods used in the pharmacokinetic studies for measuring biological drugs levels in biological samples and their validation according to regulatory requirements. Pharmacokinetic characteristics of proteins, and peptides. Pharmacokinetic characteristics of monoclonal antibodies. Pharmacokinetic characteristics of oligonucleotides. Pharmacokinetic characteristics of viral and non-viral gene delivery vectors. Pharmacokinetic data analysis and interpretation of the pharmacokinetic parameters' values of biological drugs. Solving practical assignments and calculation of pharmacokinetic parameters using pharmacokinetic softwares. Interpretation of pharmacokinetic parameters values of biological drugs. Dosing regimen adjustments based on data on measured biological drugs' concentrations. Biosimilar drugs. Design of pharmacokinetic studies for biological drugs and its variability pharmacokinetic processes. Modelling process and interpretation of final pharmacokinetic-pharmacodynamic models of the selected biologic drugs using pharmacokinetic softwares. Modelling process and interpretation of final physiologically based (perfusion) models of the selected biologic drugs using pharmacokinetic softwares.			
Recommended literature: 1. Meibohm B. Pharmacokinetics and Pharmacodynamics of Biotech Drugs, 1st ed. Wiley-Blackwell, 2006. 2. Kontermann R. Therapeutic Proteins: Strategies to Modulate Their Plasma Half-lives, 1st ed. Wiley-Blackwell, 2012.			
The total of active learning classes	Lectures: 90		
	Individual research work: 90		
Teaching methods: Theoretical lectures, problem-based learning.			
Grading system: Pre-exam activities - seminar 30 points. Final exam 70 points.			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Monitoring of adherence, efficacy and safety			
Teachers: Miljković R. Branislava, Vezmar Kovačević D. Sandra, Vučićević M. Katarina			
Course status: elective, module: Pharmacokinetics and Clinical Pharmacy			
Semester: III		Year of studies: II	
ECTS points: 15		Course code: ДФК2И4	
Requirements: Selected chapters of clinical pharmacy			
Course aims: The aim of the course is to enable students to acquire knowledgde for monitoring and critical assesment of adherence, efficacy and safety of drugs.			
Course outcomes: On completion of the course, the student will be able to apply the knowledge and monitor and critically assess adherence, efficacy and safety of treatment.			
Course contents: Treatment outcomes. The causes of the unsatisfactory adherence and/or lack of efficacy and safety of therapy. Treatment errors and methods for prevention. Methods for monitoring of compliance, adherence, concordance. The importance of valid and reliable monitoring of patient outcomes. Assessing the validity, reliability and sensitivity of measuring instruments for monitoring adherence, efficacy and safety. Methods for improving the quality of life of the patient. The role of research in improving the outcome of treatment. The development of methods for monitoring of adherence, efficacy and safety of patients with diseases of the cardiovascular system, respiratory system, central nervous system, gastrointestinal system, endocrine system, musculo-skeletal system, cancer, infectious diseases, and/or renal and hepatic insufficiency. Strategies for improving the degree of adherence, efficacy and safety of treatment. Particularities of adherence monitoring, effectiveness and safety of the treatment of diseases of the central nervous system, cardiovascular system, respiratory system, musculo-skeletal system, and the gastrointestinal system. Critical evaluation of published research in the field of monitoring of adherence, efficacy and safety of treatment. Critical assessment of quality of life studies. Critical assessment of the validity, reliability and sensitivity of instruments for monitoring adherence, efficacy and safety.			
Recommended literature: 1. Fayers P, Machin D. Quality of Life: The Assessment, Analysis and Interpretation of Patient-reported Outcomes. Wiley; 2nd ed, 2007. 2. Walker R, Whittlesea C. Clinical Pharmacy and Therapeutics, Churchill Livingstone 5th ed, 2012. 3. Kane RL, Radosevich DM. Conducting Health Outcomes Research. Jones & Bartlett Learning; 1st ed, 2010.			
The total of active learning classes	Lectures: 90		
	Individual research work: 90		
Teaching methods: Theoretical lectures, problem-based learning, seminars.			
Grading system: Pre-exam activities - seminar 30 points. Final exam 70 points.			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Advanced Course of Pharmacognosy 1			
Teachers: Nada N. Kovačević, Silvana D. Petrović, Zoran A. Maksimović, Tatjana D. Kundaković, Milica M. Drobac			
Course status: Mandatory modules, module: Pharmacognosy			
Semester: I		Year of studies: I	
ECTS points: 10		Course code: ДФГ10М1	
Requirements: no			
Course aims: The aim of this course is to introduce student to the structure, characteristics , basic principles of isolation , purification and chemical analysis of certain metabolites of plants and their pharmacological activity .			
Course outcomes: After completing the course, student is able to made chemical investigation of unknown plant materials and to made critical decision if new herbal drug/substances can be defined for the therapeutic purpose.			
Course contents: Theoretical lecture The methodology and approach to scientific research in the field of pharmacognosy. The new pharmacologically active compounds from different classes of plant secondary metabolites (alkaloids, flavonoids, coumarins, lignans, quinones, cyanogen glycosides, glucosinolates, saponins, tannins, terpenoids, polyacetylene, essential oils, etc..). Investigation of less known wild growing plant as a potential source of new herbal drugs (use plant biodiversity for herbal drug/substance/drug leads discovery). Chemotaxonomic significance of certain secondary metabolites of plants. The importance of the study of biosynthetic processes and knowledge of the specifics of their potential application in order to improve the production of specific metabolites (getting herbal products defined by quality). Methods for isolation and purification of the compounds from the plant material. Bioassay-guided isolation of plant constituent with defined pharmacological activities. The pharmacological activity of secondary metabolites of plants, and their chemical structure connectivity and pharmacological activities. Basic principles of testing feasibility of application of traditional herbal drugs and herbal drug preparations and defining new natural medicinal resources. Qualitative and quantitative analyses of herbal drugs. Research work Overview of the scientific literature and laboratory work in order to solve specific tasks and problems.			
Recommended literature: 1. Evans WC. Trease and Evans Pharmacognosy. 16th ed. Edinburgh, London, New York, Philadelphia, St Louis, Sydney, Toronto: Elsevier; 2009. 2. Heinrich M, Barnes J, Gibbons S, Williamson E. Fundamental of Pharmacognosy and Phytotherapy. Edinburgh: Churchill Livingstone; 2004. 3. Liang XT, Fang WS. Medicinal Chemistry of Bioactive Natural Products, Hoboken NJ: Wiley – Interscience; 2006. 4. Teuscher E, Melzig MF, Lindequist U. Biogene Arzneimittel. Stuttgart: Wissenschaftliche Verlagsgesellschaft mbH; 2004. 5. Hänsel R, Sticher O. Pharmakognosie - Phytopharmazie. Heidelberg: Springer Medizin Verlag; 2007. 6. Ph. Eur. 7. Strasbourg: The Council of Europe; 2011. 7. Gupta MP, Handa SS, Vasisht S. (eds). Biological Screening of Plant Constituents (Training Manual). Trieste: ICS UNIDO; 2007			
The total of active learning classes	Lectures: 60		
	Individual research work: 60		
Teaching methods: Lectures, individual work with students, study research, terrain research, case study, seminars, presentation.			
Grading system: Pre-examination activities: 40 points Exame (paper work/oral presentation): 60 points			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Determination of Structure of Plant Secondary Metabolites			
Teachers: Vele V. Tešević			
Course status: Mandatory modules, module: Pharmacognosy			
Semester: I		Year of studies: I	
ECTS points: 5		Course code: ДФГ10М2	
Requirements: no			
Course aims: The aim of this course is determination of total chemical structure of plant secondary metabolites.			
Course outcomes: After completing the course, student is able to apply modern instrumental techniques of identification (UV / Vis, NMR, IR and MS) in the analysis of plant secondary metabolites.			
Course contents: Application of the method of spectral analysis: UV / Visible spectroscopy (UV / Vis); infrared spectroscopy (IR), mass spectrometry (MS). Details on nuclear magnetic resonance spectroscopy (NMR). Basic principles of resonance, NMR detection signal (continuous irradiation and FT NMR) chemical shift (δ), coupling constants (J), integral, multiplicity of signals (spectra of first and higher order), the relationship between structure and spectral ^1H and ^{13}C NMR data. Basics multidimensional NMR techniques and tandem mass spectrometry . Analysis and interpretation of spectra. Consolidate data and define the chemical structure. Analysis of the spectra of the isolated metabolites. Combining the obtained data in order to determine the structure. Identify and use tabular spectral data.			
Recommended literature: 1. Милосављевић МС. Структурне инструменталне методе. Београд: Хемијски факултет; 1997. 2. Гођевац Д, Тешевић В. Структурне инструменталне методе - збирка спектра. Београд: Хемијски факултет; 2005. 3. Smith RM. Understanding Mass Spectra. Hoboken, New Jersey: John Wiley & Sons, Inc.; 2005. 4. Pretsch E, Clerck T, Seibl J, Simon W. Tablice za određivanje strukture organskih spojeva. Meić Z, Žinić M. Zagreb: SKTH/Kemija u industriji; 1982.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lecture, interactive work, seminars, consultative teaching, research work			
Grading system: pre-exam: 30 ; exam (written) 35, exam (oral) 35			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Advanced Course of Pharmacognosy 2			
Teachers: Nada N. Kovačević, Silvana D. Petrović, Zoran A. Maksimović, Tatjana D. Kundaković, Milica M. Drobac			
Course status: Mandatory modules, module: Pharmacognosy			
Semester: II		Year of studies: I	
ECTS points: 5		Course code: ДФГ10М3	
Requirements: Advanced Course of Pharmacognosy 1			
Course aims: The aim of this course is the introduction to modern ways and methods of production, defining quality parameters and methods of quality control of plant raw material / herbal drugs / herbal drugs preparations for the pharmaceutical and related industries.			
Course outcomes: After completing the course, the student is able to participate in the improvement of plant materials, propose method of quality control of herbal drugs / herbal drug preparations, as well as use the research results to define quality parameters of new herbal drug / herbal drug preparations.			
Course contents: Theoretical study Modern production and primary processing of plant raw materials used for the production of herbal drugs and herbal drug preparations and the isolation of the compounds for the pharmaceutical and related industries. Team work in the production of the high quality and large quantity of raw material under controlled agricultural conditions. Consideration of the possibility of using wild plants and natural habitats for the collection of plant materials through the application of best practice collection of plants. Pointing out the various influences on the quality of plant materials and associated with the notion of geographical origin as a measure of uniqueness and quality. Basic principles of agronomic production of medicinal plants and the most common ways in which it can contribute to improving the quality of manufactured herbal products. The most important aspects of good practice of the crop production relating to the medicinal plants. Examples of organic production. Presentation of the possibilities of application of the in vitro culture of plant biomass, or a compound or complex of a specific biotransformation to produce specific compounds. Quality control of herbal drugs / herbal drugs preparations / herbal products. Ways of defining quality parameters of new plant materials (herbal drug / herbal drugs preparation), based on the results obtained during the research process. Introduction to the basic legislation in this area. Research work Overview of the scientific literature and laboratory work in order to solve specific tasks and problems.			
Recommended literature: 1. Evans WC. Trease and Evans Pharmacognosy. 16th ed. Edinburgh, London, New York, Philadelphia, St Louis, Sydney, Toronto: Elsevier; 2009. 2. Heinrich M, Barnes J, Gibbons S, Williamson E. Fundamental of Pharmacognosy and Phytotherapy. Edinburgh: Churchill Livingstone; 2004. 3. Liang XT, Fang WS. Medicinal Chemistry of Bioactive Natural Products, Hoboken NJ: Wiley – Interscience; 2006. 4. Teuscher E, Melzig MF, Lindequist U. Biogene Arzneimittel. Stuttgart: Wissenschaftliche Verlagsgesellschaft mbH; 2004. 5. Hänsel R, Sticher O. Pharmakognosie - Phytopharmazie. Heidelberg: Springer Medizin Verlag; 2007. 6. Ph. Eur. 7. Strasbourg: The Council of Europe; 2011. 7. Gupta MP, Handa SS, Vasisht S. (eds). Biological Screening of Plant Constituents (Training Manual). Trieste: ICS UNIDO; 2007			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures, individual work with students, study research, terrain research, case study, seminars, presentation.			
Grading system:			

Pre-examination activities: 40 points


Exame (paper work/oral presentation): 60 points


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Screening of Pharmacological Activity of Plant Isolates			
Teachers: Silva Lj. Dobrić			
Course status: Mandatory modules, module: Pharmacognosy			
Semester: II		Year of studies: I	
ECTS points: 5		Course code: ДФГ10М4	
Requirements: no			
Course aims: The aim of this course is to introduction student with basic principles of pharmacology and experimental screening methods in pharmacology with special emphasis on the pharmacological and toxicological studies of herbal drugs, herbal drug preparations and herbal remedies including processing and interpretation of the results and reports of pharmaco/toxicological and clinical trials.			
Course outcomes: After completing the course, student is able to acquisit basic knowledge in experimental and clinical pharmacology, as well as capacity to independently conduct pharmacological and toxicological studies of herbal drugs, herbal drug preparations and herbal remedies including processing and interpretation of the results and reports of pharmaco - toxicological and clinical trials.			
Course contents: General information on the organization of work in the pharmacological-toxicological laboratory and work with laboratory animals and biological systems. Good laboratory practice. Introduction to the methods of " screening pharmacological activity " that are applied in herbal drugs testing. "lin silico", " in vitro " and " in vivo " methods. The antimicrobial activity. Antioxidant activity . Antiinflammatory activity . Antiulcer activity. Hepatoprotective activity. Immunomodulatory activity. Antinociceptive activity. Behavioral models. Toxicological tests (acute, subacute, chronic, reproductive toxicity, genotoxicity, mutagenesis, carcinogenesis). Results processing and presentation methods. A critical review and adequate decision making on literature data. Emphasis the specificity of herbal medicines and problems arising in their pharmacological-toxicological and clinical trials . Planning and conducting experiments from selected pharmacological and toxicological models. Data processing and results presentation. A critical analysis of selected scientific aricles on pharmacological-toxicological screening of herbal drugs.			
Recommended literature: 1. Williamson EM , Okpako DT , Evans FJ . Selection, Preparation and Pharmacological Evaluation of Plant Material. Chichester, New York , Brisbane, Toronto, Singapore : John Wiley & Sons; 1996. 2. Schulz V, Hänsel R , Tyler VE . Rational Phytotherapy . 4th ed . Berlin, Heidelberg, New York : Springer Verlag; 2001. 3. Barrett M. The Handbook of Clinically Tested Herbal Remedies , vol . 1-2 . New York, London , Oxford : The Haworth Herbal Press; 2004. 4. Gad SC, editor.. Animals Models in Toxicology. 2nd ed . Boca Raton, New York: Taylor & Francis Group; 2007. 5. Lee C-J, Lee LH, Wu CL , Lee BR, Chen M-L . Clinical Trials of Drugs and Biopharmaceuticals. Boca Raton, London: Taylor & Francis Group, 2006.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures, individual work with students, research, planning and conducting preclinical and clinical trials of herbal drugs, herbal drug preparations, and herbal remedies .			
Grading system: Pre-examination obligations: up to 30 points; the final exam: up to 70 points.			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Selected Chapters of Botany			
Teachers: Jančić B. Radiša, Lakušić S. Branislava			
Course status: elective, module: Pharmacognosy			
Semester: II		Year of studies: I	
ECTS points: 5		Course code: ДФГ1И1	
Requirements: no			
Course aims: Evolutionary morphology of plants. Primary and secondary metabolism - basic trends. Localization of primary and secondary metabolites in vegetative and reproductive organs and their biological roles. Secretion and secretory structures. Principles of taxonomy. Botanical nomenclature, the nomenclature type. Classification systems, structures and their significance information. Getting to know the most efficient systems for diagnostic taxon.			
Course outcomes: Knowledge of the morphological structure, their properties, functions, and adaptive significance. Understanding the role of primary and secondary metabolites, their adaptive significance and value in use. Finding your way in the nomenclature section of descriptions of taxon. The ability to use information stored in systems of classification, diagnosis belonging to a particular plant taxon using keys, iconography, herbarium.			
Course contents: Morphology of plants: vegetative and reproductive organs and their functions, the adaptive significance - features formed as a result of evolution by natural selection. Morphological features as taxonomic characters and their distribution among vascular plants. Homology and analogy in morphology, DeKandol rule, diagnostic characters. Primary and secondary metabolites - biological role and value in use. Location of secondary metabolites in tissues and organs, and connection with their use in metabolism (either directly or from reserves created). Taxonomic significance of primary and secondary metabolites. Secretory structures, the distribution in the vascular plants, the biological role of adaptive significance (attractants, repellents, bacterial and fungicidal effect), possible use as taxonomic markers. Taxonomy (nomenclature, description, diagnosis). Taxonomic characters (type, value in use and manner of use). Definition of taxon. Classification systems (natural, phylogenetic, special), the specifics of their use and importance. The most modern classification systems. Scientific names of taxon (rule nomenclature type, holotype, syntype, lectotype, homonyms, synonyms). Use of the means of diagnostic (keys, iconography, herbarium, and related software).			
Recommended literature: 1. Evert R. Esaus Plant Anatomy. 3rd ed. New Jersey: John Wiley & Sons, Inc., 2006. 2. Јанчић Р, Стојановић Д. Економска ботаника. Београд: Завод за издавање уџбеника, 2008. 3. Metcalfe CR, Chalk L. Anatomy of the Dicotyledons Vol I&II. London: Oxford, Clarendon Press, 1988. 4. Марин, П. Биохемијска и молекуларна систематика биљака. Београд: ННК Интернационал, 2003. 5. Jones SB, Luchsinger AE. Plant systematics. USA: McGraw-Hill, 1979. 6. Davis PH, Heywood VH. Principles of Angisperm taxonomy. Edinburgh and London: Oliver & Boyd, 1963. 7. Међународни ботанички кодекс. Загреб: SNL, 1987. 8. Јанчић, Р. Речник ботаничких морфолошких појмова, Београд: САНУ, 2010. 9. Applequist W. The indetification of medicinal plants. Missouri, St. Louis: Missouri Botanical Garden Press, 2006. 10. Јосифовић М, ед. Флора СРС, 1 – 10 том. Београд: САНУ, 1970.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures, individual work with students, study research, terrain research, seminars, presentation.			
Grading system: Pre-examination activities: 60 points Exame (paper work/oral presentation): 40 points			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Structure and Properties of Secondary Metabolites			
Teachers: Vladimir M. Savić			
Course status: elective, module: Pharmacognosy			
Semester: I		Year of studies: I	
ECTS points: 5		Course code: ДФГ1И2	
Requirements: no			
Course aims: The aim of this course it to describe chemical transformations and metabolic pathways leading to secondary metabolites.			
Course outcomes: After completing the course, student is able to understand chemical transformations involved in the formation of secondary metabolites and metabolic pathways leading to various classes of compounds			
Course contents: Structures and properties of building blocks and mechanisms in the formations of secondary metabolites; alkylation (nucleophilic substitutions, electrophilic additions), Wagner-Meerwein rearrangement (stability and transformation of carbocations), aldol reactions, reactions of aldehydes/ketones and amines, Mannich reactions, transaminations, decarboxylation, redox processes. Acetate pathway: synthesis of polyketides from acetates, cyclisation of polyketides leading to arenes; alkylation, phenol coupling, oxidative degradation of an aromatic ring, Diels Alder reactions in formation of polycyclic natural products. Shikimate pathway: aromatic amino acids, cinnamic acid, lignans, coumarines, flavolignans, isoflavonoids. Mevalonic and deoxyxylulose phosphate pathway: steroids as modified triterpenoids, stereochemical properties of steroids Formation of alkaloids from amino acids pyrrolidines and tropane alkaloids from ornithine; piperidine, quinolizidine and indolizine alkaloids from lysine; phenylethylamines, tetrahydroisoquinoline and other related alkaloids from tyrosine; indole, carboline, quinolone derived alkaloids from tryptophan; Synthesis of selected natural products			
Recommended literature: Dewick PM. Medicinal Natural Products. Chichester: John Wiley and Sons; 2002. original scientific articles			
The total of active learning classes		Lectures: 30	
		Individual research work: 30	
Teaching methods: Seminars, consultative teaching			
Grading system: pre-exam: 30 ; exam 35, seminar 35			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Selected Chapters of Instrumental Methods			
Teachers: Vesna S. Kuntić, Slavica M. Blagojević			
Course status: elective, module: Pharmacognosy			
Semester: II		Year of studies: I	
ECTS points: 5		Course code: ДФГ1ИЗ	
Requirements: no			
Course aims: The aim of this course is to introduce student with theoretical principles of selected chromatographic, optical and electrochemical instrumental methods which are widely applied for the analysis of the medical plants and plant materials.			
Course outcomes: After completing the course, students are expected to comprehend the fundamental physical-chemical principles of several instrumental methods (chromatographic, optical and electrochemical) and be capable of choosing a particular analytical method (technique) to complete a required task for medical plant analysis and quality control of plant preparations.			
Course contents: Chromatography. General principles, branches of chromatography, types of column, detectors. Chromatograms. Modes of chromatography: Ion exchange, "flash" chromatography, gel filtration, thin layer (TLC), gas chromatography (GC) and liquid chromatography (HPLC) for analysis of plant extracts and essential oils. Spectroscopic methods. The electromagnetic spectrum, interactions of electromagnetic radiation with matter. Molecular absorption spectrometry (UV-VIS and IR) in plant analysis. Atomic absorption spectrophotometry (techniques with and without flame); determination of traces of metal in crude samples. Emission spectrometry: fluorometry (fluorescence, phosphorescence). Fundamentals of mass spectroscopy. Ionisation modes: electron impact, chemical ionisation, fast atom bombardment, plasma desorption ionisation, electrospray ionisation, ion spray ionisation, matrix-assisted laser desorption ionisation. Mass analyser: magnetic sector field, quadrupole, ion trap, time-of-flight. Ion detectors. Coupled systems: GC-MS, HPLC-MS for medical plant analysis. Electrochemical methods: potentiometric titration, indicator electrode in potentiometric titration, titration curves. Application of potentiometric titration in quantitative analysis of phytochemicals.			
Recommended literature: 1. Skoog, D., Holler, F., Nieman, T.: Principles of Instrumental Analysis. Saunders College Publishing, Philadelphia 1998. 2. Kaplan, L., Pesce, A.: Clinical chemistry: Theory, Analysis, Correlation. Mosby,1996. 3. Hoffman E, Stroobant B.: Mass spectrometry, Principles and Application. New York: J.Wiley 2002.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Individual lectures, literature survey, research.			
Grading system: Pre-examination activities (seminar): 50 points Exame (oral): 50 points			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Principles of use of animals for scientific purposes			
Teachers: Todorović M. Zoran, Savić M. Miroslav			
Course status: elective, module: Pharmacognosy			
Semester: II		Year of studies: I	
ECTS points: 5		Course code: ДФГ1И4	
Requirements: none			
Course aims: The aim of this course is to provide participants with knowledge about principles of breeding, handling and use of animals used for scientific purposes, including legislation in Serbia, European Union and world, as well as of anaesthesia and surgery of laboratory animals (wok in vivo).			
Course outcomes: By the end of this course participants will have gained an understanding of legislation and principles of breeding, handling and work with animals used for scientific purposes.			
Course contents: Legislation and ethical questions related to work with animals used for scientific purposes. Priniciples of laboratory experiment. Principles of Good laboratory practice. Breeding and caring for animals used for scientific purposes. Animal welfare. Monitoring the health status and the most common diseases of animals used for scientific purposes. Use of animals in laboratory (routes of treatment application, introduction to anaesthesia and analgesia). Surgical procedures on animals used for scientific purposes. Practical laboratory work.			
Recommended literature: 1. Wolfensohn S, Lloyd M. Handbook of laboratory animal management and welfare. John Wiley & Sons, 2013. 2. Wilking MR (ed). Experimental Therapeutics, Martin Dunitz, Ltd., London, 2003.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures and study-research work			
Grading system: Seminar: 50 points; written exam: 50 points			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Application of GC and HPLC for the Analyses of Plants Isolates			
Teachers: Vele V. Tešević			
Course status: elective, module: Pharmacognosy			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: ДФГ2И1	
Requirements: no			
Course aims: The aim of this course is to introduce student with application of chromatographic instrumental techniques - gas and liquid chromatography for the analysis of plant isolates.			
Course outcomes: After completing the course, student is able to analyze essential oils, vegetable waxes, phenolic compounds, sesquiterpenes, triterpenes, alkaloids and other metabolites of plants.			
Course contents: Introduction to the basic principles of chromatography. Basics of chromatographic methods with special emphasis on instrumental techniques: gas and liquid chromatography. Gas chromatographic columns, detectors and injectors. Choice of operating conditions: temperature, flow. The liquid chromatography column. Methods of Separation: reversed phase, normal, ion exchange and affinity chromatography. Choice of operating conditions: mobile phase composition, flow rate. Detectors in liquid chromatography. Combination method: gas chromatography / mass spectrometry, liquid chromatography / mass spectrometry. Tandem mass spectrometry. Isolation of essential oil distillation and simultaneous distillation and extraction. Isolation and extraction epicuticular waxes . Analysis of isolates by using a combination of gas chromatography and gas chromatography / mass spectrometry. Comparison of mass spectra with the library of spectra and the use of retention data for the identification of compounds in a mixture. Extraction of the surface of flavones from plant material and the resulting analysis of the extract by liquid chromatography with UV detection, and sets performance liquid chromatography / mass spectrometry.			
Recommended literature: 1. Linskens HF, Jackson JF. Modern Methods of Plant Analysis. Gas Chromatography/Mass Spectrometry. Berlin, Heidelberg, New York, Tokyo: Springer-Verlag; 1986. 2. Sandra P, Bicchi C. Capillary Gas Chromatography in Essential Oil Analysis. Heidelberg, Basel, New York: Dr. Alfred Heuthig Verlag; 1987. 3. Adams RP. Identification of Essential Oil Components by Gas Chromatography/Quadrupole Mass Spectroscopy. Illionis, USA: Allured Publishing Corporation; 2001. 4. Waksmundzka-Hajnos M, Sherma J (eds.). High Performance Liquid Chromatography in Phytochemical Analysis. Boca Raton, London, New York: Taylor & Francis Group, CRC Press; 2001.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lecture, interactive work, seminars, consultative teaching, research work			
Grading system: pre-exam: 30 ; exam (written) 35, exam (oral) 35			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Ecology of Plants			
Teachers: Lakušić S. Branislava, Jančić B. Radiša			
Course status: elective, module: Pharmacognosy			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: ДФГ2И2	
Requirements: no			
Course aims: The aim of this course is to introduce student with ecological processes that influence the structure, function and distribution of plants on Earth. Elucidate effects of ecological factors on the quantity and quality of specific metabolites (essential oils, flavonoids, alkaloids).			
Course outcomes: After completing the course, student is able to understand the impact of ecological factors on medicinal plants, understanding the relationship between habitat and populations of medicinal plants, and especially the understanding of the negative effects of anthropogenic factors on endangered plant species and biodiversity in general			
Course contents: Definition, the object of study, classification, and relationship to other sciences. Basic concepts: environment, habitat and the ecosystem. The concept of ecosystem components and processes. Principles of functioning of ecosystems. Global aspects of biogeochemical cycles. The ratio of plants to environmental conditions, life forms, plant adaptation, adaptive types. Ecological factors - abiotic and biotic. Types of effects ecological factors (distribution, formative, physiological, orientation, phenological). Levels of action of environmental factors (individual, population, community). The structure, dynamics and zoning of vegetation. Ecological features of the basic types of vegetation Serbia and the Balkan Peninsula. The relationship of ecology and environmental protection. Vulnerability and protection of biodiversity (rare, endemic, relict and endangered plant species). Sustainable use of medicinal plants.			
Recommended literature: 1. Стевановић Б, Јанковић М. Екологија биљака са основама физиолошке екологије. Београд: ННК Интернационал, 2001. 2. Rodriguez E, Healey PL, Mehta I. Biology and chemistry of plant trichomes. New York: Plenum press, 1984. 3. Марин П. Биохемијска и молекуларна систематика биљака. Београд: ННК Интернационал, 2003. 4. Стевановић В, Васић В, едс. Биодиверзитет Југославије са прегледом врста од међународног значаја. Београд: Биолошки факултет и Еколибри, 1995. 5. Јовановић С, Лакушић Д, едс. Угрожене биљке Србије. Београд: Биолошки факултет Универзитета у Београду и ИП ННК Интернационал, 2006. 6. Стевановић В, ед. Црвена књига флоре Србије 1. Београд: Министарство за животну средину републике Србије, Биолошки факултет и Завод за заштиту природе републике Србије, 1999.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures, individual work with students, study research, terrain research, seminars, presentation.			
Grading system: Pre-examination activities: 60 points Exame (paper work/oral presentation): 40 points			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Non - medical Application of Herbal Drugs			
Teachers: Nada N. Kovačević, Silvana D. Petrović, Zoran A. Maksimović, Tatjana D. Kundaković, Milica M. Drobac			
Course status: elective, module: Pharmacognosy			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: ДФГ2ИЗ	
Requirements: no			
Course aims: The aim of this course is getting to know the composition, effects and quality control of plant raw materials (herbal drugs / herbal drug preparations) used for making non-medical herbal products.			
Course outcomes: After completing the course, student knows and is able to propose a non-medical application of plant materials (herbal drugs / herbal drug preparations) based on the knowledge of their composition and effects, and to propose a way of controlling their quality.			
Course contents: Theoretical study Getting to know the different possibilities of application of plant materials (herbal drugs and herbal drug preparations) in the food, cosmetic, parfimerijskoj industry, alcoholic and non-alcoholic beverages, paints and varnishes and related industries. Basic information about the production and the world market of vegetable raw materials (manufacturers, exporters and importers), categories of non-medical herbal products on the market, manufacturers of the final product. Examples of new and lesser-known herbal raw materials used for making non-medical herbal products. Information about the most important ingredients of plants (chemical structure, properties) for which these natural products are used. Plant materials and their isolated compounds as active, excipients and additives. Claims of safety and quality of herbal raw materials, depending on the product category. Quality control of herbal raw materials used for making non-medical herbal products. Introduction to the current legislation in this area. Research work Overview of the scientific literature and laboratory work in order to solve specific tasks and problems. The students will be discussed preliminary estimate possibilities of some plant material (which is the subject matter) for non-medical purposes, as well as the type, set up and implementation of experiments that would provide information about the feasibility of such an idea. Suggestions for characterization and definition of quality and safety profile of herbal products, depending on the product category for which it was intended.			
Recommended literature: 1. Ph. Eur. 7. Strasbourg: The Council of Europe; 2011. 2. Evans WC. Trease and Evans Pharmacognosy. 16th ed. Edinburgh, London, New York, Philadelphia, St Louis, Sydney, Toronto: Elsevier; 2009. 3. Vasisht K, Kumar V. (eds). Trade and Production of Herbal Medicines and Natural Health Products. Trieste: ICS UNIDO; 2002. 4. Vasisht K, Kumar V. (eds). Medicinal Plants and their Utilization. Trieste: ICS UNIDO, 2003. 5. Teuscher E, Bauermann U, Werner M. Medicinal Spices. Stuttgart: Medpharm GmbH Scientific Publishers; 2006.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures, individual work with students, study research.			
Grading system: Pre-examination activities (seminar): 50 points Exame (oral): 50 points			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Formulation of Herbal Medicinal Products			
Teachers: Milić-Aškračić R. Jela, Parojčić V. Jelena, Ibrić R. Svetlana			
Course status: elective, module: Pharmacognosy			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: ДФГ2И4	
Requirements: no			
Course aims: Introduction to the importance of formulation factors affecting herbal medicinal product performance and its biopharmaceutical characterization as the foundation for independent research work.			
Course outcomes: Understanding and application of pharmaceutical formulation principles in herbal preparation/ herbal medicinal product development and biopharmaceutical characterisation.			
Course contents: The types and characteristics of herbal drug dosage forms. Pharmaceutical adjuvants/excipients for pharmaceutical preparations/products. Factors taken into consideration when choosing excipients for particular pharmaceutical drug dosage form. Experimental design - principles and application in pharmaceutical development of herbal products. Manufacturing/production processes of solid drug dosage forms. Methods for pharmaceutical-technological and biopharmaceutical characterization of pharmaceutical solid dosage forms. Important factors for pharmaceutical preparations (herbal pharmaceutical products) stability.			
Recommended literature: 1.Gibson M. Pharmaceutical preformulation and formulation, 2nd ed. Informa Healthcare, 2009; 2. Allen LV (ed.). Remington: The Science and Practice of Pharmacy. 22nd ed. Gurnee: Pharmaceutical Press; 2012. 3. Gaedcke F, Steinhoff B. Herbal Medicinal Products. Stuttgart: Medpharm Scientific Publisher; 2003. 4. Rowe RC, Sheskey PJ, Owen SC (eds.). Handbook of Pharmaceutical Excipients. London, Washington: Pharmaceutical Press and American Pharmacists Association; 2008. 5. Aulton ME. Pharmaceutics – The science of dosage form design. 2nd ed. Edinburgh: Churchill Livingstone; 2002. 6. Florence and Attwood. Physicochemical Principles of Pharmacy, Pharmaceutical press, 2006;			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures, interactive sessions, practical exercises and seminars.			
Grading system: Pre-exam obligations: up to 30 points; Exam(written): up to 70 points.			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Mechanisms of drug action			
Teachers: Ugrešić D. Nenad, Stepanović-Petrović M. Radica, Savić M. Miroslav, Novaković N.Aleksandra, Tomić A. Maja, Plečaš-Solarović A. Bosiljka, Pešić P. Vesna			
Course status: Mandatory modules, module: Pharmacology			
Semester: I		Year of studies: I	
ECTS points: 10		Course code: ДФА10М1	
Requirements: Pharmacology in undergraduate studies			
Course aims: The aim of this course is to provide participants with an integrated overview of mechanisms of drug action, in the context of biological mechanisms which regulate the function of cells and the multicellular organism.			
Course outcomes: By the end of this course participants will have explored and gained a deeper understanding of the structural and functional elements of the drug-site of action interaction and hence become able to relate many elements in order to critically analyse and discuss the mechanisms of drug action.			
Course contents: Cell biology. Cell biochemistry. Integration of a multicellular organism. Immunological regulation. Neuronal regulation. Endocrine regulation. Interaction drug-mechanisms of biological regulation. Target sites for drug action. 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. Mechanisms of actions of hormones and local mediators. Principles of chemotherapy. Mechanisms of action of antibacterial drugs. Mechanisms of action of antiviral drugs. Mechanisms of action of antifungal drugs. Mechanisms of action of antiprotozoal drugs and anthelmintics. Mechanisms of action of anti-cancer drugs. Resistance to drug action.			
Recommended literature: 1. Rang HP, Dale MM, Ritter JM, Flower RJ, Henderson G. Rang and Dale’s Pharmacology. 7th edition, Churchill Livingstone Elsevier, 2011. 2. Brunton LL, Chabner BA, Knollmann BC (eds). Goodman&Gliman’s the Pharmacological Basis of Therapeutics, 12th editon. McGraw Hill, 2011. 3. Kenakin T. A Pharmacology Primer: Theory, Applications and Methods, 2nd edition. Academic Press, London, 2006. 4. Katzung BG (ed). Basic&Clinical Pharmacology, 12th ed, Lange Medical Books/McGraw-Hill Medical Publishing Division, New York, 2012. 5. Hacker M, Bachmann K, Messer W. Pharmacology Principles and Practice. Academic Press, Amsterdam, 2009.			
The total of active learning classes	Lectures: 60		
	Individual research work: 60		
Teaching methods: Lectures and study-research work			
Grading system: Seminar: 30 points; written exam: 70 points			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Data processing and analysis in pharmacology			
Teachers: Tomić A. Maja, Novaković N. Aleksandra, Stojić-Vukanić M. Zorica			
Course status: Mandatory modules, module: Pharmacology			
Semester: II		Year of studies: I	
ECTS points: 5		Course code: ДΦА10М3	
Requirements: Statistics in research			
Course aims: To instruct the candidate on the use of mathematical and statistical methods in processing and analysing the data from the pharmacological research.			
Course outcomes: The candidate will be capable of independently processing and analysing data from the pharmacological research.			
Course contents: Analysis of the regression line. Slope of the regression line. Test for parallelism. Dose response analysis: graded and quantal dose response - probit analysis. Efficacy and potency. ED50 and EDmax. Relative potency. Dissociation constant (Agonists. Partial agonists). Antagonism. pA2 analysis (Schild plot). Analysis of pharmacodynamic interactions between drugs (Interaction between drugs with high and low efficacy. Interaction between two drugs with high efficacy: isobolographic analysis. Experimental design with fixed dose ratios. Isobologram. Interaction index). Qualitative and quantitative analysis of the protein (antigen) expression, cell cycle and apoptosis using flow cytometer and data analysis using appropriate software programs. Analysis of protein expression at the mRNA and protein level using suitable software programs. Qualitative and quantitative analysis of proteins and other molecules expression within a tissue or within compartments of a cell after immunochemical labeling or induction of autofluorescence.			
Recommended literature: 1. Tallarida RJ, Murray RB. Manual of 1.Pharmacologic Calculations with Computer Programs. 2nd ed. New York, Berlin, Heidelberg, London, Paris, Tokyo: Springer Verlag, 1986. 2. Tallarida RJ, Drug Synergism and Dose-Effect Data Analysis, CRC Press, 2000. 3. A Pharmacology Primer: Theory, Applications and Methods. Academic Press, London, 2006.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures and individual research work			
Grading system: Seminar: 30; written exam: 70			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Principles of use of animals for scientific purposes			
Teachers: Todorović M. Zoran, Savić M. Miroslav			
Course status: Mandatory modules, module: Pharmacology			
Semester: I		Year of studies: I	
ECTS points: 5		Course code: ДΦА10М2	
Requirements: none			
Course aims: The aim of this course is to provide participants with knowledge about principles of breeding, handling and use of animals used for scientific purposes, including legislation in Serbia, European Union and world, as well as of anaesthesia and surgery of laboratory animals (wok in vivo).			
Course outcomes: By the end of this course participants will have gained an understanding of legislation and principles of breeding, handling and work with animals used for scientific purposes.			
Course contents: Legislation and ethical questions related to work with animals used for scientific purposes. Priniciples of laboratory experiment. Principles of Good laboratory practice. Breeding and caring for animals used for scientific purposes. Animal welfare. Monitoring the health status and the most common diseases of animals used for scientific purposes. Use of animals in laboratory (routes of treatment application, introduction to anaesthesia and analgesia). Surgical procedures on animals used for scientific purposes. Practical laboratory work.			
Recommended literature: 1. Wolfensohn S, Lloyd M. Handbook of laboratory animal management and welfare. John Wiley & Sons, 2013. 2. Wilking MR (ed). Experimental Therapeutics, Martin Dunitz, Ltd., London, 2003.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures and study-research work			
Grading system: Seminar: 50 points; written exam: 50 points			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Pharmacology of the Cardiovascular System			
Teachers: Stepanović-Petrović M. Radica, Novaković N. Aleksandra			
Course status: elective, module: Pharmacology			
Semester: II		Year of studies: I	
ECTS points: 7,5		Course code: ДФА1И2	
Requirements: Mechanisms of drug action			
Course aims: Understanding the mechanisms of drugs action used in the treatment of cardiovascular disease, as well as, their indications, contraindications, adverse effects, and interactions with simultaneously applied drugs.			
Course outcomes: Understanding the molecular and cellular basis of pharmacological modulation of cardiovascular function.			
Course contents: Vascular and cardiac structure and function. Specifics of circulation in the certain regions - cerebral, coronary, splanchnic and renal circulation. Control of vascular smooth muscle tone. Blood pressure regulation. Shock and hypotensive states. Hypertension. Antihypertensive drugs. Angina and myocardial infarction and drugs used in the treatment of these diseases. Biogenic agents that affect cardiac function. Heart failure and drugs used in the treatment of this disease. Kidney and diuretics. Electrophysiology of normal and altered heart rhythm. Antiarrhythmics. Lipoprotein metabolism and atherosclerosis. Lipid-lowering drugs. Haemostasis and thrombosis. Anticoagulants, fibrinolytic, and antiplatelet drugs.			
Recommended literature: 1. Rang HP, Dale MM, Ritter JM, Flower RJ, Henderson G. Rang and Dale’s Pharmacology. 7th edition, Churchill Livingstone Elsevier, 2011. 2. Brunton LL, Chabner BA, Knollmann BC (eds). Goodman&Gilman’s the Pharmacological Basis of Therapeutics, 12th editon. McGraw Hill, 2011. 3. Katzung BG (ed). Basic&Clinical Pharmacology. 12th ed, Lange Medical Books/McGraw-Hill Medical Publishing Division, 2012.			
The total of active learning classes	Lectures: 45		
	Individual research work: 45		
Teaching methods: Lectures and research work.			
Grading system: Seminars: 30 point; Written test: 70 points.			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Pharmacology of nervous system			
Teachers: Ugrešić D. Nenad, Stepanović-Petrović M. Radica, Savić M. Miroslav, Novaković N.Aleksandra, Tomić A. Maja			
Course status: elective, module: Pharmacology			
Semester: II		Year of studies: I	
ECTS points: 7,5		Course code: ДФА1И1	
Requirements: Pharmacology in undergraduate studies			
Course aims: The aim of this course is to provide participants with: an integrated overview of contemporary knowledge on nervous system and possibilities to pharmacologically modulate nervous functions; knowledge on indications, contraindications, adverse effects and interactions, as well as therapeutic outcomes of drug administration in nervous system disorders.			
Course outcomes: By the end of this course participants will have gained a deeper understanding of the molecular and cellular underpinnings of pharmacological modulation of nervous functions.			
Course contents: Functional anatomy of central and peripheral nervous system. Neuron. Neuroglia. Neurotransmitter. Neuromodulator. Roles of transmitters and modulators in nervous regulation. Integration of neuronal, endocrine and immunological regulation. Central and peripheral neurotransmission. Excitatory and inhibitory neurotransmission. Glutamate. GABA. Glycine. Noradrenaline. Dopamine. Serotonin. Acetylcholine. Histamine. Purines. Melatonin. Nitrous oxide. Eicosanoids. Cannabinoids. Endogenous opioids. Transmission and modulation of pain. Analgesics. Anaesthesia and anesthetics. Epilepsy and antiepileptics. Neurodegenerative diseases. Memory and nootropic drugs. Disorders of sleep and hypnotics. Neuronal and molecular substrate of anxiety. Anxiolytics. Neuronal and molecular substrate of affective disorders. Antidepressants. Mood stabilizers. Neuronal and molecular substrate of psychosis. Antipsychotics. Psychotomimetics. Stimulants of central nervous system. Addiction. Nicotin. Alcohol. Cannabis.			
Recommended literature: 1. Davis KL, Coyle J, Charney D, Nemeroff C (eds). Neuropsychopharmacology: the fifth generation of progress, Lippincott, Williams & Wilkins, 2002. 2. Rang HP, Dale MM, Ritter JM, Flower RJ, Henderson G. Rang and Dale’s Pharmacology. 7th edition, Churchill Livingstone Elsevier, 2011. 3. Brunton LL, Chabner BA, Knollmann BC (eds). Goodman&Gliman’s the Pharmacological Basis of Therapeutics, 12th editon. McGraw Hill, 2011. 4. Katzung BG (ed). Basic&Clinical Pharmacology, 12th ed, Lange Medical Books/McGraw-Hill Medical Publishing Division, New York, 2012. 5. Kandel ER, Schwartz JH, Jessell TM. Principles of Neural Science, 4th ed, McGraw-Hill, New York, 2013.			
The total of active learning classes	Lectures: 45		
	Individual research work: 45		
Teaching methods: Lectures and study-research work			
Grading system: Seminar: 30 points; written exam: 70 points			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Molecular and Cellular Physiology			
Teachers: Plečaš-Solarović A. Bosiljka, Pešić R. Vesna, Nedeljković S. Miodrag			
Course status: elective, module: Pharmacology			
Semester: II		Year of studies: I	
ECTS points: 7,5		Course code: ДФА1И5	
Requirements: no			
Course aims: A central goal of physiology in the post-genomic era is to understand how thousands of encoded proteins serve to bring about the highly coordinated behaviour of cells and tissues. Molecular and cellular physiology explores all levels of physiological organization, from individual molecules, cells, organs, the systems of organs and of the body as a whole. Accordingly, the main objective of the MCP course is to develop in students understanding of complex and coordinated principles of operation and regulation of bodily functions at all levels of the organization.			
Course outcomes: In addition to mastering and understanding the physiological principles at the molecular and cellular level, students are expected to develop scientific curiosity, critical and independent thinking and the ability to solve problems that were previously not encountered . Upon completing the course, students are expected to: have competent knowledge of the structure and functions of plasma membranes with emphasis on transport mechanisms through the cell membrane as well as the processes involved in the regulation of the transport mechanisms, the mechanisms of hormones action (hormone - receptor interactions, regulation at the receptor level and interactions of intracellular mediators), to know the mechanism of action of the neurotransmitters, and the regulation of the neurotransmitter's effects at the level of interaction between the receptor and the intracellular mediators.			
Course contents: The function of membrane proteins and their role in intracellular signalling. Cell communication mechanisms: direct communication, signalling through soluble chemical substances, the second messenger system, eicosanoids. Nuclear receptors. Transport of water and hydrophilic substances through the cell membrane. Transport of ions and regulation of their intracellular concentration. Electrophysiology of the cell membrane, molecular physiology of ion channels. Action potential in neuron and muscle cells. Synaptic transmission and neuromuscular junction. Cellular physiology of skeletal, cardiac and smooth muscles cells. Synaptic transmission in the central and autonomic nervous system and neurotransmitters. Molecular basis of mental processes. Molecular physiology of pain. Organization of the endocrine control, role of peptide hormones, amino acid derivatives and steroid hormones.			
Recommended literature: 1. Medical Physiology: A Cellular and Molecular Aproach (2009) Boron and Boulpaep, Saunders Elsevier, Philadelphia, PA. 2. Kandel ER, Schwartz JH, Jessell TM 2000. Principles of Neural Science, 4th ed. McGraw-Hill, New York. ISBN 0-8385-7701-6. 3. Regulation of phospholipase D. Exton JH. FEBS Lett. 2002 Oct 30;531(1):58-61. Review. 4. Inositol 1,4,5-trisphosphate receptors and pacemaker rhythms. Ju YK, Woodcock EA, Allen DG, Cannell MB. J Mol Cell Cardiol. 2012 Sep;53(3):375-81. Review. 5. The last few frames of the voltage-gating movie. Sigworth FJ. Biophys J. 2007 Nov 1;93(9):2981-3. Review. 6. The role of amino acid transporters in inherited and acquired diseases. Bröer S, Palacín M. Biochem J. 2011 Jun 1;436(2):193-211. Review.			
The total of active learning classes	Lectures: 45		
	Individual research work: 45		
Teaching methods: Lectures and literature research			
Grading system: Seminars: 50 points; Written exam: 50 points			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Molecular and Cellular Immunology			
Teachers: Leposavić M. Gordana, Arsenović-Ranin M. Nevena, Stojić-Vukanić M. Zorica			
Course status: elective, module: Pharmacology			
Semester: II		Year of studies: I	
ECTS points: 7,5		Course code: ДФА1ИЗ	
Requirements: no			
Course aims: State of art and the main directions of further research of immune cells and tissues; cellular and molecular interactions in the immune response in physiological and immunopathological conditions and immunomodulation; consequences of immunoderegulations.			
Course outcomes: Understanding of: mechanisms of immune responses to different types of infectious and non-infectious agents (tumor and transplantation antigens); the most important cellular and molecular mechanisms of immunoregulation and factors and mechanisms underlying disturbances in the immunoregulation; etiology and cellular and molecular basis of the pathogenesis of various immunological disorders; basic principles of therapeutic approaches for the most common immunologic disorders; new approaches and further directions in reserch of cellular and molecular mechanisms of immune response and its regulation.			
Course contents: Cells and tissues of the immune system. Innate immunity. The complement system. The antigens and antibodies. Organization and expression of immunoglobulin genes. Major histocompatibility complex molecules and antigen presentation to T lymphocytes. T-cell receptor. Maturation, activation, and differentiation of T and B lymphocytes. The effector mechanisms of cellular and humoral immunity. Cellular and molecular mechanisms of regulation of the immune response. Immunologic tolerance. Transplantation immunology. Immunity to tumors. Cellular and molecular basis of: allergic and autoimmune diseases as well as immunodeficiencies.			
Recommended literature: 1. Abul K. Abbas, Andrew H. Lichtman, Shiv Pillai. Cellular and molecular immunology. Elsevier Saunders, 2012. 2. Thomas J. Kindt, Richard A. Goldsby, Barbara A. Osborne. Kuby Immunology. W.H. Freeman and Company, 2007. 3. Frans P. Nijkamp, Michael J. Parnham, Principles of Immunopharmacology. Birkhäuser Verlag, 2005. 4. Robert Luebke, Robert House, Ian Kimber, Immunotoxicology and Immunopharmacology, CRC press, 2007. 5. Manzoor M Khan. Immunopharmacology. Springer, 2008. 6. Review papers published in leading international journals.			
The total of active learning classes	Lectures: 45		
	Individual research work: 45		
Teaching methods: Lectures and individual reading and group discussion			
Grading system: Seminars: 70 points; Written examination: 30 points.			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Immunopharmacology			
Teachers: Leposavić M. Gordana, Arsenović Ranin M. Nevena, Stojić-Vukanić M. Zorica			
Course status: elective, module: Pharmacology			
Semester: II		Year of studies: I	
ECTS points: 7,5		Course code: ДФА1И4	
Requirements: Molecular and Cellular Immunology; Mechanisms of Drug Action			
Course aims: To provide knowledge on: the basic postulates related to the treatment of immune dysfunctions; drugs that alter imune system functions and the mechanisms of their action, as well as on the main approches and directions of further research on the development of immunomodulatory drugs.			
Course outcomes: Understanding of: basic principles of immune system dysfunction therapy; mechanisms of action of drugs used in treatment of various diseases having immunopathogenetic background; the side effects of immunotherapy drugs; immune effects of various drugs used in the treatment of diseases with non-immune pathogenesis.			
Course contents: Cellular and molecular mechanisms of immunosuppression and immunostimulation. Basic principles of vaccine design and mechanisms of vaccine action. Serums and immunoglobulins as immunotherapeutics. Basic therapeutic approaches and mechanisms of action of agents/drugs used in the therapy of allergic diseases. Immunostimulatory agents and their mechanisms of action. Immunosupressive agents and their mechanisms of action. The side effects of the drugs used in therapy of immune system dysfunctions. Immune effects of various drugs used in the treatment of non-immune diseases. New approaches and directions in the development of immunomodulatory drugs.			
Recommended literature: 1. Abul K. Abbas, Andrew H. Lichtman, Shiv Pillai. Cellular and molecular immunology. Elsevier Saunders, 2012. 2. Thomas J. Kindt, Richard A. Goldsby, Barbara A. Osborne, Kuby Immunology, 6th ed. W.H. Freeman and Company, 2007. 3. Frans P. Nijkamp, Michael J. Parnham, Principles of Immunopharmacology, 2nd ed. A Birkhäuser book, 2005. 4. Robert Luebke, Robert House, Ian Kimber, Immunotoxicology and Immunopharmacology, 3rd ed., CRC press, 2006. 5. Review articles in this scientific field published in leading international journals.			
The total of active learning classes	Lectures: 45		
	Individual research work: 45		
Teaching methods: Lectures, personal reading and group discussion			
Grading system: Seminars: 30 points; Written examination: 70 points			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Methodology in pharmacoepidemiology			
Teachers: Ugrešić D. Nenad, Savić M. Miroslav			
Course status: elective, module: Pharmacology			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: ДФА2И4	
Requirements: none			
Course aims: The aim of this course is to provide participants with an understanding of the principles of pharmacoepidemiological methods and different study designs, as well as with the systems of adverse drug reactions reporting and collection			
Course outcomes: By the end of this course participants will have gained a deeper understanding of the methodological principles of pharmacoepidemiology and modalities of their application in scientific research. They will become trained to critically evaluate pharmacoepidemiological signals and use databases specialised for drug use and safety issues.			
Course contents: Basic principles of pharmacoepidemiological methods of collection, processing and analysis of data related to drug and medical products use. Methods of detection of adverse and useful effects of drugs, including spontaneous reporting, ad hoc epidemiological studies and use of databases. Study design. Cross-section studies, observational (cohort and case-contol) studies. Clinical studies. Bias and confounding. Drug utilisation studies (conservative and qualitative). Meta-analysis. Principles of pharmacoepidemiological methods of collection, processing and analysis of data related to drugs and medical products. Control of quality of data collection. Assessment methods of risks and benefits of drug use.			
Recommended literature: 1. Strom BL, Kimmel SE, Hennessy S. Pharmacoepidemiology, 5th ed., John Wiley&Sons, 2011. 2. Mann RD, Andrews EB, editors. Pharmacovigilance. Chichester, UK: John Wiley & Sons Ltd.; 2002. 3. Pharmacoepidemiology and Drug Safety Journal.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures and study-research work			
Grading system: Seminar: 30 points; written exam: 70 points			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Methodology of nervous system pharmacology			
Teachers: Ugrešić D. Nenad, Stepanović-Petrović M. Radica, Savić M. Miroslav, Novaković N.Aleksandra, Tomić A. Maja			
Course status: elective, module: Pharmacology			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: ДФА2И1	
Requirements: Mechanisms of drug actions, Pharmacology of nervous system			
Course aims: The aim of this course is to provide participants with an overview of techniques and methods used in research of drug actions on nervous functions and with knowledge necessary for proper interpretation of results obtained using such methodology. An additional aim is to delivery the training necessary to achieve good command of the elected techniques in the field of nervous system pharmacology.			
Course outcomes: By the end of this course participants will have gained a deeper understanding of the techniques and methods used in investigation of drug actions on nervous functions and obtained skills to achieve good command of the elected techniques in the field of nervous system pharmacology.			
Course contents: Techniques of brain visualisation. Behavioural methods. Locomotor activity and exploration. Stereotyped behavior. Models of aggressive behaviour. Behaviour connected with feeding. Reproductive behaviour. Behavioural pharmacology of sleep. Classical conditioning. Dependence models. Drug discrimination. Mazes. Models of depression. Models of psychosis. Models of anxiety. Models of learning and memory. Convulsive tests. Models of epilepsy. Nociceptive tests. Models of tonical pain. Models of inflammatory and neuropathic pain. Stereotaxic surgery and in vivo techniques. Biochemical assays and intracellular signalisation. Western blot. Neurochemistry methods. Quantification of neurotransmitters, metabolites and metabolic turnover. Electrophysiological methods. Immunological techniques in pharmacology of nervous system. Histological techniques in pharmacology of nervous system. Methods of genetic engineering in pharmacology of nervous system.			
Recommended literature: 1. Carter M, Shieh J. Guide to Research Techniques in Neuroscience. Academic Press, Amsterdam, 2010. 2. Vogel HG (ed.). Drug Discovery and Evaluation. Pharmacological Assays. 2nd edition. Springer-Verlag, Berlin, 2002.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures and study-research work			
Grading system: Seminar: 50 points; written exam: 50 points			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Methodology of the cardiovascular pharmacology			
Teachers: Ugresic D. Nenad, Stepanovic-Petrovic M. Radica, Novakovic N. Aleksandra, Tomic A. Maja			
Course status: elective, module: Pharmacology			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: ДФА2И2	
Requirements: Courses in the I year doctoral studies: Molecular biology, Mechanisms of drug action, Processing and data analysis in Pharmacology, Pharmacology of cardiovascular system			
Course aims: Familiarizing with techniques and methods used in the research of drugs action on the cardiovascular system. Training for the proper understanding and interpretation of the results of research using this methodology. Mastering certain techniques in the area of cardiovascular pharmacology.			
Course outcomes: Understanding techniques and methods used in the research of drugs action on the cardiovascular functions. Practical mastering of the chosen techniques and methods.			
Course contents: In vitro methods: Method of isolated heart – Langendorff, Method on isolated rabbit atriums, Method of isolated blood vessels. Electrophysiological methods. Immunological techniques in pharmacology of cardiovascular system. Histological techniques in pharmacology of cardiovascular system. Methods of genetic engineering in pharmacology of cardiovascular system. In vivo methods: Method of direct monitoring of blood pressure changes on anesthetized cat/dog. Method of blood pressure monitoring on despinalized rat/guinea pig on electrophysiograph.			
Recommended literature: 1. Vogel HG (ed.). Drug Discovery and Evaluation. Pharmacological Assays. 2nd edition. Springer-Verlag, Berlin, 2002.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Demonstrations and the experimental work.			
Grading system: Seminars: 50 points; practical work: 50 points.			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Methodology in Immunopharmacological Research			
Teachers: Leposavić M. Gordana, Arsenović-Ranin M. Nevena, Stojić-Vukanić M. Zorica			
Course status: elective, module: Pharmacology			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: ДФА2ИЗ	
Requirements: Molecular and Cellular Immunology			
Course aims: Introduction to: basic theoretical principles, protocols, advantages and limitations of common methods used in testing phenotypic characteristics and functions of immune system cells and intracellular signaling, and experimental models of autoimmune diseases and inflammation.			
Course outcomes: Understanding of: basic theoretical principles and protocols of common methods for examining immune system cell phenotypic characteristics and functions, and intracellular signalling; advantages and limitations of these methods; experimental models of autoimmune diseases and inflammation and the main directions of further development of methods for exploring immune system cell functions and intracellular signaling. Acquiring some laboratory skiles.			
Course contents: The principles and research applications of antigen-antibody interactions. Production of polyclonal and monoclonal antibodies. Immunoassays with labelled antigens or antibodies: radioimmunoassay (RIA , RIST , RAST), enzyme immunoassays (ELISA, cell-ELISA, ELISPOT). Flow citometry. Immunocytochemistry and immunohistochemistry. Western blot. Recombinant DNA technology (polymerase chain reaction - PCR). Separation of cells of the immune system based on the physical properties and expression of surface antigens. Cell cultures. Methods to study functional responses of T and B lymphocytes and other cells of the immune system. Assays to measure cell proliferation and apoptosis. Methods for examination of intracellular signaling. Experimental models of autoimmune and inflammatory diseases.			
Recommended literature: 1. John E. Coligan, Barbara Bierer, David H. Margulies, Ethan M. Shevach, Warren Strober, Richard Coico. Guest Editors: Patricia Brown, John C. Donovan. Past Editor: Ada Kruisbeek. Current Protocols in Immunology. John Wiley and Sons, Inc. 2007. 2. Fred M. Ausubel, Roger Brent, Robert E. Kingston, David D. Moore, J.G. Seidman, John A. Smith, Kevin Struhl. Current Protocols in Molecular Biology. John Wiley and Sons, Inc. 2007. 3. Ivan Lefkovits. Immunology Methods Manual: The Comprehensive Sourcebook of Techniques (4 Volume) Academic Press,1997. 4. Hay FC, Westwood OMR, Nelson PN, Practical Immunology. Oxford; Malden, MA: Blackwell Science; 2002.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures and practical work			
Grading system: Practical work: 90 points; Written examination: 10 points.			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Drug discovery and development			
Teachers: Savić M. Miroslav			
Course status: elective, module: Pharmacology			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: ДФА2И5	
Requirements: none			
Course aims: The aim of this course is to provide participants with an understanding of the principles of drug discovery, discovery and authorization.			
Course outcomes: By the end of this course participants will have gained a deeper understanding necessary for critical analysis of information sets connected with processes of drug discovery, development and authorization, with the final of goal of optimal assesment of relations between pharmaceutical quality, safety and efficacy of a novel drug.			
Course contents: Strategies of novel drugs research and development. Selection of the target of the potential drug. In vitro screening of biological activity of drugs. Choice of lead compounds. Good laboratory practice. In vitro pharmacological investigation. In vivo pharmacological investigation. Pharmacokinetics of potential drugs in animals. Toxicity tests. Interpretation of toxicological data and extrapolation to humans. Phases of clinical studies. Documents governing clinical studies (local and international). Good clinical practice. Pharmacological-toxicological and clinical expert reports in drug authorization process. Summary of product characteristics and patient information leaflet. Drug authorization. Pharmaceutical aspects in drug development process. Intellectual property and patent issues in pharmaceutical industry.			
Recommended literature: 1. Rang HP. Drug discovery and development. Elsevier, Amsterdam, 2006. 2. Friedman LM, Furberg CD, DeMets DL. Fundamentals of clinical trials, 3rd edition. Mosby, St Louis, 1996.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures and study-research work			
Grading system: Seminar: 50 points; written exam: 50 points			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Pharmacokinetics			
Teachers: Miljković P. Branislava, Vezmar Kovačević D. Sandra, Vučićević M. Katarina			
Course status: elective, module: Pharmacology			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: ДФА2И6	
Requirements: none			
Course aims: The aim of the course is to provide students with relevant tools needed for understanding the importance of the pharmacokinetics and drug metabolism, importance of pharmacokinetic variability in drug therapeutic response, the application of pharmacokinetic principles in drug therapy and individualization of dosage regimen.			
Course outcomes: On completion of the course, the student will be able to understand and apply drug's pharmacokinetic and metabolism characteristics into the decision-making process related to drug's pharmacological profile.			
Course contents: Prediction of pharmacokinetic processes, metabolism and parameter values based on physico-chemical characteristics of a drug candidate. Design of pharmacokinetic studies in different phases of drug development. Preclinical in vitro pharmacokinetic and metabolism studies of a drug candidate. Preclinical pharmacokinetic studies in experimental animals. Prediction of the pharmacokinetics in humans (allometric approach, physiological models). Clinical pharmacokinetic studies. Assessment of ADME processes of the drug candidate. Induction and inhibition of enzyme systems. Drug metabolism kinetics. Pharmacological and toxicological significance of drug metabolism. Drug metabolism in vivo. Examination of the drug's potential for pharmacokinetic interactions, and consequently adverse drug effects. Calculation of pharmacokinetic parameters using different pahrmacokinetic approaches to data analysis. Data interpretation, interpretation of the pharmacokinetic parameters' values. Variability in pharmacodynamic response as a consequence of the variability in the pharmacokinetic level. Pharmacokinetic-pharmacodynamic models. Pharmacokinetic principles in individualization of drug therapy. Application of pharmacokinetic, pharmacokinetic-pharmacodynamic models in predicting concentration-time and efficacy/safety drug's profile following specific dosage regimen.			
Recommended literature: 1. Shargel L, Wu-Pong S, Yu A. Applied Biopharmaceutics & Pharmacokinetics, 6th ed. McGraw-Hill, 2012. 2. Rowland M, Tozer TN. Clinical Pharmacokinetics and Pharmacodynamics: Concepts and Applications, 4th ed. Lippincott Williams & Wilkins, 2011. 3. Krishna R (ed). Applications of Pharmacokinetic Principles in Drug Development, 1st ed. Springer, 2003. 4. Coleman M. Human drug metabolism, 2nd ed. Wiley, 2010. 5. Zhang D, Zhu M, Humphreys WH (eds). Drug Metabolism in Drug Design and Development, 1st ed. Wiley, 2007.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Theoretical lectures, seminars.			
Grading system: Pre-exam activities - seminar 30 points. Final exam 70 points.			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Neuroendocrineimmunomodulation			
Teachers: Leposavić M. Gordana, Arsenović Ranin M. Nevena, Stojić-Vukanić M. Zorica			
Course status: elective, module: Pharmacology			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: ДФА2И7	
Requirements: Molecular and Cellular Immunology; Immunopharmacology			
Course aims: To provide knowledge on molecular and cellular interactions between three „supersystems“ – nervous, endocrine and immune in the maintenance of homeostasis and immunopathogenesis in order to understand: i) new approaches and directions in research of neuro-endocrine-immune interactions, ii) possibilities for therapeutic interventions in immunopathologic conditions related to the alterations in these interactions and iii) consequences of action of xenobiotics /drug affecting these interactions.			
Course outcomes: Understanding of: cellular and molecular basis of two-way communications between immune and central nervous/ endocrine system; modulatory action of neurotransmitters, neuropeptides and hormones on cells of innate and adaptive immune system; significance of age-related changes in neuroendocrineimmune communication for immunosenescence; role of neurotransmitters, neuropeptides and hormones in immunopathology; therapeutic approaches in immune system disturbances caused by neuroendocrine deregulations; consequences of the action of xenobiotics/drugs affecting neuro-endocrine-immune communication.			
Course contents: Receptors for neurotransmitters, neuropeptides and hormones on/in immune system cells. Synthesis of neurotransmitters, neuropeptides and hormones in immune system cells. Receptors for cytokines on nervous and endocrine cells. Synthesis of cytokines in immune system cells. Two-way communications between immune and central nervous/endocrine system. Three signal theory. Immune system as diffuse sensory receptor organ. Role of neurotransmitters, neuropeptides and hormones in regulation of B- and T-lymphocyte differentiation/maturation. Role of sympathetic nervous system neurotransmitters, neuropeptides and hormones in immunosenescence. Role of neurotransmitters, neuropeptides and hormones in immunopathology. Xenobiotics/drugs affecting neuro-endocrine-immune interactions.			
Recommended literature: 1. George P. Chrousos, Gregory A. Kaltsa, George Mastorakos. Neuroendocrine and Immune Crosstalk. Wiley, 2006. 2. Berczi I., Szentivanyi A. Series editors. Neuroimmune Biology: Vol. 3: The Immune-Neuroendocrine Circuitry. History and Progress. Elsevier, 2003. 3. Esther M. Sternberg, France C. Haour, Craig C. Smith. Neuroendocrine and Neural Regulation of Autoimmune and Inflammatory Disease: Molecular, Systems, and Clinical Insights. Annals of New York Academy of Science ,Vol. 992, 2003. 4. Review articles in this scientific field published in leading international journals.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures, personal reading and group discussion			
Grading system: Seminar paper: 70 points; Written examination: 30 points			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Inflammation and Anti-inflammatory Agents			
Teachers: Leposavić M. Gordana, Arsenović Ranin M. Nevena, Stojić-Vukanić M. Zorica, Stepanović-Petrović M. Radica			
Course status: elective, module: Pharmacology			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: ДФА2И8	
Requirements: Molecular and Cellular Immunology			
Course aims: To provide: i) knowledge on the inflammatory cells and mediators and their role in the pathogenesis of inflammation, as well as on the mechanisms of action of anti-inflammatory drugs and ii) understanding of ongoing research on the cellular and molecular mechanisms of inflammation and development on new anti-inflammatory drugs.			
Course outcomes: i) understanding of: role of various cell types and mechanisms of inflammatory mediator action in inflammation; the criteria which an endogenous substance should satisfy to be considered as mediator of inflammation; pathogenesis of chronic inflammatory diseases (chronic autoimmune inflammatory diseases, atherosclerosis); the mechanisms of action of anti-inflammatory drugs and ii) reaching ability to perceive direction of further research on, primarily, inflammatory mediators, pathogenesis of the chronic inflammatory diseases and anti-inflammatory drug development.			
Course contents: The pathogenesis of acute inflammation. Cells involved in inflammatory response. Disfunctions of cells involved in inflammation and their consequences. Mediators of inflammation and mechanisms of their action. The main directions of further research on inflammation mediators. Anti-inflammatory drugs and their mechanism of action. New trends in the research of anti-inflammatory drugs. The pathogenesis of chronic inflammation (chronic autoimmune inflammatory diseases, atherosclerosis). The main directions of further research on the pathogenesis of chronic inflammatory diseases.			
Recommended literature: 1. Abul K. Abbas, Andrew H. Lichtman, Shiv Pillai. Cellular and molecular immunology. Elsevier Saunders, 2012. 2. Rang HP, Dale MM, Ritter JM, Flower RJ, Henderson G. Rang and Dale’s Pharmacology. 7th edition, Churchill Livingstone Elsevier, 2011. 3. Review articles in this scientific field published in leading international journals..			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures, personal reading and group discussion			
Grading system: Mandatory seminar: 70 points; Written examination: 30 points			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Molecular Biology			
Teachers: Biljana M. Potparević			
Course status: elective, module: Pharmacology			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: ДФА2И9	
Requirements: no			
Course aims: Student should be able to: <ul style="list-style-type: none">•describe and explain the chemical composition, structure and function of DNA and RNA molecules•Understand the universality of the genetic code•Explain the transfer of genetic information from DNA via RNA to the measurement of protein structure•know and understand the basic methods of molecular biology			
Course outcomes: Understanding the principles of molecular biology and the modern techniques used in this scientific field.			
Course contents: The chemical composition, structure and function of DNA and RNA, replication, transcription and translation. Recombination of genetic material. Repair of DNA molecules. Regulation of gene expression in eukaryotes and prokaryotes. Methods of molecular biology. Analysis of the genes and proteins: blot techniques. Detection of nucleic acids, detection of proteins. Gene therapy and recombinant DNA technology: Recombinant protein products, (pharmacogenetics and pharmacogenomics), genetically modified laboratory animals "knock-in"and "knock-out" transgenic mice.			
Recommended literature: 1. Molecular biology of the cell (2007) B.Alberts, A. Johnson, J. Lewis, M.Raff, K. Roberts, P. Walter, 5th edition, New York. 2. Principles of Pharmacogenetics and Pharmacogenomics (2012); Russ B. Altman, David Flockhart, David B. Goldstein, Stanford University, California. 3. Molecular Biology 1,(2011), Gordana Matic, Dusanka Savic-Pavicevic, Zavet, Beograd. 4. Molecular Biology 2, (2011), Goran Brajuskovic , Savremena Administracija, Beograd			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures and study research			
Grading system: Seminars: 30 points, written exam 70.			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Pharmaceutical preformulation and formulation			
Teachers: Parojčić V. Jelena, Ibrić R. Svetlana, Đuriš D. Jelena, Cvijić V. Sandra, Corrigan I. Owen			
Course status: Mandatory modules, module: Pharmaceutical Technology			
Semester: I		Year of studies: I	
ECTS points: 10		Course code: ДФТ10М1	
Requirements: no			
Course aims: Introduction to the importance of preformulation studies in the early stages of drug product development and formulation factors affecting drug product performance and its biopharmaceutical characterization as the foundation for independent research work.			
Course outcomes: Understanding and application of pharmaceutical preformulation and formulation principles in drug product development and biopharmaceutical characterisation			
Course contents: Importance of preformulation studies in candidate drug selection and early development. Role of preformulation studies in the early phases of drug product development. Physicochemical characteristics of active pharmaceutical substances and excipients. pKa value determination. Partition coefficient. Drug solubility (solubility determination, solubility prediction, influence of excipients on drug solubility). Solid state characteristics; Crystal state and structural analysis (polymorphism and the related phenomena, evaluation of thermodynamic stability of different polymorphs, salts and co-crystals, solvates, hydrates, amorphous material). Solid state characterization (x-ray diffraction, IR spectroscopy, near IR spectroscopy, Raman spectroscopy, NMR). Crystal morphology assessment (microscopy, SEM, AFM). Hygroscopicity. Thermal analysis. Particle size; determination of particle size distribution and specific surface area. Drug stability and its importance in pharmaceutical formulation development. Biopharmaceutical approaches in pharmaceutical development: solubility and dissolution; physiological aspects of drug release and drug dissolution testing; biorelevant dissolution testing; the principles of drug absorption; evaluation of drug absorption potential. Biopharmaceutical classification system. Physiological factors influencing drug bioavailability administered by different routes of administration. Drug dissolution in vitro and in vivo. Drug dissolution from different dosage forms. In vitro - in vivo correlation. Principles of different dosage forms development. Regulatory aspects of pharmaceutical development. QbD concept in pharmaceutical development. Principles of drug product optimisation. Experimental design - principles and application in pharmaceutical development.			
Recommended literature: 1. Gibson M. Pharmaceutical preformulation and formulation, 2nd ed. Informa Healthcare, 2009; 2. Florence and Attwood. Physicochemical Principles of Pharmacy, Pharmaceutical press, 2006; 3. Aulton ME. Pharmaceutics - the science of dosage form design, 2nd ed. Churchill Livingstone, 2002; 4. Encyclopedia of pharmaceutical Technology, Swarbrick J., Boylan J.C.; second edition, marcel Dekker Inc., New York, Basel, 2002; 5. Pharmaceutical Dissolution Testing, editors Jennifer J. Dressman, Johannes Kramer, Informa Healthcare, 2005; 6. Physiological Pharmaceutics: Barriers to Drug Absorption, by Neena Washington, Clive Washington, Clive Wilson, CRC 2000;			
The total of active learning classes	Lectures: 60		
	Individual research work: 60		
Teaching methods: Lectures, interactive lectures, simulation workshops, seminars			
Grading system: Pre-exam (homeworks and presentations) up to 50 points; Final written exam up to 50 points.			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Theoretical aspects of liquid and semisolid pharmaceutical dosage forms			
Teachers: Savić D. Snežana, Đekić M. Ljiljana, Krajišnik R. Danina			
Course status: Mandatory modules, module: Pharmaceutical Technology			
Semester: I		Year of studies: I	
ECTS points: 5		Course code: ДФТ1ОМ2	
Requirements: /			
Course aims: Knowledge of theoretical and practical aspects of colloidal systems / conventional and nanodispersed systems such as emulsions and suspensions, and techniques for their characterization for the purpose of formulation of stable, efficient and safe conventional and advanced dosage forms/drug carriers.			
Course outcomes: The students are able to solve a research problem in the field of colloidal systems / conventional and nanodispersed systems i.e., in formulation development of conventional and advanced pharmaceutical dosage forms/drug carriers and know techniques for their characterization.			
Course contents: Dispersions. Theories on stabilisation of different colloidal systems: DLVO theory, theory of steric and electrosteric stabilisation. Characteristics of colloids. Zeta potential. Physical stability of colloidal systems for pharmaceutical application. Phenomenon on the surfaces and interfaces. Rheology of the pharmaceutical systems. Surfactants. Micellization, solubilization. Liquid crystals state. Dispersions. Suspensions. Mechanisms of stabilisation of suspensions. Emulsions and mechanisms of stabilisation of emulsions. Nanoemulsions obtained by high-energy and low-energy emulsification methods. Nanosuspensions - suspensions of nanocrystals. Nanoparticles - liquid dispersions of nanoparticles. Techniques for characterisation of colloids with different dispersity grade and consistency: photon correlation spectroscopy, laser diffraction analysis, microscopy (light, polarizing, and transmission electron microscopy), Cryo-electron microscopy, fluorescent microscopy, Raman spectroscopy, Atomic force microscopy, Differential scanning calorimetry, Thermogravimetric analysis, Rheological characterisation, x-ray diffraction.			
Recommended literature: 1. Vuleta G, Milić J, Primorac M, Savić S. Farmaceutska tehnologija I, Farmaceutski fakultet Beograd, 2012. 2. Florence & Attwood. Physicochemical Principles of Pharmacy, Pharmaceutical Press 2009. 3. Gibson M. Pharmaceutical Preformulation and Formulation, Informa Healthcare 2009. 4. Savić S. Fizičko-hemijski aspekti i in vitro/in vivo karakterizacija emulzionih sistema sa nejonskim emulgatorima tipa šećernog etra. Farmaceutski fakultet Beograd, 2004. 5. Selected journal papers: Advanced Drug Delivery Reviews, European Journal of Pharmaceutics and Biopharmaceutics, European Journal of Pharmaceutics, Internaional journal of Pharmaceutics, Current Opinion in Colloid and Interface Science, Advances in Colloid and Interface Science.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures, interactive methods, seminars.			
Grading system: Pre-commitments: seminar - maximum 50 points; exam (written/test): maximum 50 points			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Formulation and characterization of pharmaceutical dosage forms for cutaneous application			
Teachers: Vuleta M. Gordana, Đekić M. Ljiljana, Savić D. Snežana			
Course status: Mandatory modules, module: Pharmaceutical Technology			
Semester: II		Year of studies: I	
ECTS points: 5		Course code: ДФТ10М3	
Requirements: Preformulation and formulation research and development, Theoretical aspects of liquid and semisolid pharmaceutical dosage forms			
Course aims: Introduction in theoretical and practical aspects of dermal and transdermal drug delivery, influence of the factors relevant for selection of optimal formulation of the dosage form, biopharmaceutical aspects of cutaneous drug application and current methods for in vitro and in vivo characterization of pharmaceutical preparations for cutaneous application.			
Course outcomes: The students are able to apply theoretical and practical aspects of formulation of dosage forms for cutaneous application and methods for their characterization, through an individual research work.			
Course contents: Considerations on the importance of the design and development of pharmaceutical preparations for cutaneous application. Specificity of the cutaneous dosage forms development. Criteria for selection of: pharmaceutical excipients regarding a pharmaceutical dosage form type or skin disease type (skin condition), aspects of dermal and transdermal drug delivery. Influence of the vehicle of the semi-solid preparations for cutaneous application on drug release and effects in local therapy. Theoretical aspects of penetration, permeation and percutaneous absorption of the drugs and physical and chemical approaches for skin barrier properties modification, in order to affect the diffusion rate of a permeant. Chemical penetration enhancers of the drugs. Biological and physico-chemical factors relevant for percutaneous penetration and permeation. Principles of development of pharmaceutical preparations for cutaneous application: ointments, creams, gels. Transdermal drug delivery systems: transdermal patches (basic types: drug-in-adhesive type, matrix type, reservoir type) and other systems (application of microneedles). In vitro and in vivo methods for characterization of pharmaceutical dosage forms for cutaneous application. In vitro diffusion models (with different membranes) for evaluation of drug release and percutaneous penetration/permeation.			
Recommended literature: 1. Vuleta G, Milić J, Primorac M, Savić S. Farmaceutska tehnologija I, Farmaceutski fakultet Beograd, 2012. 2. Gibson M. Pharmaceutical Preformulation and Formulation, Informa Healthcare 2009. 3. Niazi S. Handbook of Pharmaceutical Manufacturing Formulations: Semisolid Products, CRC Press, 2004. Savić S. 4. Remington: The Science and Practice of Pharmacy, 22nd ed., Pharmaceutical Press, 2012. 5. Allen LV, Popovich NG, Ansel HC. Ansel's Pharmaceutical Dosage Forms and Drug Delivery Systems, Lippincot Williams & Wilkins, Philadelphia, 2005. 6. Voight R. Pharmazeutische Technologie, Deutscher Apotheker Verlag, Stuttgart, 2006.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures, interactive methods with problem simulations, individual research work.			
Grading system: Pre-commitments: seminars (minimum 30 points); exam (written) (minimum 70 points).			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Theoretical aspects of parenteral and ophthalmic preparations			
Teachers: Milić-Aškrabić R. Jela, Krajišnik R. Danina			
Course status: Mandatory modules, module: Pharmaceutical Technology			
Semester: II		Year of studies: I	
ECTS points: 5		Course code: ДФТ10М4	
Requirements: non			
Course aims: Knowledge of formulation theoretical and practical aspects of parenteral and ophthalmic preparations, which will serve to doctoral students as the basis for their application in independent researches within the doctoral studies in pharmaceutical sciences – elective module/area pharmaceutical technology as well as in the future professional activities.			
Course outcomes: Application of advanced knowledge related to theoretical and practical aspects of the formulation of parenteral and ophthalmic preparations and methods for their characterization within the independent researches.			
Course contents: Formulation considerations of parenteral preparations: physiological, physicochemical and pharmaceutical technological requirements. The requirement for sterility of parenteral preparations – the impact on formulation and principles of the preparation development. Excipients for parenteral preparations and factors significant for their choice. Strategies for formulation of parenteral dosage forms with poorly soluble active substances, unstable molecules and macromolecules. Novel drug carriers for parenteral administration. Methods for the characterization of various pharmaceutical formulations/drug carriers for the parenteral administration during preformulation and formulation. Quality requirements for the parenteral preparations. Factors important for the stability of parenteral preparations. Compatibility problems related to interaction of parenteral preparations and containers as well as mixing of several parenteral preparations. Factors relevant for formulation of ophthalmic preparations (anatomical and physiological features of the eye, the physicochemical properties of the drug substance). Types and characteristics of the pharmaceutical dosage forms for application to the eyeball and in the conjunctival sac. Excipients in ophthalmic preparations and factors significant for their choice. Quality requirements for the ophthalmic preparations. Approach for optimizing ocular drug availability in the local administration. Novel dosage forms and drugs carriers for ophthalmic administration. Methods for the characterization of some pharmaceutical formulations/drug carriers for ophthalmic administration during preformulation and formulation.			
Recommended literature: 1. Pharmaceutical preformulation and formulation, 2nd ed., Mark Gibson (Ed.), Informa Healthcare, New York, 2009 2. Avis K.E. and Avis A.E. Pharmaceutical Dosage Forms: Parenteral Medications, Lippincott Williams &Wilkins, 1992 3. Remington: The Science and Practice of Pharmacy, 22nd ed. Pharmaceutical Press, Gurnee, 2012 4. Encyclopedia of Pharmaceutical Technology, Swarbrick J., Boylan J.C., second edition, vol. 1-3, Marcel Dekker Inc., New York, Basel, 2002 5. Katdare A., Chaubal M.V. (eds.), Excipient Development for Pharmaceutical, Biotechnology and Drug Delivery Systems, informa healthcare, New York, London, 2006 6. Avis K.E, Sterile Pharmaceutical Products: Process Engineering Applications, CRC, 1995 7. Turco S.J., Sterile Dosage Forms Their Preparation and Clinical Application, Lippincott Williams &Wilkins, 1994			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures, interactive sessions			
Grading system: Exam prerequisites: 50 points; Final exam: 50 points			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Theoretical Aspects of Solid Dosage Forms			
Teachers: Đurić R. Zorica, Parojčić V. Jelena, Ibrić R. Svetlana, Đuriš D. Jelena, Vasiljević D. Dragana			
Course status: Mandatory modules, module: Pharmaceutical Technology			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: ДФТ2ОМ1	
Requirements: previously completed course Preformulation and Formulation Research and Development			
Course aims: To provide students with knowledge about theoretical and practical aspects of formulation of solid dosage forms, so that they can acquire competences to perform independent research activities within doctoral studies in Pharmaceutical Sciences – Modul Pharmaceutical Technology, and later on, related research activities in practice.			
Course outcomes: Application of theoretical and practical aspects of formulation and manufacturing procedures of solid dosage forms, and methods for their characterization in the independent research activities.			
Course contents: Modern approaches in the formulation of solid dosage forms. Solid dispersions (methods of preparation, characterization). Hard capsules. Soft capsules. Fast-dissolving solid oral dosage forms. Powder characterization (particle size, flowability, density, porosity). Compressibility and compactibility. Theoretical aspects of compression. Analysis of the material characteristics which are important for the compression. Compaction simulators. Basic principles of the formulation of inhalation powders (particle size, disposition in the lungs, impaction). Pelets. Characteristics of the pharmaceutical excipients for solid dosage forms. Multifunctional excipients. Characteristics of pharmaceutical operations in the preparation (production) of solid dosage forms. Milling. Mixing. Granulation (hot-melt granulation, fluidized-bed granulation, granulation in high-shear mixers). Tableting. Extrusion. Spheronization. Equipment for the manufacturing of solid dosage forms. Tablet machines: instrumentation of tablet machines. Fluidized-bed granulation: types and characteristics of the equipment. Concept of continuous production of solid dosage forms. Application of spray drying in the production of solid dosage forms. Application of lyophilization in the production of solid dosage forms. Analysis of solid dosage forms. Principles of Process Analytical Technology–PAT in the production of solid dosage forms. Process control in the production of solid dosage forms.			
Recommended literature: 1. Handbook of Pharmaceutical Granulation Technology, Second Edition by Dilip M. Parikh (Editor), Taylor & Francis, 2005. 2. Pharmaceutical Powder Compaction Technology. Editors: G Alderborn, C Nystrom, New York: Marcel Dekker, 1995. 3. Pharmaceutical Principles of Solid Dosage Forms by Jens T. Carstensen, Informa Health Care 1993. 4. Handbook of Pharmaceutical Excipients by Raymond C. Rowe, Paul J. Sheskey, Siân C. Owen, 4th edition, McGraw-Hill 2005. 5. Pharmaceutical Dosage Forms-tablets by Herbert A. Lieberman, Leon Lachman, Joseph B. Schwartz, Informa Health Care, 1990. 6. Encyclopedia of Pharmaceutical Technology, Swarbrick J., Boylan J.C., second edition, Marcel Dekker Inc., New York, Basel, 2002.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Theoretical classes, interactive classes including demonstrations and simulation integrated with problem-based learning, laboratory and computer practical classes.			
Grading system: Pre-exam requirements: practical work/elaborate study/seminar paper – maximum 50 points; final exam: written – maximum 50 points.			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Theoretical Aspects of Modified Release Dosage Forms/Drug Delivery Systems			
Teachers: Primorac M. Marija, Ibrić R. Svetlana, Đekić M. Ljiljana, Cvijić V. Sandra			
Course status: Mandatory modules, module: Pharmaceutical Technology			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: ДФТ2ОМ2	
Requirements: none			
Course aims: To provide students with knowledge about theoretical and practical aspects of the formulation of modified release dosage forms/drug delivery systems for different dosage routes, so that they can acquire competences to perform independent research activities within doctoral studies in Pharmaceutical Sciences – Modul Pharmaceutical Technology.			
Course outcomes: Application of theoretical and practical knowledges regarding formulation of modified release dosage forms/drug delivery systems in the independent research activities within doctoral studies, and later on in practise.			
Course contents: Formulation approaches for modified release dosage forms. Mechanisms of modified drug release (practical examples). Diffusion-controlled drug release. Dissolution-controlled drug release. Swelling-controlled drug release. Osmosis-controlled drug release. Programmed drug release. Matrix type drug delivery systems. Pharmaceutical excipients for oral modified release dosage forms. Modified release dosage forms for the use in the mouth. Multiparticulate drug delivery systems. Modern aspects of the formulation of drug delivery systems. Ocular, intravaginal/intrauterine, peroral, parenteral, pulmonary, buccal, nasal and transdermal drug delivery systems. Chronotherapeutic drug delivery systems: classes and characteristics. Target drug delivery systems. Colon-specific drug delivery systems. Colloidal drug carriers. Biopharmaceutical aspects of oral modified release preparations. Specificities of modified release dosage forms assessment.			
Recommended literature: 1. Wen H., Park K., Oral Controlled Release Formulation Design and Drug Delivery, John Wiley & Sons, New Jersey, 2010. 2. Allen L.V., Popovich N.G., Ansel H.C., Ansel's Pharmaceutical Dosage Forms and Drug Delivery Systems, Lippincot Williams&Wilkins, Philadelphia, 2005. 3. Encyclopedia of Pharmaceutical Technology, Swarbrick J., Boylan J.C., second edition, vol. 1-3, Marcel Dekker Inc., New York, Basel, 2002. 4. Rathbone M.J., Hadgraft J., Roberts M.S., Modified-Release Drug Delivery Technology, Marcel Dekker, Inc., New York, Basel, 2003. 5. Одабрани радови из часописа: Advanced Drug Delivery Reviews, European Journal.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Theoretical classes, interactive classes, seminars.			
Grading system: Pre-exam requirements: seminar paper – maximum 50 points; final exam: written – maximum 50 points.			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Physico-chemical phenomena and instrumental methods			
Teachers: Mirjana B. Medenica, Nataša D. Pejić			
Course status: elective, module: Pharmaceutical Technology			
Semester: II		Year of studies: I	
ECTS points: 5		Course code: ДФТ1И1	
Requirements: no			
Course aims: Introduction to the selected physical and chemical phenomena and instrumental techniques which candidates will use in his doctoral dissertation			
Course outcomes: Knowledge of the theoretical principles of physical and chemical phenomena, as well as performing selected techniques and methods during the experimental work, and in the interpretation of the obtained results.			
Course contents: Selected topics of colloid chemistry : kinetic, electrical and optical properties of colloids, surfactants. Theoretical aspects of rheology : Newtonian and Non-Newtonian systems, viscoelastic systems. Physicochemical surface properties: surface tension, adsorption, wetting . Chemical Kinetics: Theoretical aspects and analysis of kinetic data. X-ray powder diffraction analysis: principles, instrumentation, sample preparation, the use of structural analysis, monitoring the conversion of solid phase during the production of the drug, the determination of impurities. Absorption (atomic and molecular absorption spectrophotometry), fluorimetry and Raman spectroscopy methods: principles, techniques and instrumentation applications. Infrared spectroscopy with Fourier transform : principle, instrumentation, application to the analysis of the active principle in a solid and semisolid pharmaceutical formulations. Mass spectrometry: principles, instrumentation and applications. Nuclear magnetic resonance imaging: principles, applications for the confirmation of the chemical structure and the analysis of the active principle. Turbidimetry and nephelometry: application to the determination of the concentration of the system , and solubilization. Thermal methods of analysis (thermogravimetry and differential scanning calorimetry) principles, instrumentation, sample preparation, interpretation of thermogram, the application for the determination of physicochemical properties of different pharmaceutical products, the stability of the active principles and excipients and water content. Selected methods for the electrochemical determination of ingredients in pharmaceutical products (e.g., water) , as well as the characteristics of the surfactants.			
Recommended literature: . Skoog D, Holler FJ, Niemen TA. Principles of Instrumental Analysis (5th ed.). Philadelphia: Saunders College Publishing; 1998.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures, interactive lectures.			
Grading system: Pre-exam (homeworks and presentations) up to 50 points; Final written exam up to 50 points.			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Formulation and characterization of herbal medicines			
Teachers: Vuleta M. Gordana, Kundaković D. Tatjana, Vasiljević D. Dragana			
Course status: elective, module: Pharmaceutical Technology			
Semester: II		Year of studies: I	
ECTS points: 5		Course code: ДФТ1И2	
Requirements: Pharmaceutical preformulation and formulation			
Course aims: Introduction to the theoretical and practical aspects of the formulation, and the specific characteristics of herbal medicines. Knowledge of the active ingredients of plant origin (herbal drugs, herbal drugs preparation), their chemical composition and stability, in order to select the most appropriate formulation of the pharmaceutical form , and herbal drug, as well as the production procedure.			
Course outcomes: Knowledge of the chemical and other properties of the active substances of plant origin and specific characteristics of plant drugs, important to select the most appropriate formulation and the appropriate herbal medication, for a particular route of administration, as well as a method for their characterization.			
Course contents: Introduction to herbal medicines and specificity of this group of products. Active components (herbal drug preparations, herbal drugs) and their chemical composition. The most important aspects of herbal drugs and herbal drug preparations. Herbal extracts. Methods selection and conditions of extraction depending on the desired characteristics of the extracts. Considerations relevant for the development of the pharmaceutical formulation of the drug for a particular plant routes of administration. Specific features of the development of herbal medicines and herbal medicines characteristics. The criteria for the choice of auxiliary substances (excipients) in relation to the physicochemical properties and stability of the active ingredients of plant origin (herbal drug preparations, herbal drugs), pharmaceutical form of the medicinal product and the production process of plant medicine. Modern pharmaceutical forms of herbal medicines. Methods for characterization of herbal medicines.			
Recommended literature: 1. Vuleta G, Milić J, Primorac M, Savić S, Farmaceutska tehnologija I, Farmaceutski fakultet, Beograd, 2012. 2. ESCOP Monographs. Stuttgart: Georg Thieme Verlag, 2003. 3.Community Monographs: www.ema.europa.eu 4. Voigt R, Pharmazeutische Technologie, Deutscher Apotheker Verlag, Stuttgart, 2006. 5. Vallisuta O, Olimat S. (Ed). Drug Discovery Research in Pharmacognosy. InTech, Rijeka, 2012			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures, work in group, seminars			
Grading system: Pre-commitments: practical work/display problems/essay - maximum 40 points; final exam: Oral - maximum 60 points			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Pharmacokinetics			
Teachers: Miljković R. Branislava, Vezmar Kovačević D. Sandra, Vučićević M. Katarina			
Course status: elective, module: Pharmaceutical Technology			
Semester: II		Year of studies: I	
ECTS points: 5		Course code: ДФТ1И3	
Requirements: none			
Course aims: The aim of the course is to provide students with relevant tools needed for understanding the importance of the pharmacokinetics and drug metabolism in drug development, different designs of pharmacokinetic trial depending on the phase of drug development, for performing and critical appraisal of clinical pharmacokinetics and bioequivalence trials.			
Course outcomes: On completion of the course, the student will be able to apply drug's pharmacokinetic and metabolism characteristics into the decision-making process related to drug's development and critically appraise pharmacokinetic and bioequivalence studies.			
Course contents: Prediction of pharmacokinetic processes, metabolism and parameter values based on physico-chemical characteristics of a drug candidate. Assessment of ADME processes of the drug candidate. Prediction of the pharmacokinetics in humans (allometric approach, physiological models). Pharmacokinetic profiles and parameters depending on the route of drug administration. Pharmacokinetics of biological drugs. Pharmacokinetics of modified release drug preparations. Regulatory aspects in pharmacokinetic trials. Preparing reasearch protocol for clinical pharmacokinetic and bioequivalence studies according to regulatory aspects. Design of pharmacokinetic and bioequivalence trials. Performing pharmacokinetic and bioequivalence trials. Calculation of pharmacokinetic parameters using different pharmacokinetic approaches to data analysis. Data interpretation, statistical tests in analysing pharmacokinetic parameters from pharmacokinetic and bioequivalence trials. Interpretation of the pharmacokinetic and statistic results. Preparing the report of pharmacokinetic and bioequivalence trials. Critical appraisal of pharmacokinetic and bioequivalence trials.			
Recommended literature: 1. Shargel L, Wu-Pong S, Yu A. Applied Biopharmaceutics & Pharmacokinetics, 6th ed. McGraw-Hill, 2012. 2. Rowland M, Tozer TN. Clinical Pharmacokinetics and Pharmacodynamics: Concepts and Applications, 4th ed. Lippincott Williams & Wilkins, 2011. 3. Krishna R (ed). Applications of Pharmacokinetic Principles in Drug Development, 1st ed. Springer, 2003. 4. Coleman M. Human drug metabolism, 2nd ed. Wiley, 2010. 5. Chow S-C, LiuJ-P. Design and Analysis of Bioavailability and Bioequivalence Studies, 3rd ed. Chapman and Hall/CRC, 2008.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Theoretical lectures, problem-based learning.			
Grading system: Pre-exam activities - seminar 30 points. Final exam 70 points.			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Pharmaceutical Analysis and Quality Control			
Teachers: Anđelija M. Malenović, Biljana S. Stojanović			
Course status: elective, module: Pharmaceutical Technology			
Semester: II		Year of studies: I	
ECTS points: 5		Course code: ДФТ1И4	
Requirements: /			
Course aims: Acquiring knowledge from pharmaceutical analysis important for quality control in development and formulations of drugs, as well in quality control of final medical product			
Course outcomes: Getting knowledge on quality of medical products including knowledge on methods needed for quality control			
Course contents: The methods important for drug analysis during formulation development. Separation methods for drug analysis in formulation development. Chromatographic parameters and criteria for the evaluation of chromatographic analysis quality. The types of chromatographic methods. Characteristics of the stationary phase and selection of the proper type . Modifications of mobile phases (ion-pair chromatography, ion suppression). Ultra High Performance Liquid Chromatography, characteristics and possibilities for application. Development of chromatographic methods for a particular analysis. Discussion on the implications to the method characteristics (sample properties, detector types, solution stability, selection of the stationary phase and mobile phase, etc). Other chromatographic methods important for estimation of product quality in different phases of formulation development with special attention on gas chromatographic methods and inverse gas chromatographic methods. The principles and theoretical foundations of thermal analysis. Evaluation of thermal analysis methods: thermogravimetry - TG, derivative thermogravimetry - DTG , thermogravimetric analysis - TGA, differential thermal analysis - DTA and differential scanning calorimetry - DSC. Possibilities and importance of application of TGA for drug characterization and importance for formulation development. Quality control and definition of specifications in different phases of development, drug manufacturing and drug release. Compendial methods and validation of new qualitative and quantitative methods for drug analysis. Legislative and evaluation of product quality.			
Recommended literature: 1. Kazakevich, Y., Lobrutto, R., Editors: HPLC for pharmaceutical scientist. John Wiley & Sons, Inc., New York,USA 2007. 2. Ahuja, S.: Chromatography and separation science. Volume 4 of Separation science and technology, Academic Press, San Diego, USA 2003. 3. Craig, D. Q. M., Reading, M.: Thermal Analysis of Pharmaceuticals. CRC Press is an imprint of Taylor & Francis Group, an Informa business, Boca Raton, USA, 2007. 4. Gabbott P., Editor: Principles and Applications of Thermal Analysis, Blackwell Publishing Ltd ,Oxford, UK 2008. 5. Ahuja, S., Scipynski, S., Editors: Handbook of Modern Pharmaceutical Analysis. Academic Press, San Diego, 2001.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures, workshops, seminars, interactive teaching and internet.			
Grading system: Pre-exam engagements: 30 points Final exam: 70 points			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Drug Stability			
Teachers: Ibrić R. Svetalana			
Course status: elective, module: Pharmaceutical Technology			
Semester: II		Year of studies: I	
ECTS points: 5		Course code: ДФТ1И5	
Requirements: Pharmaceutical preformulation and formulation			
Course aims: Introduction into drug stability and evaluation of drug stability			
Course outcomes: Application of techniques for evaluation of drug stability.			
Course contents: Investigation into drug stability in preformulation and formulation stages of drug development. Introduction into methods for drug stability evaluation. Functional changes in farmaceutical dosage forms in time. Effects of packaging on drug stability. Stabilization of drugs in dosage forms. Estimation of shelf life (pratical examples). Regulatory requirements for drug stability.			
Recommended literature: 1. Stability of Drugs and Dosage Forms by Yoshioka, Sumie.; Stella, Valentino J. New York Kluwer Academic Publishers, 2002. 2. Chemical Stability of Pharmaceuticals: A Handbook for Pharmacists by Kenneth Antonio Connors, Informa Health Care, 2000. 3. Drug Stability, Principles and Practices, Kenneth Antonio Connors, Wiley-IEEE, 1986.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures, interactive lectures, simulation workshops			
Grading system: Pre-exam (homeworks and presentations) up to 30 points; Final written exam up to 70 points.			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Application of optimization techniques in Pharmaceutical Technology			
Teachers: Ibrić R. Svetlana, Đuriš D. Jelena			
Course status: elective, module: Pharmaceutical Technology			
Semester: II		Year of studies: I	
ECTS points: 5		Course code: ДФТ1И6	
Requirements: /			
Course aims: Introduction into experimental design and artificial neural network and their application in pharmaceutical technology			
Course outcomes: Certain experimental design techniques, as well as artificial neural networks, student may apply in own research.			
Course contents: Fundamentals of experimental design. Screening experimental design. Fractional experimental design. Analysis of factor effects. Full factorial desing. Response surface methodology application. Mixture experimental design. Fundamentals in artificial neural networks and their application in pharmaceutical technology. Multilayer perceptron. Generalizer Rgression Neural Network. Dynamic artificial neurla networks.			
Recommended literature: 1. Djuris J. (Ed.) Computer aided applications in pharmaceutical technology. Woodhead Publishing, Cambridge, United Kingdom. 2013. 2. Ибрић С. Примена математичке теорије експеримената у фармацеутској технологији, Констиси, Београд, 2006. 3. Lewis G.A. (Ed.) Pharmaceutical Experimental Design. Marcel Dekker. New York, 1999. 4. Rajasekaran S, Vijayalakshmi Pai GA. Neural networks, fuzzy logic and genetic algorithms: synthesis and applications. Prentice-Hall, New Delhi, India, 2003.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures, interactive lectures, simulation workshops			
Grading system: Pre-exam (homeworks and presentations) up to 30 points; Final written exam up to 70 points.			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Methodologies in Biopharmaceutical Drug Characterization			
Teachers: Parojčić V. Jelena, Cvijić V. Sandra, Owen I. Corrigan			
Course status: elective, module: Pharmaceutical Technology			
Semester: II		Year of studies: I	
ECTS points: 5		Course code: ДФТ1И7	
Requirements: none			
Course aims: A student should get to know the methodology and application of biopharmaceutical drug characterization in order to be able to perform independent research activities within doctoral studies in Pharmaceutical Sciences – Modul Pharmaceutical Technology, and later on, related research activities in practice.			
Course outcomes: The application of various methods in biopharmaceutical drug characterization.			
Course contents: Biopharmaceutics Drug Classification Systems. Present techniques for solubility determination. In vitro, in vivo and in silico methods for the prediction/determination of drug permeability. In vitro and in vivo methods for determination of drug dissolution rate from different pharmaceutical preparations. Biorelevant media. In vitro, in vivo and in silico methods for the assessment of food effects on oral drug absorption. Recent methods for the evaluation of the influence of transporters on oral drug absorption. In silico absorption prediction. Mathematical modeling of drug absorption process. In vitro-in vivo correlation: Application of linear and nonlinear models. Biopharmaceutical characterization of herbal drugs. Regulatory aspects and the importance of biopharmaceutical drug characterization.			
Recommended literature: 1. Drug Bioavailability: Estimation of Solubility, Permeability, Absorption and Bioavailability, H. Waterbeemd, H. Lennernäs, P. Artursson, editors, Wiley-VCH, Weinheim. 2006. 2. Biopharmaceutics applications in drug development, R. Krishna, L.Yu, editors, Springer, New York. 2008. 3. Pharmaceutical Dissolution Testing, J. Dressman, J. Kramer, editors, Taylor and Francis Group, Boca Raton. 2005. 4. Physiological Pharmaceutics: Barriers to Drug Absorption, N. Washington, C. Washington, C. Wilson, Taylor & Francis Series in Pharmaceutical Sciences. 2001.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Theoretical classes, interactive classes including demonstrations, problem based learning.			
Grading system: Pre-exam requirements: practical work/elaborate study/seminar paper – maximum 40 points; final exam: written – maximum 60 points.			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Polymers for pharmaceutica/medical applications			
Teachers: Milić-Aškračić R. Jela, Krajišnik R. Danina			
Course status: elective, module: Pharmaceutical Technology			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: ДФТ2И1	
Requirements: no			
Course aims: Advancement of knowledge related to the types and characteristics of the polymers used in the formulation of pharmaceutical dosage forms/drug carriers, as well as the factors relevant for polymer selection, which would serve as a basis for individual research within the doctoral studies and future professional activities.			
Course outcomes: Ability to apply the acquired knowledge to individual consideration of polymeric material characteristics relevant for their application in formulation of pharmaceutical dosage forms/drug carriers.			
Course contents: Polymers in medical/biomedical products: reasons and objectives of the application. The types and properties of polymer materials for pharmaceutical application (conventional dosage forms, drug carriers of drugs and therapeutic systems). Characteristics and application of: hydrophilic polymers, hydrogels (cross-linked hydrated polymer), micelle-forming polymers (self-associative polymers). Characteristics of biodegradable polymers. Polymers that change structure and properties in response to environmental factors ("Smart"/" Intelligent " polymers). Methods for polymers characterization in drug preformulation and formulation studies. GRAS (Generally Recognized As Safe) status of polymers. Correlation between a polymer structure and properties - significance for drug carriers. Polymer-drug conjugates (polymer therapeutics).			
Recommended literature: 1. Kwon G.S. (ed.), Polymeric Drug Delivery Systems, Taylor S. Francis, Boca Raton, London, 2005. 2. Remington: The Science and Practice of Pharmacy, 22nd ed. Pharmaceutical Press, Gurnee, 2012. 3. Fried, J. R., Polymer Science and Technology, Prentice Hall, New Jersey, 2003. 4. Rowe R.C., Sheskey P.J., Owen S.C., (eds.), Handbook of Pharmaceutical Excipients. Pharmaceutical Press and American Pharmacists Association, London, Washington 2008. 5. Malmsten M. Surfactants and Polymers in Drug Delivery, Marcel Dekker Inc, New York, 2002. 6. Evans D. and Wennerström H., The colloidal Domain-Where Physics Chemistry, Biology, and Techology Meet ,Wiley-VCH, New York, 1999. 7. Pürma J., Polymeric Surfactants, Marcel Dekker,New York,1992.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures, interactive sessions			
Grading system: Exam prerequisites: 50 points; Final exam: 50 points.			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Drug delivery carriers			
Teachers: Primorac M. Marija, Đekić M. Ljiljana			
Course status: elective, module: Pharmaceutical Technology			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: ДФТ2И2	
Requirements: Preformulation and formulation research and development			
Course aims: Knowledge of characteristics and application of novel drug carriers (liposomes, elastic vesicular carriers, microparticles, nanoemulsions, microemulsions, polymeric micelles, dendrimers, cyclodextrins and solid dispersions). Introduction in methods for physico-chemical and biopharmaceutical characterisation of drug delivery carriers. Introduction in major strategies for development of pharmaceutical formulations with drug delivery carriers.			
Course outcomes: The students know characteristics and application of novel drug carriers (liposomes, elastic vesicular carriers, microparticles, nanoemulsions, microemulsions, polymeric micelles, dendrimers, cyclodextrins and solid dispersions). They are familiar with the methods for physico-chemical and biopharmaceutical characterisation of drug delivery carriers. The students are introduced in major strategies for development of pharmaceutical formulations with drug delivery carriers.			
Course contents: Liposomes - types, characteristics and applications. Elastic vesicular carriers (transfersomes, ethosomes and invasomes). Microparticles (microcapsules and microspheres) - characteristics and applications. Nanoparticles (polymeric nanoparticles and solid lipid nanoparticles) - characteristics and applications. Nanoemulsions. Microemulsions. Polymeric micelles. Dendrimers. Cyclodextrins. Solid dispersions. Physicochemical and biopharmaceutical characterisation of liposomes, elastic vesicular carriers, microparticles, nanoemulsions, microemulsions, polymeric micelles, dendrimers, cyclodextrins and solid dispersions by applying different techniques (photon correlation spectroscopy, fourier transform infrared spectroscopy (FT-IR), differential scanning calorimetry (DSC), thermogravimetric analysis (TGA), scanning electron microscopy (SEM), transmission electron microscopy (TEM), optical microscopy, polarising light microscopy, rheological characterisation). Major approaches in development of pharmaceutical formulations with drug delivery carriers for different routes of application.			
Recommended literature: 1. Fanun M, Colloids in Drug Delivery, CRC Press/Taylor and Francis Group, Boca Raton, 2010. 2. Rathborne MJ, Hadgraft J, Roberts MS, Modified-Release Drug Delivery Technology, Marcel Dekker, Inc., New York, Basel, 2003. 3. Encyclopedia of Pharmaceutical Technology, Swarbrick J, Boylan JC, second edition, vol. 1-3, Marcel Dekker Inc., New York, Basel, 2002. 4. Gibson M. Pharmaceutical Preformulation and Formulation, Informa Healthcare 2009.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures, interactive methods, problem-based learning.			
Grading system: Pre-commitments: seminars - 50 points; exam (written): 50 points			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Selected chapters of pharmaceutical biotechnology			
Teachers: Savić D. Snežana			
Course status: elective, module: Pharmaceutical Technology			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: ДФТ2И3	
Requirements: Passed exams at compulsory courses of the module Pharmaceutical Technology at I and II school year of doctoral studies. студија			
Course aims: The aim of the course is to provide the participant with knowledge of preparation/manufacturing procedures, characterization techniques, properties, carrier systems, efficacy and safety aspects of proteins/peptide drugs and monoclonal antibodies.			
Course outcomes: By the end of this course participant should have a knowledge on preparation procedures, characterization techniques and administration of biological drugs/biopharmaceutics in human medicine.			
Course contents: Administration and distribution routes for proteins – parenteral rout, oral rout, alternative administration routes; Carrier systems and mechanisms for targeted drug delivery – colloidal particulate systems, mechanical pumps, biosensor pumps, osmotic-dependent systems, microencapsulated secretor cells; Excipients in formulation of biologics/biopharmaceutics; Microbiological quality of protein drugs; Monoclonal antibodies (mAbs) as carrier systems, human and humanized antibodies, biospecific antibodies, immunoconjugates; Pharmaceutical consideration of monoclonal antibodies-based drugs (examples). Regulatory affairs in marketing authorization of biologics and biosimilars; Stabilization techniques for improvement of proteins and mAbs: mutagenesis of primary sequences, pegylation technique, encapsulation technique into micro- and nanosystems. Some examples of biopharmaceutics: insulins, erythropoietins, colony-stimulating factors, coagulation factors, mAbs, vaccines produced by biotechnology procedures.			
Recommended literature: 1.Crommelin DJA, Sindelar RD. eds Pharmaceutical Biotechnology. 2nd ed. Philadelphia, Penn: Taylor&Francis , Inc; 2012. 2. Allen LV, Popovich NG, Ansel HC. Eds Ansel's Pharmaceutical Dosage Forms and Drug Delivery Systems, 8th ed. Philadelphia, Lippincott Williams&Wilkins, 2010. 3. Groves M. Pharmaceutical Biotechnology, 2nd Ed., Taylor&Francis Group LLC, New York, 2006. 4. Selected papers from international peer review journals: Journal of Biotechnology, Nature Biotechnology, Trends in Biotechnology.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures, and study-research work.			
Grading system: Seminar: 30 points; written exam: maximal 70 points.			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Micro- and nanoencapsulation of drug substances			
Teachers: Đekić M. Ljiljana, Krajišnik R. Danina			
Course status: elective, module: Pharmaceutical Technology			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: ДФТ2И4	
Requirements: Preformulation and formulation research and development			
Course aims: Knowledge of characteristics of micro- and nanoencapsulated drugs (pharmaceutical technology and biopharmaceutical aspects). Introduction in preparation methods for potential drug carriers such as microemulsions, nanoparticles, liposomes, nanoemulsions, microemulsions and micelles, procedures for micro- and nanoencapsulation of the drugs and principles of analitical techniques suitable for their physico-chemical and biopharmaceutical characterisation. Introduction in major strategies for development of pharmaceutical formulations with micro- and nanoencapsulated drug substances.			
Course outcomes: The student knows pharmaceutical technology and biopharmaceutical aspects of micro- and nanoencapsulated drugs, knows and understands procedures of preparation of functional microparticles, nanoparticles, liposomes, nanoemulsions, microemulsions and micelles and micro- and nanoencapsulation of the drugs; knows principles of analytical techniques suitable for physicochemical and biopharmaceutical characterisation of potential drug carriers such as microparticles, nanoparticles, lipsomes, nanoemulsions, microemulsions and micelles; knows current approaches in development of pharmaceutical formulations with micro-/nanoencapsulated drug substances.			
Course contents: Approaches for improvement of pharmaceutical technology characteristics and biopharmaceutical profile of the drugs by micro-/nanoencapsulation. Major methods of preparation of functional microparticles, nanoparticles, liposomes, nanoemulsions, microemulsions and micelles (precipitation, coacervation, polymerization, surfactant self-assembly); phase behaviour of multicomponent systems comprising pharmaceutical excipients such as surfactants, and lipids, and applicability of phase behaviour studies in development of drug delivery carriers of nanoemulsion, microemulsion, micelles and liposome types. Major mechanisms of micro-/nanoencapsulation of the drugs (conjugation, adsorption, solubilization, dispersing). Methods for isolation/purification of micro-/nanoencapsulated drugs and strategies for their stabilisation. Analytical techniques suitable for physicochemical and biopharmaceutical characterisation of potential drug carriers such as microparticles, nanoparticles, liposomes, nanoemulsions, microemulsions and micelles, for different routes of administration (photon correlation spectroscopy, fourier transform infrared spectroscopy (FT-IR), differential scanning calorimetry (DSC), thermogravimetric analysis (TGA), scanning electron microscopy (SEM), transmission electron microscopy (TEM), optical microscopy, polarising light microscopy, rheological characterisation). Major approaches in development of pharmaceutical formulations with micro-/nanoencapsulated drug substances.			
Recommended literature: 1. Gad SC, Pharmaceutical Manufacturing Handbook: Production and Processes, Jonh Wiley & Sons, 2009. 2. Benita S. Microencapsulation: Methods and Industrial Applications (2nd ed.), Taylor & Francis, 2006. 3. Fanun M. Colloids in Drug Delivery, CRC Press / Taylor & Francis Group, Boca Raton, 2010. 4. Gibson M. Pharmaceutical Preformulation and Formulation, Informa Healthcare 2009.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures, interactive methods, problem-based learning.			
Grading system: Pre-commitments: seminars - 30 points; exam (written): 70 points			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Advanced concepts in data analysis			
Teachers: Đuriš D. Jelena, Ibrić R. Svetlana			
Course status: elective, module: Pharmaceutical Technology			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: ДФТ2И5	
Requirements: /			
Course aims: Introduction into multivariate analysis, machine learning techniques, expert systems, in silico tools and their application in pharmaceutical technology			
Course outcomes: Certain techniques and tools student may apply in own research			
Course contents: Multivariate analysis (chemometry in classification and/or regression), factor analysis, principal component analysis. Machine learning methods (fuzzy logic, decision trees, genetic algorithms, genetic programming, self-organizing maps). Expert systems and in silico tools. Application of these methods and tools in drug formulation.			
Recommended literature: 1. Djuris J. (Ed.) Computer aided applications in pharmaceutical technology. Woodhead Publishing, Cambridge, United Kingdom. 2013. 2. Ибрић С. Примена математичке теорије експеримената у фармацеутској технологији, Констиси, Београд, 2006. 3. Balakin KV. (Ed.) Pharmaceutical Data Mining. John Wiley & Sons, Inc., Hoboken, New Jersey, 2010. 4. Ekins S. (Ed.) Computer applications in pharmaceutical research and development. John Wiley & Sons, Inc., Hoboken, New Jersey, 2006. 5. Rajasekaran S, Vijayalakshmi Pai GA. Neural networks, fuzzy logic and genetic algorithms: synthesis and applications. Prentice-Hall, New Delhi, India, 2003.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures, interactive lectures, simulation workshops			
Grading system: Pre-exam (homeworks and presentations) up to 30 points; Final written exam up to 70 points.			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Selected topics in organic chemistry			
Teachers: Savić M. Vladimir			
Course status: Mandatory modules, module: Pharmaceutical Chemistry			
Semester: I		Year of studies: I	
ECTS points: 5		Course code: ДФХ10М1	
Requirements: None			
Course aims: To demonstrate general principles of synthetic methodologies such as solid phase synthesis, combinatorial and parallel synthesis and their application in drug design and development. To describe stereochemical properties of organic molecules and their significance for biological profile of drugs.			
Course outcomes: Acquired knowledge should provide a. understanding of some modern synthetic technologies and their application in drug design b. understanding of significance of drug stereochemical properties and their influence on biological behavior.			
Course contents: Basic stereochemical terms. Enantiomers and diastereoisomers. Stereochemical features important for biological properties. Interactions of chiral compounds and biomolecules. Eutomers and distomers. Activity of enantiomers. The effect of drug stereochemistry on pharmacokinetics and metabolism. Stereochemistry in patent application. Enantiomeric purity, significance and determination (polarimetry, GC, HPLC, NMR). Asymmetric synthesis, application in pharmaceutical industry. Solid phase synthesis. Polymers and linkers. Combinatorial and parallel synthesis. Peptidomimetics. Process development.			
Recommended literature: 1.Medicinal chemistry, Principles and Practice; 2.F.D.King;An introduction to medicinal chemistry; 3.G.L.Patrick;Contemporary drug synthesis; J.Li, D.S.Johnson, D.R.Sliskovic, B.D.Roth; 4.Stereochemistry of organic compounds; E.L.eliel, S.H.Wilen 5. Original scientific articles			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Seminars, consultative teaching			
Grading system: Seminar 50 points, Written/oral exam 50 points (max 100 points)			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: The chemical and biopharmaceutical aspects of the design of biologically active molecules			
Teachers: Vladimirov M.Sote, Agbaba D. Danica			
Course status: Mandatory modules, module: Pharmaceutical Chemistry			
Semester: I		Year of studies: I	
ECTS points: 10		Course code: ДФХ10М2	
Requirements: Previously Passed Selected topics in organic chemistry			
Course aims: Introduction; structure, chemical and biopharmaceutical properties and metabolic processes of selected stuctural models of substances/ligands used as drugs.			
Course outcomes: Acquired knowledge should provide an understanding of structural and physicochemical properties of molecules, ligand-receptor-enzymes interaction, as well as certain skills in predication of physicochemical properties of newly synthesized compounds with potential biological activity.			
Course contents: Solubility of biologically active molecules and methods of calculation . Acid- base properties of molecules , conjugated base and acids. Ionization of biologically active molecules and types of interaction with biomolecules under in vivo conditions. Amphiphilicity of molecules. Lipophilicity of molecules, methods of determination and experimental calculation. Structures of biological membranes or receptors, and their functionallity in humans. Impact of chemical stuctures and physico-chemical properties of pharmacologically active compounds/ligands on different modes of drug absorption. Permeability. Biopharmaceutical clasification of biologically active substances. Role, types and functionalities of biological transportes on resorption (efflux transpoters). Concept of pro drug forms.			
Recommended literature: 1. Patrick GL. Medicinal chemistry, Principles and Practice; 3rd edition,Oxford University Press, Oxford, 2005. 2. King F.D. An introduction to medicinal chemistry; 2nd edition, RSC,Cambridge, 2005. 3..Li J, Johnson DS,Slišković DR. Roth BD. Contemporary drug synthesis;; Wiley Interscience, Hoboken, 2004. 4. Eliel EL,Wilen SH. Stereochemistry of organic compounds, John Wiley and Sons, INC, 1994. 5. Original scientific papers			
The total of active learning classes	Lectures: 60		
	Individual research work: 60		
Teaching methods: Seminars, consultative teaching			
Grading system: Seminar 30 points, Written/oral exam 70 points (max 100 points)			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Methods in Computer-Assisted Drug Design			
Teachers: Erić M. Slavica, Nikolić M.Katarina			
Course status: Mandatory modules, module: Pharmaceutical Chemistry			
Semester: II		Year of studies: I	
ECTS points: 10		Course code: ДФХ10М3	
Requirements: None			
Course aims: Advancing the knowledge about theoretical methods for molecular modelling, conformational analysis, calculation and selection of molecular descriptors, pharmacophore mapping and search. Gaining the skills for analysis of quantitative structure-activity and structure-property relationships, as well as for prediction and modification of ADMET properties.			
Course outcomes: Knowledge of basic and advanced theoretical methods and computational programs for: QSAR and molecular modelling; calculation, selection and interpretation of molecular descriptors; fragment design; mapping and analysis of pharmacophores; protein-protein docking; homology modeling; virtual docking, and molecular dynamics. The application of computational models for prediction and optimization of ADMET properties.			
Course contents: Theoretical and computational programs for molecular modelling, conformational analysis and calculation of molecular descriptors; QSAR/QSPR studies by use of various mathematical methods and application of QSAR/QSPR models for the prediction and interpretation of activities and properties of novel designed structures; principles of three-dimensional QSAR modelling; mapping and analysis of three-dimensional pharmacophores; fragment design; computational methods for homology modelling of specific targets and study of protein-protein and drug-target interactions by use of docking and molecular dynamic methods. Computational methods for prediction of absorption, distribution, metabolism, excretion and toxicity (ADMET); analysis of structural requirements of pharmacologically active compounds for optimization of ADMET properties. Case studies for the design of novel drugs by methods of ligand-based and structure-based drug design. The use of programs for the design of new drugs.			
Recommended literature: 1. Partick GL. An Introduction to Medicinal Chemistry, 4th Edition, Oxford University Press, ed.. 2009. 2. Abraham DJ. Burger’s Medicinal Chemistry and Drug Discovery, 7th Edition, volume 1: Methods in Drug Discovery and volume 2: Discovering Lead Molecules, John Wiley&Sons, Inc.,2010. 3. Merz KM, Ringe D, Reynolds CH. Drug design: Structure and Ligand-based Approaches, Cambridge University Press, 2010. 4. Krogsgaard-Larsen P, Madsen U, Stromgaard K. Textbook of Drug Design and Discovery, 4th ed. CRC Press; 2009.			
The total of active learning classes	Lectures: 60		
	Individual research work: 60		
Teaching methods: Lectures. Practical examples by use of computational medicinal chemistry tools.			
Grading system: Final exam: 60 points; Project: 20 points; Presentation of project: 20 points			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Mechanisms of degradation and origin of impurities in pharmaceuticals			
Teachers: Vujić B. Zorica, Čudina A. Olivera, Brborić S. Jasmina			
Course status: Mandatory modules, module: Pharmaceutical Chemistry			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: DΦX2OM1	
Requirements: None			
Course aims: To gain a knowledge about API impurity profile and impurities in pharmaceutical-technological formulations from chemical and safety aspects.			
Course outcomes: Use of knowledge in assessment of drug substance quality. Understanding of degradation mechanisms and in vitro stability, terms of related substances, impurities and safety assessment based on valid regulatory requirements.			
Course contents: Functional groups, basic mechanisms and kinetics of degradation. Chemical degradation (hydrolysis, dehydration, isomerization, decarboxylation, oxidation, photodegradation); physical degradation (crystallization of amorphous drugs, transition state, sublimation, moisture adsorption), degradation kinetics and methods for detection of chemical and physical degradation. Thermal analysis (differential scanning calorimetry, differential thermal analysis, differential thermogravimetry). Origin of imuprities, process impurities (organic, inorganic), identification, qualification and specification of impurities, purification processes (crystallization, filtration, preparative chromatography), control, standard analytical methods, measurement of drug substance impurities, spectroscopic techniques, NMR, HPLC, MS, acceptance criteria. Impurities introduced during storage. Standard, spectroscopic and separation techniques as analytical procedures in impurity control. Prevention of chemical degradation: molecular modification, complex formation, cyclodextrin inclusion complexes, antioxidants and stabilizers. Regulatory law, acceptance criteria.			
Recommended literature: 1. Li M. Organic chemistry of drug degradation, RSC Publishing, Cambridge, UK, 2012. 2. Beale JM, Block JH. Organic Medicinal and Pharmaceutical Chemistry, 12th Edition, Lippincot Williams&Wilkins, 2011. 3. Carstensen JT, Rhode CT. Drug stability Principles and Practices, 3rd Edition, 1998. 4. Connors KA, Amidon GL, Stella VJ. Chemical stability of pharmaceuticals: a handbook for pharmacists, 2nd Edition, John Willey&Sons, 1986.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures, case-study, seminar papers. Reading and analysis of original scientific papers relevant to selected topics.			
Grading system: Written exam: 40 points; Oral exam: 30 points; Seminar papers: 30 points			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Modern Drug Synthesis			
Teachers: Vladimir M. Savić, Jasmina S. Brborić			
Course status: elective, module: Pharmaceutical Chemistry			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: ДФХ1И1	
Requirements: none			
Course aims: To learn about strategies in drug design and development based on organic chemistry and synthetic routes applied in drug synthesis.			
Course outcomes: To learn about general principles of drug synthesis and methodologies used for the synthesis of various drug classes. General understanding of drug/biological active compounds synthesis in laboratory and industrial environment.			
Course contents: Organic synthesis. “Ideal” synthetic route, properties. Laboratory vs industrial synthesis. Importance and role of organic synthesis in drug development. Standard and combinatorial synthesis. Solid phase synthesis and application in pharmaceutical industry. Synthesis of selected drug classes: e.g. antiinflammatory agents, kinase inhibitors, antidepressant, ATPase inhibitors, HIV drugs.			
Recommended literature: 1. Lednicher D. Strategies for Organic Drug Synthesis and Design, 2 ed, John Wiley&Sons, 2008. 2. Johnson DS, Li JL. The Art of Drug Synthesis, John Wiley&Sons, 2007. 3. Li JL, Johnson DS. Modern Drug Synthesis, John Wiley&Sons, 2010.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Seminars, consultative teaching			
Grading system: Seminar 50 points, Written exam 50 points (max 100 points)			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Electrochemical methods used in the study of biologically active molecules in vitro and in vivo			
Teachers: Kapetanović P. Vera			
Course status: elective, module: Pharmaceutical Chemistry			
Semester: II		Year of studies: I	
ECTS points: 5		Course code: ДФХ1И2	
Requirements: None			
Course aims: The use of electrochemical methods for studying of mechanism of reduction/oxidation processes of biologically active molecules. Development of new electrochemical methods for detection and determination of biologically active compounds in buffer system and in the biological medium as well (urine, plasma and serum). Study of interactions of biologically active substances with DNA and their electrochemical detection based on the principle of a biosensor.			
Course outcomes: Getting of skills in electrochemical methods applied in the study of redox processes of biologically active compounds with the aim of their detection and determination in vitro and in vivo .			
Course contents: A modern access in electrochemical characterisation of biologically active molecules requires knowledge of complex electrochemical processes, an appropriate methodology in order to be able to explain the processes involved by using the modern adsorptive techniques with different solid electrodes as BDDE, GC and CP. The interaction of DNA modified electrodes with biologically active substances could be a good basis for biosensors characteristics of this couple. Development of the new electroanalytical methods for detection and determination of biologically active substances in buffers and biological system (urine, plasma, serum..).			
Recommended literature: 1.Wang J. Electroanalytical Techniques in Clinical Chemistry and Laboratory Medicine, VCH Publisher, New York, 1988. 2.Ozkan SA. Electroanalytical methods in pharmaceutical analysis and their validation, HNB Publisher, USA, 2011.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Individual activities, seminars			
Grading system: Oral exam 50 points, seminars 50 points.			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Protolytic equilibria			
Teachers: Popović V. Gordana			
Course status: elective, module: Pharmaceutical Chemistry			
Semester: II		Year of studies: I	
ECTS points: 5		Course code: ДФХ1И3	
Requirements: None			
Course aims: Introduction to the physical-chemical parameters of importance for the mechanism of action of biologically active substances and analysis of pharmaceuticals.			
Course outcomes: Implementation physicochemical principles to predict the ADME characteristics (absorption, distribution, metabolism, elimination) of potentially biologically active substances and the re-evaluation of the existing ones. A rational approach to the selection optimal conditions for the analysis of pharmaceuticals.			
Course contents: Protolytic equilibria of monoprotic and polyprotic acids and bases, ampholytes, zwitterion ions; micro and macro equilibrium constants; distribution equilibrium species as a function of pH, pKa, log P and log D; methods and techniques for experimental determination of pKa values (spectrophotometry, potentiometry, electrophoresis, HPLC, NMR); parameters that affect the choice of the appropriate method for the determination of pKa values . Protolytic equilibrium in heterogeneous systems (solubility); the solubility - pH profile of a biologically active substance; mathematical interpretation protolytic equilibria in saturated solution; the methods, techniques , and selection of the experimental conditions for the determination of solubility; protocol for determining the solubility using the "shake-flask" method, the effect of buffer, co-solvents, surfactants and complexing agents on the solubility.			
Recommended literature: 1. Florence AT, Attwood D. Physicochemical principles of pharmacy, Pharmaceutical Press, London, 2006. 2. Sinko PJ. Martin’s physical pharmacy and pharmaceutical sciences, Lippincott Williams & Wilkins, Philadelphia, PA, 2006. 3. Avdeef A. Absorption and drug development: Solubility, permeability, and charge state, John Wiley & Sons, Inc., Hoboken, New Jersey, 2012			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures, practical work, seminars.			
Grading system: Written exam: 30 points; oral exam: 10 points; practical work: 10 points; Seminar: 20 points, seminar presentations: 30 points.			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Structure analysis of solid state			
Teachers: Sote M. Vladimirov, Bojan D. Marković			
Course status: elective, module: Pharmaceutical Chemistry			
Semester: II		Year of studies: I	
ECTS points: 5		Course code: ДФХ1И4	
Requirements: None			
Course aims: Introduction to basic physicochemical parameters and methods used in the characterization of the solid state (amorphous, crystalline state, phase transitions, polymorphism, monocrystals).			
Course outcomes: It is expected that students expand additional knowledge about the methods of structural analysis used in the characterization of a solid state and application of appropriate methods, significant for the assessment of biopharmaceutical properties of drugs.			
Course contents: Solid, crystalline, amorphous state, liquid crystals. Polymorphism and phase transitions. X-ray diffraction analysis, x-ray source and absorption of monochromatic x-rays. Thermogravimetry. TGA-FTIR spectroscopy. Case study from literature and practical examples. Crystallisation methods. Determining the crystal composition. Monocrystal definition and characterization. Unit cell, symmetry of the crystal system, space group, factor P, structural parameters of molecular geometry, molecular modelling, 3D structure of small molecules, intermolecular interactions, hydrogen bonds. Crystallization methods. Introduction to modern tandem methods used in the characterization of crystalline state of molecule. The applying of appropriate methods to define the solid state (Ph.Eur. 8 official methods). The influence of polymorphism and other properties of solid state substances to do use in the pharmacy, on the stability characteristics and biopharmaceutical properties of drugs. Examples of drugs where polymorphism is essential for bioavailability and drug-excipients interactions.			
Recommended literature: 1. Chatten L. Pharmaceutical Chemistry volume 1 Theory and Application, UMI, Michigan, 1992. 2. Chatten L. Pharmaceutical Chemistry volume 2 Instrumental Techniques, UMI, Michigan, 1992. 3. Wermuth C. The Practice of Medicinal Chemistry, Academic Press, San Diego, 2008. 4. Krogsgaard-Larsen P, Liljefors T, Madsen U.Textbook of Drug Design and Discovery, Taylor & Francis, New York, 2002. 5. Babine R, Abdel-Meguid S. Protein Crystallography in Drug Discovery, Wiley-VCH, Weinheim, 2004. 6. Thomas G, Fundamentals of Medicinal Chemistry, Wiley, Chichester, 2003.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Seminar work, case study			
Grading system: Seminar work: 70 points, exam: 30 points			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Spectroscopic methods 1			
Teachers: Katarina D.Karljiković-Rajić, Bojan D.Marković			
Course status: elective, module: Pharmaceutical Chemistry			
Semester: II		Year of studies: I	
ECTS points: 5		Course code: ДФХ1И5	
Requirements: None			
Course aims: Knowledge improvement of applications of UV-visible spectrophotometry with special topics of derivative spectrophotometry (DS) and applications of IR spectroscopy in the studies of importance in pharmaceutical chemistry.			
Course outcomes: Enhancement of knowledge on spectroscopic methods applications (UV-visible spectrophotometry and IR spectroscopy) of significance for pharmaceutical chemistry intended for investigations in stability studies, pharmaceutical purity, molecular interactions, determination of partition coefficients, inclusion complex formation and evaluation of bioactivation via monitoring in vitro processes, with special topic of IR spectroscopy applications for investigations of polymorphism and polymers.			
Course contents: Fundamental principles of the spectroscopic method's applications in pharmaceutical chemistry including stability studies, pharmaceutical purity, molecular interactions, determination of partition coefficients, inclusion complex formation and evaluation of bioactivation via monitoring in vitro processes, with special topic of IR spectroscopy applications for investigations of polymorphism and polymers. The significance of the selection of: working (analytical) wavelength; solvent; absorption bands shifting; chromospheres evaluation; amplitudes in DS, method's elimination of interferences and technique selection for demanding problematical systems in DS; decreasing noise signals for limits of detection and quantification; characteristic shifting of absorption bands in IR spectra caused by molecular interactions, inclusion complexes and polymorphic forms.			
Recommended literature: 1.Brittain HG.Spectroscopy of Pharmaceutical Solids, Taylor & Francis Group, LLC., 2006. 2.Stuart B. Infrared Spectroscopy: Fundamentals and Applications”, Analytical Techniques in Sciences, AnTS, Wiley, 2004. 3.Talsky G. Derivative Spectrophotometry, VCH, (1994; 2004.), Verlagsgesellschaft GmbH, online library 2004. Wiley			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures, problem oriented teaching methods, structural discussion about topics. Reading and analyses of original scientific papers of significance for selected topics.			
Grading system: Written exam: 40 points; oral exam: 30 points; seminar paper: 30 points.			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Spectroscopic methods 2			
Teachers: Agbaba D. Danica, Nikolić M. Katarina			
Course status: elective, module: Pharmaceutical Chemistry			
Semester: II		Year of studies: I	
ECTS points: 5		Course code: ДФХ1И6	
Requirements: none			
Course aims: Advancing the knowledge about spectroscopic methods as infrared spectrometry, near-infrared spectrometry, nuclear magnetic resonance spectroscopy and mass spectrometry.			
Course outcomes: Knowledge of spectroscopic methods and TLC-MS/LC-MS/LC-NMR techniques for structural characterisation and determination of drugs and related substances. Gaining knowledge about the application of spectroscopic methods in study of drug-target complexes and inclusion complexes of drugs with other macromolecules.			
Course contents: Principles of spectroscopic methods, infrared spectrometry, near-infrared spectrometry, nuclear magnetic resonance spectroscopy and mass spectrometry . Application of spectroscopic methods and TLC-MS/LC-MS/LC-NMR techniques for structural characterisation and determination of drugs and related substances. The use of nuclear magnetic resonance spectroscopy in structural characterisation of drug-target complexes. Application of nuclear magnetic resonance spectroscopy in study of the inclusion complexes of drugs and macromolecules.			
Recommended literature: 1. Partick GL. An Introduction to Medicinal Chemistry 4th Edition, Oxford University Press UK,2009. 2. Roberts G, Lian LY. Protein NMR Spectroscopy: Practical Techniques and Applications Wiley, 2011. 3. Hoffmann E, Stroobant V. Mass Spectrometry: Principles and Applications, 3rd Edition, Wiley, 2007.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Practical examples of spectroscopic methods in pharmaceutical chemistry, research work, projects			
Grading system: Final exam: Project: 50 points; Presentation of project: 50 points			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Chemometric methods in pharmaceutical chemistry			
Teachers: Nikolić M.Katarina			
Course status: elective, module: Pharmaceutical Chemistry			
Semester: II		Year of studies: I	
ECTS points: 5		Course code: ДФХ1И7	
Requirements: None			
Course aims: Advancing the knowledge about principles of analytical methods for study lipophilicity/retention/migration parameters of pharmacologically active compounds. Gaining the knowledge about advanced chemometric methods in pharmaceutical chemistry.			
Course outcomes: Knowledge of experimental methods for study lipophilicity/chromatographic retention/migration parameters of pharmacologically active compounds. Gaining the knowledge in molecular modeling, conformational analysis, molecular descriptors, and theoretical and chemometric methods.			
Course contents: Chromatographic retention parameters in pharmaceutical chemistry: hydrophobicity-thermodynamic approach, chromatographic retention parameters and lipophilicity of pharmacologically active compounds, correlation studies. Development of new analytical method by use of various designs of experiment and mathematical analysis of the obtained results. Theoretical predictions of the dominant ionic and tautomeric forms of the analyte at a given pH value, the theoretical methods and computer programs for optimization of three-dimensional structure of the analyte, conformational analysis and calculation of molecular descriptors, forming QSPR/QSRR models using different mathematical methods; validation QSPR/QSRR model and application of QSPR/QSRR models to predict the parameters/retention of related compounds. Case Studies in QSPR/QSRR modeling and design of experiment.			
Recommended literature: 1. L. Eriksson, E. Johansson, N. Kettaneh-Wold, J. Trygg, C. Wikstrom, and S. Wold ed. (2008) „Design of Experiments, Principles and Applications“, Third edition, Umetrics Academy, Umea, Sweden; 2. R. Brereton ed. (2009) „Applied Chemometrics for Scientists“, John Wiley&Sons, Inc; 3. G. Hanrahan, F. A. Gomez ed. (2009) “Chemometric Methods in Capillary Electrophoresis”, John Wiley&Sons, Inc.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures. Practical example of chemometric methods in pharmaceutical chemistry. Reading and analysis of original scientific research relevant to date teaching unit.			
Grading system: Final exam: 60 points; Project: 20 points; Presentation of project: 20 points			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Computation Methods in Chemical Biology			
Teachers: Nevena V. Veljković, Katarina M. Nikolić			
Course status: elective, module: Pharmaceutical Chemistry			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: ДФХ2И1	
Requirements: None			
Course aims: Advancing the knowledge about the drug targets as a basis for the design of drugs, signaling pathways that transmit signals from the extracellular environment and activate cellular responses. Gaining knowledge about design of drugs that acting on one or more targets at the same time (multi-target drugs).			
Course outcomes: Knowledge of biological databases and tools used to identify potential targets for new drugs and computational methods for their identification on the basis of the expression data or Next Generation Sequencing (NGS) data.			
Course contents: Molecular biological phenomena and technologies relevant to the development of new drugs. Bioinformatical methods for identification of a drug target. Computational tools for analysis sequences of the biological molecules. Data bases of bioactive compounds, drugs, targets, and signaling pathways. Drugs able to modify the specific signaling pathways. Macromolecular descriptors. Computational methods for the analysis of molecular biological data. Genomic informatics and systems biology. Identification of the target molecule (the target site) for the discovery of new drugs. Computational approaches in pharmacogenomics. The development of new drugs. Experimental methods for testing the bioactivity of the drug. The development of medicines that act on a number of targets simultaneously. Case Studies.			
Recommended literature: 1.Yuryev A. Pathway analyses for drug discovery: Computational Infrastructure and Applications, Wiley-VCH; 2008. 2. Waldmann H, Janning P. Chemical biology: learning through case studies Wiley-VCH, 2009. 3. Bunnage ME. New Frontiers in Chemical Biology” RSC Publishing 2010.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures. Problem-oriented education (working on a practical example that is solved by means of bioinformatics and cheminformatics method) and discussions. Reading and analysis of original scientific research relevant to date teaching unit.			
Grading system: Final exam: 60 points; Practical work: 20 points; Presentation of project: 20 points			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Targeted Drug Design			
Teachers: Erić M.Slavica			
Course status: elective, module: Pharmaceutical Chemistry			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: ДФХ2ИЗ	
Requirements: None			
Course aims: Advancing the knowledge of function, role, characterization and validation of molecular targets for the diseases of interest. Gaining the knowledge about new methods for the discovery of leading compounds for the specific targets, as well as strategies for optimization of properties of new pharmacologically active compounds.			
Course outcomes: Knowledge of basic methods for selection, characterization and validation of the molecular targets for the design of novel pharmacologically active compounds. Knowledge of basic methods for discovery and optimization of novel pharmacologically active compounds for specific targets.			
Course contents: Function and role of molecular targets that are involved in the process of specific disease development. Characterization and validation of specific molecular targets for the design of new pharmacologically active compounds. Strategies of optimization of leading compounds for specific targets with aim of modification of efficacy, selectivity, solubility and permeability through cell membranes, safety and minimization of side effects. Case studies of selection and validation of targets for the diseases of interest: neoplasms, infections caused by resistant bacterias, viruses and parasites. Study of the basic methods for the discovery of leading compounds for specific targets: high-throughput screening, virtual screening, combinatorial synthesis, screening of natural compounds. Case studies of natural products, i.e. estimation of their potential as leading compounds. Study of the concept of privileged structures. Case studies of drugs discovered by targeted-design methods. Case studies of the drugs designed for multiple targets. Study of the various strategies for modification of physico-chemical properties, efficacy, selectivity and safety as well as minimization of side effects of leading compounds designed for specific target.			
Recommended literature: 1. Merz K.M. Drug Design, Cambridge University Press, UK; 2010; 2. Fernandez A. Transformative Concepts for Drug Design: Target Wrapping, Springer, 2010; 3. Klebl B, Miller G, Hamacher M, Mannhold R, Kubinyi H, Folkers G. Protein Kinases as Drug Targets, John Wiley and sons, 2011; 4. D. Thurston. Designing multi-targeted drugs, Royal Society of Chemistry, London, UK, 2012.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures, problem-oriented teaching, practical exercises, case studies, analysis and presentation of original scientific work relevant for teaching subject.			
Grading system: Final exam: 50 points; practical exercises: 30 points; seminar paper: 20 points;			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Radiopharmaceutical chemistry			
Teachers: Brborić S. Jasmina			
Course status: elective, module: Pharmaceutical Chemistry			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: ДФХ2И4	
Requirements: no			
Course aims: Improving of knowledge about the basic principles of nuclear physics and nuclear chemistry, properties and production of radioisotopes for use in nuclear medicine. Acquiring of necessary knowledge about the characteristics and production of various types of radiopharmaceuticals, quality control in nuclear medical centres and the requirements of good manufacture practice. Providing advanced knowledge related to the application of radiopharmaceuticals in nuclear medicine: use in diagnosis with special emphasis on PET radiopharmaceuticals and use in therapy.			
Course outcomes: Understanding of basic principles of nuclear physics and nuclear chemistry, properties and production of radioisotopes for use in nuclear medicine; Detailed knowledge of the characteristics and production of various types of radiopharmaceuticals and quality control in nuclear medical centres and the requirements of good radiopharmaceutical manufacture practice. Detailed knowledge about the application of radiopharmaceuticals in nuclear medicine:use in diagnosis with special emphasis on PET radiopharmaceuticals and use in therapy.			
Course contents: The basic principles of nuclear physics and nuclear chemistry. Properties and production of radioisotopes for use in nuclear medicine. Measures of protection against ionizing radiation. Properties and production of various types of radiopharmaceuticals: methods of radiolabeling, chemistry of technetium and technetium complexes, radiopharmaceutical kits preparing. Quality control of radiopharmaceuticals: physicochemical and biological tests. Monographs of radiopharmaceuticals. European Regulations governing radiopharmaceuticals. Preparation of radiopharmaceuticals and quality control in nuclear medicine centers, good manufacturing practice. Radiation regulations and radiation protection. Diagnostic uses of radiopharmaceuticals in nuclear medicine. PET radiopharmaceuticals. Therapeutic uses of radiopharmaceuticals.			
Recommended literature: 1. Saha GB. Fundamentals of Nuclear Pharmacy, 6th edition, Springer, 2010. 2. Zolle I. Technetium-99m Pharmaceuticals, Preparation and Quality control in Nuclear Medicine, Springer, 2007.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures, problem-based learning and structured class discussions. Reading and analysis of original scientific papers relevant to selected topics.			
Grading system: seminar work: 30 points, oral: 30 points			
Final exam - written: 40 points,			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Chemical approach to prodrug design of pharmacologically active compounds			
Teachers: Čudina A. Olivera, Brborić S. Jasmina, Marković D. Bojan, Vujić B. Zorica			
Course status: elective, module: Pharmaceutical Chemistry			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: ДФХ2И5	
Requirements: None			
Course aims: Improvement of knowledge about prodrugs: definitions, properties, classification, use; various types of prodrugs, properties, mechanisms of prodrug activation and their application.			
Course outcomes: Detailed knowledge about prodrugs: definition, properties, classification, use; various types of prodrugs, properties, mechanisms of prodrug activation and their application.			
Course contents: Prodrug: definitions, characteristics, classification and application of prodrugs. Types of Prodrugs: Bioprecursor prodrug and Carrier-linked prodrug (bipartate, tripartate and mutual). Ideal drug carriers. Mechanisms of prodrug activation: hydrolytic activation, oxidative activation (N-dealkylation, O-dealkylation, oxidative deamination, N-oxidation, S-oxidation, aromatic hydroxylation, alkene epoxidation), reductive activation (azo, azido, nitro, disulfide and sulfoxide reduction), phosphorylation activation, decarboxylation activation... Carrier linkages for various functional groups: alcohols, carboxylic acids and related groups, amine and imine prodrugs, Mannich base as prodrugs. Examples of carrier-linked bipartate prodrugs: Prodrugs to improve membrane permeability, Prodrugs for improved absorption through skin, Prodrugs for increased water solubility, Prodrugs to lower water solubility, Prodrugs for stability protection from first-pass effect, Prodrugs to minimize toxicity and side effects, Prodrugs for slow and prolonged release, Prodrugs for site specificity, Prodrugs to increase patient acceptance, Prodrugs to eliminate formulation problems			
Recommended literature: 1. Patrick GL. An Introduction to Medicinal Chemistry, 4th Edition, Oxford University Press UK, 2009. 2. Silverman RB. The Organic Chemistry of Drug Design and Drug Action, 2nd Edition, Elsevier Academic Press, 2004. 3. Wermuth CG. The Practice of Medicinal Chemistry, 3rd ed., Elsevier, 2008.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures, problem-based learning and structured class discussions. Reading and analysis of original scientific papers relevant to selected topics.			
Grading system: Written exam: 40 points; oral exam: 30 points; seminar: 30 points.			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Biophysical approaches of G-protein coupled receptor: structure, function and pharmacological aspects			
Teachers: Agbaba D.Danica, Vladimirov M.Sote, Vujić B. Zorica			
Course status: elective, module: Pharmaceutical Chemistry			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: ДФХ2И2	
Requirements: None			
Course aims: An introduction to new therapeutic drug classes.			
Course outcomes: Discovery and development of drugs acting on G protein-coupled receptor.			
Course contents: G protein-coupled receptors structure and classification. GPCRs Class A, rhodopsin-type receptors; GPCRs, Class B, glucagon-type receptors; GPCRs Class C, glutamate type, metabotropic receptor. Receptor activation; Conformational change of receptors caused by activation. Structure of G protein, GPCRs interaction with G protein. G protein subtypes and their function. GPCR dimerization, homo-oligomerization and hetero-oligomerization, GPCR dimers and bivalent ligands. New therapies based on G protein-coupled receptor hetero-oligomerization. Chemistry of new therapeutic drugs acting on GPCRs.			
Recommended literature: 1. Abraham DJ., Rotella, DP.Burger`s Medicinal Chemisty, Drug Discovery and Development, 2010. 2. Annual Reports in Medicinal Chemistry, Ed. John E.Macor, Academic Press, USA ,2012. 3. Current Medicinal Chemistry, Bentham Science Publishers. 4. Original scientific papers			
The total of active learning classes		Lectures: 30	
		Individual research work: 30	
Teaching methods: Analysis of original scientific paper related to the course or doctoral thesis.			
Grading system: Seminar 50 points, Exam 50 points			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Biophysical approaches of ion channel: structure, function and pharmacological aspects			
Teachers: Agbaba D.Danica, Vladimirov M.Sote, Vujić B.Zorica			
Course status: elective, module: Pharmaceutical Chemistry			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: ДФХ2И7	
Requirements: None			
Course aims: An introduction to new therapeutic drugs.			
Course outcomes: Discovery and development of drugs acting on ion channel receptor.			
Course contents: Definition of ion pumps, cotransporters and channels. Active transport, voltage-gated ion channels, action potential. Ion channels structure and classification, sodium and potassium channels, voltage-gated calcium channels. Voltage-gated ion channels as drug target. Sodium-channel blockers and local anesthetic. Voltage-gated ion channels in epilepsy. Ion channels and transporters in cardiovascular diseases. Structure and structure-function correlations in ion channels: classification of ion channels, pharmacological properties of ion channels, chemistry of new therapeutic drugs acting on ion channels.			
Recommended literature: 1. Abraham DJ, Rotella, DP.Burger`s Medicinal Chemisty, Drug Discovery and Development, 2010. 2. Annual Reports in Medicinal Chemistry, Ed. John E.Macor, Academic Press, USA ,2012. 3. Current Medicinal Chemistry, Bentham Science Publishers. 4. Original scientific papers.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Analysis of original scientific paper related to the course or doctoral thesis.			
Grading system: Seminar 50 points, exam 50 points			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Peptides and peptidomimetics			
Teachers: Vladimirov M.Sote, Agbaba D.Danica, Vujić B.Zorica			
Course status: elective, module: Pharmaceutical Chemistry			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: ДФХ2И6	
Requirements: None			
Course aims: An introduction to new therapeutic drugs.			
Course outcomes: Trends in development of protein and peptide-based therapeutics.			
Course contents: Chemical and physical properties of peptide and proteins. Structural and stereochemical features of peptides and proteins. Metabolism, proteolytic processing, chemical modifications and biopharmaceutical applications of protein modifications. Pseudopeptides, retro-inverso peptides, peptide and protein drugs in medicine and pharmacy.			
Recommended literature: 1. Abraham DJ, Rotella, DP.Burger`s Medicinal Chemisty, Drug Discovery and Development, 2010. 2. Annual Reports in Medicinal Chemistry, Ed. John E.Macor, Academic Press, USA ,2012. 3. Current Medicinal Chemistry, Bentham Science Publishers. 4. Original scientific papers.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Analysis of original scientific paper related to the course or doctoral thesis.			
Grading system: Seminar 50 points, exam 50 points			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Microbiology 1			
Teachers: Milenkovic T. Marina, Antic Stankovic A Jelena			
Course status: Mandatory modules, module: Pharmaceutical Microbiology			
Semester: I		Year of studies: I	
ECTS points: 10		Course code: ДФМ1ОМ1	
Requirements: none			
Course aims: The aim of this course is to introduce students to the morphological characteristics of the bacterial cells, the conditions affecting the growth of bacteria, virulence factors of pathogenic bacteria, microbial genetics and mechanisms of action of antimicrobial agents.			
Course outcomes: Knowing the structure of bacterial cell factors required for bacterial growth in vitro, and the influence of chemical and physical agents in their growth and reproduction. Knowledge of the genetic mechanisms of prokaryotic cell and tissue damage in the course of a bacterial infection.			
Course contents: The shape, size and structure of the bacterial cell (Gram positive and Gram negative bacteria) . Definition of growth and growth curve . Factors affecting the growth bacteria : temperature , hydrogen ion concentration , oxygen content , and other factors , and the effect of physical chemical agents on bacteria . Effect of temperature and radiation on different bacteria . mechanisms of action disinfectants and antiseptics . Virulence factors of pathogenic bacteria and molecular mechanisms of their action. Bacterial gene (bacterial chromosome , plasmids , transposons) . Transfer of genetic material between bacteria (transformation , conjugation and transduction) . Antibiotics: separation , chemical structure , selectivity , molecular mechanisms of action of the bacterial cell. The side effects of antibiotics. Methods of in vitro tests susceptibility to various antibiotics and chemotherapeutics . Origin and mechanisms of bacterial resistance to antimicrobial drugs . Mechanisms of resistance to the spread of a bacterial population			
Recommended literature: 1. Stephen P. Denyer, Norman Hodges, Sean P. Gorman, Brendan F. Gilmore: Hugo & Russell's Pharmaceutical microbiology, 8th edition (2011). 2. Geo F. Brooks, Karen C. Carroll, Janet S. Butel, Stephen A. Morse, Timothy A. Mietzner: Jawetz, Melnick, & Adelbergs Medical microbiology, 25th edition (2010). 3. Kenneth J. Ryan, C. George Ray: Sherris Medical microbiology, 5th edition (2010). 4. Jacquelyn G. Black, Microbiology: Principles and Explorations, 7th edition, (2008). 5. Richard V. Goering, Hazel Dockrell, Mark Zuckerman: Mims' Medical Microbiology, 4th edition, (2008). 6. David Greenwood, Richard Slack, John Peutherer, Mike Barer: Medical microbiology, 17th edition (2007).			
The total of active learning classes	Lectures: 60		
	Individual research work: 60		
Teaching methods: teaching, seminars, laboratory work			
Grading system: Seminars 40, final exam 60 points.			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Selected topics in organic chemistry			
Teachers: Vladimir M. Savić			
Course status: Mandatory modules, module: Pharmaceutical Microbiology			
Semester: I		Year of studies: I	
ECTS points: 5		Course code: ДФМ1ОМ2	
Requirements: none			
Course aims: To learn about the properties of biomolecules and to get insight into the drug discovery and development process			
Course outcomes: Understanding of structures and chemical properties of biomolecules. Understanding the initial phases of drug discovery and development.			
Course contents: Structures and properties of biomolecules. Stereochemical aspect of stability, reactivity and functionality of biomolecules. Weak interactions in biomolecules. Lead compound: properties, finding, structural optimization (biological and physico-chemical properties). Modern methods in drug discovery and development.			
Recommended literature: .F.D.King, Medicinal Chemistry ; G.L.Patrick, An introduction to medicinal chemistry; Original scientific articles			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Seminars, consultative teaching			
Grading system: Seminar 70 points, Written/oral exam 30 points (max 100 points)			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Microbiology 2			
Teachers: Antic Stankovic A Jelena, Milenkovic T. Marina, Begovic M. Jelena, Strahinic D. Ivana			
Course status: Mandatory modules, module: Pharmaceutical Microbiology			
Semester: II		Year of studies: I	
ECTS points: 10		Course code: ДФМ10М3	
Requirements: none			
Course aims: Acquiring additional knowledge on the microorganisms which are used in pharmaceutical sciences (morphology, growth characteristics, biochemical characteristics, identification),common microbial contaminants of pharmaceutical products. Knowing general structure and classification of viruses, virus-host cell interactions, tumour viruses, laboratory identification of viruses, antiviral chemotherapy, viral vaccines, physiology of parasitic protozoa, detection of parasites, antiprotozoal drugs –mechanisms of action and selective toxicity.			
Course outcomes: Knowing characteristics of microorganisms which have been used in pharmaceutical sciences; characteristics and identification of common microbial contaminants of pharmaceutical products, understanding the principles of laboratory identification of viruses. Parasitic protozoa and antiprotozoal drugs.			
Course contents: Morphology and biochemical characteristics of bacteria-common microbial contaminants of pharmaceutical products. Morphological and biochemical characteristics of bacteria which are used in pharmaceutical industry. Use of microorganisms and their products in assays. Probiotic bacteria. General structures of viruses: viral nucleic acid, viral capsid and envelope. Replication of viruses. Virus-host cell interaction (citocital, latent infections, transformation of cell). Effects of chemical and physical agents on viruses. Cultivation of human viruses. Interferons –mechanisms of antiviral activity. Antiviral drugs. Resistance to antiviral drugs. Viral vaccines (live attenuated, inactivated and recombinant vaccines). Morphology and physiology of parasitic protozoa. Helminths –morphology and life cycles. Detection of parasites. Antiparasitic agents-mechanisms of action and selective toxicity. Resistance to antiparasitic drugs.			
Recommended literature: 1. Stephen P. Denyer, Norman Hodges, Sean P. Gorman, Brendan F. Gilmore: Hugo & Russell's Pharmaceutical microbiology, 8th edition, Wiley-Blackwell (2011). 2. Geo F. Brooks, Karen C. Carroll, Janet S. Butel, Stephen A. Morse, Timothy A. Mietzner: Jawetz, Melnick, & Adelberg's Medical microbiology, 25th edition, The McGraw-Hill Companies (2010). 3. Kenneth J. Ryan, C. George Ray: Sherris Medical microbiology, 5th edition, The McGraw-Hill Companies (2010). 4. Jacquelyn G. Black, Microbiology: Principles and Explorations, 7th edition, John Wiley & Sons (2008). 5. Richard V. Goering, Hazel Dockrell, Mark Zuckerman: Mim's Medical Microbiology, 5th edition, Elsevier, (2013). 6. Patrick R. Murray, Ken S. Rosenthal, Michael A. Pfaller: Medical Microbiology, 5th edition, The McGraw-Hill Companies (2005).			
The total of active learning classes	Lectures: 60		
	Individual research work: 60		
Teaching methods: teaching, seminars, laboratory work			
Grading system: Exam prerequisites 30, final exam 70 points.			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Principles of use of animals for scientific purposes			
Teachers: Todorović M. Zoran, Savić M. Miroslav			
Course status: elective, module: Pharmaceutical Microbiology			
Semester: II		Year of studies: I	
ECTS points: 5		Course code: ДФМ1И1	
Requirements: none			
Course aims: The aim of this course is to provide participants with knowledge about principles of breeding, handling and use of animals used for scientific purposes, including legislation in Serbia, European Union and world, as well as of anaesthesia and surgery of laboratory animals (wok in vivo).			
Course outcomes: By the end of this course participants will have gained an understanding of legislation and principles of breeding, handling and work with animals used for scientific purposes.			
Course contents: Legislation and ethical questions related to work with animals used for scientific purposes. Priniciples of laboratory experiment. Principles of Good laboratory practice. Breeding and caring for animals used for scientific purposes. Animal welfare. Monitoring the health status and the most common diseases of animals used for scientific purposes. Use of animals in laboratory (routes of treatment application, introduction to anaesthesia and analgesia). Surgical procedures on animals used for scientific purposes. Practical laboratory work.			
Recommended literature: 1. Wolfensohn S, Lloyd M. Handbook of laboratory animal management and welfare. John Wiley & Sons, 2013. 2. Wilking MR (ed). Experimental Therapeutics, Martin Dunitz, Ltd., London, 2003.			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: Lectures and study-research work			
Grading system: Seminar: 50 points; written exam: 50 points			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Immune response in infection			
Teachers: Milenkovic T. Marina, Antic Stankovic A Jelena, Arsenovic Ranin M Nevena, Stojic Vukanic M Zorica			
Course status: elective, module: Pharmaceutical Microbiology			
Semester: II		Year of studies: I	
ECTS points: 5		Course code: ДФМ1И2	
Requirements: none			
Course aims: The aim of this course is to introduce students to the mechanisms of innate and acquired immunity in response to infection caused extracellular or intracellular microorganisms.			
Course outcomes: Knowledge of the defense mechanisms the human on the extracellular and intracellular pathogens.			
Course contents: The immune response to bacterial infection. Components of innate immunity: the epithelial barrier, phagocytes (neutrophils andmacrophages), NK cells, the complement system, cytokines. Innate immunity. Activation of the complement (alternative and lectin pathway), phagocytosis, inflammatory reaction. Activation of T cells by intracellular microorganisms. Effector mechanisms of cellular immunity. Effector functions of CD4 + T lymphocytes , CD8 + effector functions of cytotoxic T lymphocytes . The mechanisms by which intracellular bacteria avoid the immune response . Damage caused by the immune response to intracellular bacteria. The immune response to viral infection . Mechanisms of innate immunity in the defense against viral infections: humoral immunity (interferons alpha and beta) and cellular immunity . Mechanisms of acquired immunity in the defense against viral infections.			
Recommended literature: 1. Abul K. Abbas, Andrew H. Lichtman, Shiv Pillai: Cellular and Molecular Immunology, 7th edition, (2012). 2. Thomas J. Kindt, Barbara A. Osborne and Richard A. Goldsby: Kuby Immunology, 6th edition, (2006) 3. Stephen P. Denyer, Norman Hodges, Sean P. Gorman, Brendan F. Gilmore: Hugo & Russell's Pharmaceutical microbiology, 8th edition (2011). 4. Geo F. Brooks, Karen C. Carroll, Janet S. Butel, Stephen A. Morse, Timothy A. Mietzner: Jawetz, Melnick, & Adelberg's Medical microbiology, 25th edition (2010). 5. Kenneth J. Ryan, C. George Ray: Sherris Medical microbiology, 5th edition (2010). 6. Jacquelyn G. Black, Microbiology: Principles and Explorations, 7th edition, (2008). 7. Richard V. Goering, Hazel Dockrell, Mark Zuckerman: Mims' Medical Microbiology, 4th edition, (2008).			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: teaching, seminars, consultative teaching			
Grading system: Seminar 30, final exam 70 points.			


University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Resistance to antimicrobial drugs-molecular mechanisms			
Teachers: Milenkovic T. Marina, Antic Stankovic A Jelena			
Course status: elective, module: Pharmaceutical Microbiology			
Semester: II		Year of studies: I	
ECTS points: 5		Course code: ДФМ1И3	
Requirements: none			
Course aims: To provide knowledge regarding molecular mechanisms by which bacteria might exhibit resistance to different antimicrobial drugs. Origin of drug resistance (nongenetic origin and genetic origin of drug resistance). Limitation of drug resistance. Clinical implications of drug resistance. Clinical use of antibiotics: selection of antibiotics, dangers of indiscriminate use.			
Course outcomes: Knowing of molecular mechanisms by which bacteria might exhibit resistance to different antimicrobial drugs (penicillins, cephalosporins, aminoglycosides, tetracyclines, macrolides), genetic mechanisms and epidemiology of resistance.			
Course contents: Selection of antibacterial agents : empiric and specific therapy. Antibiotic policies and the control of resistance (restrictive policies, rotational policies). Problems of toxicity, alteration of normal flora, failure to reach the site of infection. Genetic origin of resistance. Acquired resistance. Resistance genes on plasmids (R plasmids), transposons resistance genes. Resistance spread (transposition and conjugation), multidrug resistance. Mechanisms of resistance to different antimicrobial drugs (penicillins, cephalosporins, aminoglycosides, tetracyclines, macrolides) : exclusion of the antimicrobial from the bacterial cell as a result of impermeability or active efflux, alterations of an antimicrobial target, inactivation of the antimicrobial agent. Multiresistant bacterial strains : methicillin-resistant Staphylococcus aureus (MRSA), strains which produce extended-spectrum beta-lactamases (ESBLs). Hospital-acquired infections caused by multi-resistant microorganisms. Resistance of Mycobacterium tuberculosis. Multi-drug resistant tuberculosis. Measurement of antimicrobial activity (diffusion method, dilution method) and interpretation of results. Practical classes: Determination of the susceptibility of a bacterial pathogen to antimicrobial drugs using appropriate standard test organisms and clinical isolates. Determination of minimal inhibitory concentration (MIC) and minimal bactericidal concentration (MBK) of antibiotic.			
Recommended literature: 1. Richard V. Goering, Hazel M. Dockrell, Mark Zuckerman, Peter L. Chiodini, Ivan M. Roitt: Mims' Medical Micro-biology, 5th edition, Elsevier (2013). 2. Stephen P. Denyer, Norman Hodges, Sean P. Gorman, Brendan F. Gilmore: Hugo & Russell's Pharmaceutical microbiology, 8th edition, Wiley-Blackwell (2011). 3. Geo F. Brooks, Karen C. Carroll, Janet S. Butel, Stephen A. Morse, Timothy A. Mietzner: Jawetz, Melnick, & Adelberg's Medical microbiology, 25th edition, The McGraw-Hill Companies (2010). 4. Kenneth J. Ryan, C. George Ray: Sherris Medical microbiology, 5th edition, The McGraw-Hill Companies (2010). 5. Jacquelyn G. Black, Microbiology: Principles and Explorations, 7th edition, John Wiley & Sons (2008). 6. Pascale Cossart, Patrice Boquet, Staffan Normark, Rino Rapupuoli: Cellular Microbiology, 2nd, edition, ASM Press, (2005).			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: teaching, seminars, laboratory work			
Grading system: Exam prerequisites 30, final exam 70 points.			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Molecular methods and recombinant biotechnology			
Teachers: Milenkovic T. Marina, Antic Stankovic A Jelena, Golic E Natasa, Zivkovic P Lada, Kojic O Molan			
Course status: elective, module: Pharmaceutical Microbiology			
Semester: II		Year of studies: I	
ECTS points: 5		Course code: ДФМ1И4	
Requirements: none			
Course aims: Introduction to the methods of recombinant DNA technology and its application.			
Course outcomes: Knowledge of the principles and application of recombinant DNA technology methods.			
Course contents: The genome of prokaryotic and eukaryotic microorganisms. Genetic engineering. DNA fragment separation with restriction enzymes. DNA sequencing. DNA hybridization. DNA amplification: polymerase chain reaction (PCR). Recombinant DNA technology and DNA transfer. Plasmids and cosmids. Recombinant gene expression. Protein synthesis in bacteria and yeast. The expression of fusion protein. Expressed protein purification. Inclusion body formation. Production of human hormones by recombinant DNA technology. Biotechnology in pharmaceutical industry: recombinant human insulin, recombinant somatostatin and recombinant somatotropin. Recombinant vaccines: recombinant hepatitis B vaccine, recombinant flu vaccine. Recombinant antibiotics. Recombinant retrovirus and using of retroviral vectors. Recombinant adenoviruses and gene therapy using adenovirus vector. Synthetic vaccines. DNA vaccines. Vaccines for treatment of autoimmune and cancer diseases.			
Recommended literature: 1. Stephen P. Denyer, Norman Hodges, Sean P. Gorman, Brendan F. Gilmore: Hugo & Russell's Pharmaceutical microbiology, 8th edition (2011). 2. Geo F. Brooks, Karen C. Carroll, Janet S. Butel, Stephen A. Morse, Timothy A. Mietzner: Jawetz, Melnick, & Adelberg's Medical microbiology, 25th edition (2010). 3. Kenneth J. Ryan, C. George Ray: Sherris Medical microbiology, 5th edition (2010). 4. Jacquelyn G. Black, Microbiology: Principles and Explorations, 7th edition, (2008), Alexander N. Glazer, Hiroshi Nikaido: Microbial biotechnology, 2nd edition (2007)			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: teaching, seminars, consultative teaching, laboratory work			
Grading system: Exam prerequisites 30, final exam 70 points.			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Application of microorganisms in medicine and pharmacy			
Teachers: Antic Stankovic A Jelena, Milenkovic T Marina			
Course status: Mandatory modules, module: Pharmaceutical Microbiology			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: ДФМ2ОМ1	
Requirements: none			
Course aims: The student acquires knowledge about the use of microorganisms in medicine and pharmacy			
Course outcomes: Knowing the type of microorganisms and their products which are used in the pharmaceutical industry, a variety of assays and models for testing the activity and metabolism of drugs.			
Course contents: Applications of microorganisms in the production of antibiotics, vitamin, amino acids, organic acids and enzymes. Pharmaceuticals produced by microorganisms: dextrans (the characteristics of the application), streptokinase, streptodornaza and L - asparaginase. Neurominidase. Iron chelating agents. Use of microorganisms or their products in a variety of assays and models for testing the activity and metabolism of drugs . The use of microorganisms for the bioassay determining the concentration of amino acids, vitamins, and some antibiotics. Microbiological assays - urease assay and luciferase assay . The use of microorganisms in laboratory tests for the diagnosis of metabolic disorders such as phenylketonuria test . Ames test: the principle of the test and application. Botulinumski toxin: characteristics and application. Insecticides . Bioterrorism - microorganisms as a potential biological weapon.			
Recommended literature: 1. Stephen P. Denyer, Norman Hodges, Sean P. Gorman, Brendan F. Gilmore: Hugo & Russell's Pharmaceutical microbiology, 8th edition (2011). 2. Geo F. Brooks, Karen C. Carroll, Janet S. Butel, Stephen A. Morse, Timothy A. Mietzner: Jawetz, Melnick, & Adelbergs Medical microbiology, 25th edition (2010). 3. Kenneth J. Ryan, C. George Ray: Sherris Medical microbiology, 5th edition (2010). 4. Jacquelyn G. Black, Microbiology: Principles and Explorations, 7th edition, (2008).			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: teaching, seminars, laboratory work, consultative teaching			
Grading system: Exam prerequisites 30, final exam 70 points.			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Selected Chapters of Micology			
Teachers: Milenkovic T. Marina, Antic Stankovic A Jelena			
Course status: elective, module: Pharmaceutical Microbiology			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: ДФМ2И1	
Requirements: none			
Course aims: Gaining knowledge about morphology and biology of medically important fungi.			
Course outcomes: Understanding of morphology and biology of medically important yeasts and molds.			
Course contents: Classification of fungi. Morphology and biology of fungi. Diseases caused by fungi. Superficial mycoses. Cutaneous mycoses. Subcutaneous mycoses. Systemic mycoses. Infections caused by yeasts (Candida, Cryptococcus). Chronic mucocutaneous candidiasis, ivasive candidiasis and nosocomial infections caused by fungi of the genus Candida. Dermatophyte and non-dermatophyte molds. Morphological characteristics of dermatophytes (Trychophyton, Microsporum, Epidermophyton). Clinical manifestations of dermatomycoses. Invasive aspergillosis. Invasive candidiasis. Mucormycosis and fusariosis. Endemic mycoses. Laboratory diagnosis dermatomycoses. Other medically important fungi (Pneumocystis, Trichosporon, Histoplasma, Geotrichum). Morphology, biology and diseases caused by fungi of the genus Penicillium . Fusarium - morphology , biology and infection caused by fungi of the genus . Laboratory methods of isolation and identification of the fungi. Hypersensitivity to fungi. Mycotoxins. The immune response to mushrooms. Antifungals (amphotericin B, flucytosine, azoles, echinocandin, griseofulvin, terbinafine, nystatin): mechanism of action . Antifungals for topical and systemic use . Mechanisms of resistance to fungus antifungal drugs .			
Recommended literature: 1. Stephen P. Denyer, Norman Hodges, Sean P. Gorman, Brendan F. Gilmore: Hugo & Russell's Pharmaceutical microbiology, 8th edition (2011). 2. Geo F. Brooks, Karen C. Carroll, Janet S. Butel, Stephen A. Morse, Timothy A. Mietzner: Jawetz, Melnick, & Adelberg's Medical microbiology, 25th edition (2010). 3. Kenneth J. Ryan, C. George Ray: Sherris Medical microbiology, 5th edition (2010). 4. Jacquelyn G. Black, Microbiology: Principles and Explorations, 7th edition, (2008). 5. Valentina Arsic Arsenijevic, Suyana Otasevic, Marina Milenkovic, Dusan Pavlica: Medical micolgy, (2012).			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: teaching, seminars, laboratory work, consultative teaching			
Grading system: Exam prerequisites 30, final exam 70 points.			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Vaccines			
Teachers: Antic Stankovic A Jelena, Milenkovic T Marina, Arsenovic Ranin M Nevena			
Course status: elective, module: Pharmaceutical Microbiology			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: ДФМ2И2	
Requirements: none			
Course aims: Gaining knowledge about the active immunization and different types of vaccines			
Course outcomes: The knowledge of the active principles of immunization, immunological memory, and the characteristics of various types of vaccines.			
Course contents: The development of immunological memory. Types of bacterial vaccines. The characteristics and the method of obtaining of "live" (attenuated) vaccines. The characteristics of the "dead" vaccines. Subunit and conjugate vaccines. Combination vaccines. BCG vaccine. Di Te Per vaccine. Vaccines against diseases caused by pneumococci. Vaccine against meningococcal meningitis. Vaccines against diseases caused by Haemophilus type b . General characteristics of viral vaccines. Vaccines composed of subunits . Vaccines with naked DNA. Polio vaccine and method of application characteristics . 'Attenuated vaccines against measles , mumps and rubella . Recombinant vaccine against hepatitis B . Vaccines against the flu (influenza) . Vaccine against papilloma viruses. Vaccine against rabies . Hyperimmune gamma globulins and their application . Antitetanus immunoglobulin, antidiphtheria serum.			
Recommended literature: 1. Stephen P. Denyer, Norman Hodges, Sean P. Gorman, Brendan F. Gilmore: Hugo & Russell's Pharmaceutical microbiology, 8th edition (2011). 2. Geo F. Brooks, Karen C. Carroll, Janet S. Butel, Stephen A. Morse, Timothy A. Mietzner: Jawetz, Melnick, & Adelberg's Medical microbiology, 25th edition (2010). 3. Kenneth J. Ryan, C. George Ray: Sherris Medical microbiology, 5th edition (2010). 4. Jacquelyn G. Black, Microbiology: Principles and Explorations, 7th edition, (2008).			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: teaching, seminars, consultative teaching			
Grading system: Exam prerequisites 30, final exam 70 points.			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Virulence factors of pathogenic microorganisms			
Teachers: Milenkovic T. Marina, Antic Stankovic A Jelena			
Course status: elective, module: Pharmaceutical Microbiology			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: ДФМ2И3	
Requirements: none			
Course aims: To provide knowledge regarding virulence factors of pathogenic microorganisms and mode of actions of bacterial exotoxins and endotoxins.			
Course outcomes: Knowing of bacterial virulence factors (factors of adherence and invasion, characteristics of exotoxins and endotoxins, genetic elements that code for bacterial virulence factors).			
Course contents: Definitions of pathogenicity and virulence. Colonization and infection. Classification of bacteria as pathogens, opportunistic pathogens or nonpathogens. The pathogenesis of infection : transmission of infection, portals of entry of pathogens. Adherence factors : pili (fimbriae), lipoteichoic acid, proteins, capsule, glycocalyx. Invasion of host cells and tissues. Antiphagocytic factors of bacterial pathogens. Bacterial exotoxins the mode of action (inhibition of protein synthesis, neurotoxins, cytolytins, exotoxins associated with diarrheal diseases, superantigens). The protein secretion systems –the type III secretion pathway (injection of a toxin into the host cell directly). Endotoxin (lipopolysaccharide) : structure and endotoxin-mediated toxicity. Characteristics of exotoxins and endotoxins. The role of bacterial biofilms in human infections. Mechanisms for escaping host defenses. Vaccines : live vaccines, inactivated vaccines (toxoid, inactivated bacteria , and capsule or protein sub-units of the bacteria). Detection of bacterial toxins- laboratory methods. The role of bacterial biofilms in persis-tent infections.			
Recommended literature: 1. Stephen P. Denyer, Norman Hodges, Sean P. Gorman, Brendan F. Gilmore: Hugo & Russell's Pharmaceutical microbiology, 8th edition, Wiley-Blackwell (2011). 2. Geo F. Brooks, Karen C. Carroll, Janet S. Butel, Stephen A. Morse, Timothy A. Mietzner: Jawetz, Melnick, & Adelberg's Medical microbiology, 25th edition, The McGraw-Hill Companies (2010). 3. Kenneth J. Ryan, C. George Ray: Sherris Medical microbiology, 5th edition, The McGraw-Hill Companies (2010). 4. Jacquelyn G. Black, Microbiology: Principles and Explorations, 7th edition, John Wiley & Sons (2008). 5. Alexander N. Glazer, Hiroshi Nikaido: Microbial biotechnology, 2nd edition (2007). 6. Pascale Cossart, Patrice Boquet, Staffan Normark, Rino Rapupuoli: Cellular Microbiology, 2nd, edition, ASM Press, (2005). 7. Warren Levinson: Review of Medical Microbiology and Immunology, 12th edition, The McGraw-Hill Companies (2012).			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: teaching, seminars, laboratory work			
Grading system: Exam prerequisites 30, final exam 70 points.			

University of Belgrade Faculty of Pharmacy	DOCTORAL ACADEMIC STUDIES		
Course title: Laboratory methods in parasitology			
Teachers: Milenkovic T. Marina, Antic Stankovic A Jelena			
Course status: elective, module: Pharmaceutical Microbiology			
Semester: III		Year of studies: II	
ECTS points: 5		Course code: ДФМ2И4	
Requirements: none			
Course aims: Acquiring additional knowledge on the laboratory methods used in medical parasitology.			
Course outcomes: Understanding and application of laboratory methods (standard, immunodiagnostic tests and PCR) for detection of human parasites.			
Course contents: Examination of clinical specimens for detection of parasites. Concentration methods . Microscopical examinations of stained smears. Methods for preparation and permanent staining of blood films (thin blood films, thick blood films). Diferential stains for the identification of protozoan parasites (iron hematoxylin, trichrome stains, Wright-Giemsa stain). Immunodiagnostic techniques for antigen detection of parasites (ELISA, Western blot). Immunodiagnostic techniques for antibody detection in toxoplasmosis. Molecular techniques for detection of parasitic infections. Examination of the egg morphology of nematodes (Ascaris lumbricoides, En-terobius vermicularis). Physiology and structure of medically important cestodes (Taenia solium, Taenia sagi-nata).			
Recommended literature: 1. Stephen P. Denyer, Norman Hodges, Sean P. Gorman, Brendan F. Gilmore: Hugo & Russell's Pharmaceutical microbiology, 8th edition, Wiley-Blackwell (2011). 2. Geo F. Brooks, Karen C. Carroll, Janet S. Butel, Stephen A. Morse, Timothy A. Mietzner: Jawetz, Melnick, & Adelberg's Medical microbiology, 25th edition, The McGraw-Hill Companies (2010). 3. Kenneth J. Ryan, C. George Ray: Sherris Medical microbiology, 5th edition, The McGraw-Hill Companies (2010). 4. Jacquelyn G. Black, Microbiology: Principles and Explorations, 7th edition, John Wiley & Sons (2008). 5. Pascale Cossart, Patrice Boquet, Staffan Normark, Rino Rapupuoli: Cellular Microbiology, 2nd, edition, ASM Press, (2005). 6. Warren Levinson: Review of Medical Microbiology and Immunology, 12th edition, The McGraw-Hill Companies (2012). 7. John DT, Petri WA : Markell and Voge’s Medical Parasitology, 9th edition, Elsevier (2006).			
The total of active learning classes	Lectures: 30		
	Individual research work: 30		
Teaching methods: teaching, seminars, laboratory work			
Grading system: Exam prerequisites 30, final exam 70 points.			