





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: Д1031		
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: Д1032		
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: <ol style="list-style-type: none"> 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, Oxford 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 research 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: 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 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: 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: ДФМ1ОМ3		
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 (cytotoxic, 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 (work 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. Principles 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 and macrophages), 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, invasive 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 micology, (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, antidipteria 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, cytolysins, 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). Differential 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.			