| **University of Belgrade**<br>**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:** Д1О31 |

**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-researh 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-researh 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:** Д1О32 |

**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:

- 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. Vitingoff 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.

**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, Plećaš-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

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|---|---|
| **Semester:** I | **Year of studies:** I |
| **ECTS points:** 5 | **Course code:** Д1О33 |

**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:**

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 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.

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|---|---|
| **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

**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, Plećaš-Solarović A. Bosiljka, Pešić P. Vesna, Nedeljković S. Miodrag, Milenković T. Marina, Antić Stanković A. Jelena, Parojčić V. Jelena, Ibrić R.Svetlana, Điriš 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

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|---|---|
| **Semester:** II | **Year of studies:** I |
| **ECTS points:** 5 | **Course code:** Д1О34 |

**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:**

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 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

**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, Plećaš-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

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|---|---|
| **Semester:** III | **Year of studies:** II |
| **ECTS points:** 5 | **Course code:** Д2О31 |

**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

**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:**

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 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.

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|---|---|
| **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

**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, Plećaš-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

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|---|---|
| **Semester:** IV | **Year of studies:** II |
| **ECTS points:** 5 | **Course code:** Д2О32 |

**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

**Course title:** Mechanisms of drug action

**Teachers:** Ugrešić D. Nenad, Stepanović-Petrović M. Radica, Savić M. Miroslav, Novaković N.Aleksandra, Tomić A. Maja, Plećaš-Solarović A. Bosiljka, Pešić P. Vesna

**Course status:** Mandatory modules, module: Pharmacology

| **Semester:** I | **Year of studies:** I |
|---|---|
| **ECTS points:** 10 | **Course code:** ДФА1ОМ1 |

**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 multicelllular 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 chemiotherapy. Mechanisms of action of antibacterial drugs. Mechanisms of action of antiviral drugs. Mechanisms of action of antifungal drugs. Mechanisms of action ofantiprotozoal drugs and anthelminthics. Mechanisms of action of anti-cancer drugs. Resistence 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:** ДФА1ОМ3 |

**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

**Course title:** Principles of use of animals for scientific purposes

**Teachers:** Todorović M. Zoran, Savić M. Miroslav

**Course status:** Mandatory modules, module: Pharmacology

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| **Semester:** I | **Year of studies:** I |
| **ECTS points:** 5 | **Course code:** ДФА1ОМ2 |

**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. Prinicples 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<br>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.

**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

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|---|---|
| **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 possibilitites to pharmacologicaly modulate nerovus functions; knowledge on indications, contraindikcations, 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 anasthetics. Epilepsy and antiepilepitcs. 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.

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|---|---|
| **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

**Course title:** Molecular and Cellular Physiology

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

**Course status:** elective, module: Pharmacology

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|---|---|
| **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

**Course title:** Molecular and Cellular Immunology

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

**Course status:** elective, module: Pharmacology

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|---|---|
| **Semester:** II | **Year of studies:** I |
| **ECTS points:** 7,5 | **Course code:** ДФА1И3 |

**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.

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| **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.

**Course title:** Immunopharmacology

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

**Course status:** elective, module: Pharmacology

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|---|---|
| **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.

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|---|---|
| **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

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| **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

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| **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<br>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 |
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| 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<br>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:** ДФА2И3 |

**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. Aquring 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<br>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 |
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| **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

**Course title:** Pharmacokinetics

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

**Course status:** elective, module: Pharmacology

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| **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<br>Faculty of Pharmacy | DOCTORAL ACADEMIC STUDIES | |
|---|---|---|

**Course title:** Neuroendocrineimmunemodulation

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

**Course status:** elective, module: Pharmacology

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| **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. Neuroimmmune 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

**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

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| **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 inflammatatory 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

**Course title:** Molecular Biology

**Teachers:** Biljana M. Potparević

**Course status:** elective, module: Pharmacology

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| **Semester:** III | **Year of studies:** II |
| **ECTS points:** 5 | **Course code:** ДФА2И9 |

**Requirements:** no

**Course aims:**

Student should be able to:

•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 prokariotes. 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 edidtion, 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.