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:** 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.

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, 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

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.

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, 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

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

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, 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

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.

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, 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

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

University of Belgrade Faculty of Pharmacy	**DOCTORAL ACADEMIC STUDIES**	

Course title: Advanced Course of Pharmacognosy 1

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

Course status: Mandatory modules, module: Pharmacognosy

Semester: I	**Year of studies:** I
ECTS points: 10	**Course code:** ДФГ1ОМ1

Requirements: no

Course aims:

The aim of this course is to introduce student to the structure, characteristics , basic principles of isolation , purification and chemical analysis of certain metabolites of plants and their pharmacological activity .

Course outcomes:

After completing the course, student is able to made chemical investigation of unknown plant materials and to made critical decision if new herbal drug/substances can be defined for the therapeutic purpose.

Course contents:

Theoretical lecture

The methodology and approach to scientific research in the field of pharmacognosy. The new pharmacologically active compounds from different classes of plant secondary metabolites (alkaloids, flavonoids, coumarins, lignans, quinones, cyanogen glycosides, glucosinolates, saponins, tannins, terpenoids, polyacetylene, essential oils, etc..). Investigation of less known wild growing plant as a potential source of new herbal drugs (use plant biodiversity for herbal drug/substance/drug leads discovery). Chemotaxonomic significance of certain secondary metabolites of plants. The importance of the study of biosynthetic processes and knowledge of the specifics of their potential application in order to improve the production of specific metabolites (getting herbal products defined by quality).

Methods for isolation and purification of the compounds from the plant material. Bioassay-guided isolation of plant constituent with defined pharmacological activities. The pharmacological activity of secondary metabolites of plants, and their chemical structure connectivity and pharmacological activities. Basic principles of testing feasibility of application of traditional herbal drugs and herbal drug preparations and defining new natural medicinal resources. Qualitative and quantitative analyses of herbal drugs.

Research work

Overview of the scientific literature and laboratory work in order to solve specific tasks and problems.

Recommended literature:

1. Evans WC. Trease and Evans Pharmacognosy. 16th ed. Edinburgh, London, New York, Philadelphia, St Louis, Sydney, Toronto: Elsevier; 2009.

2. Heinrich M, Barnes J, Gibbons S, Williamson E. Fundamental of Pharmacognosy and Phytotherapy. Edinburgh: Churchill Livingstone; 2004.

3. Liang XT, Fang WS. Medicinal Chemistry of Biaoctive Natural Products, Hoboken NJ: Wiley – Interscience; 2006.

4. Teuscher E, Melzig MF, Lindequist U. Biogene Arzneimittel. Stuttgart: Wissenschaftliche Verlagsgesellschaft mbH; 2004.

5. Hänsel R, Sticher O. Pharmakognosie - Phytopharmazie. Heidelberg: Springer Medizin Verlag; 2007.

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

7. Gupta MP, Handa SS, Vasisht S. (eds). Biological Screening of Plant Constituents (Training Manual). Trieste: ICS UNIDO; 2007

The total of active learning classes	**Lectures:** 60
	Individual research work: 60

Teaching methods:

Lectures, individual work with students, study research, terrain research, case study, seminars, presentation.

Grading system:

Pre-examination activities: 40 points

Exame (paper work/oral presentation): 60 points

University of Belgrade Faculty of Pharmacy	**DOCTORAL ACADEMIC STUDIES**	

Course title: Determination of Structure of Plant Secondary Metabolites

Teachers: Vele V. Tešević

Course status: Mandatory modules, module: Pharmacognosy

Semester: I	**Year of studies:** I
ECTS points: 5	**Course code:** ДФГ1ОМ2

Requirements: no

Course aims:

The aim of this course it determination of total chemical structure of plant secondary metabolits.

Course outcomes:

After completing the course, student is able to apply modern instrumental techniques of identification (UV / Vis, NMR, IR and MS) in the analysis of plant secondary metabolites.

Course contents:

Application of the method of spectral analysis: UV / Visible spectroscopy (UV / Vis); infrared spectroscopy (IR), mass spectrometry (MS). Details on nuclear magnetic resonance spectroscopy (NMR). Basic principles of resonance, NMR detection signal (continuous irradiation and FT NMR) chemical shift (δ), coupling constants (J), integral, multiplicity of signals (spectra of first and higher order), the relationship between structure and spectral 1H and 13C NMR data. Basics multidimenzional NMR techniques and tandem mass spectrometry . Analysis and interpretation of spectra. Consolidate data and define the chemical structure.

Analysis of the spectra of the isolated metabolites. Combining the obtained data in order to determine the structure. Identify and use tabular spectral data.

Recommended literature:

1. Милосављевић МС. Структурне инструменталне методе. Београд: Хемијски факултет; 1997.

2. Гођевац Д, Тешевић В. Структурне инструменталне методе - збирка спектара. Београд: Хемијски факултет; 2005.

3. Smith RM. Understanding Mass Spectra. Hoboken, New Jersey: John Wiley & Sons, Inc.; 2005.

4. Pretsch E, Clerck T, Seibl J, Simon W. Tablice za određivanje strukture organskih spojeva. Meić Z, Žinić M. Zagreb: SKTH/Kemija u industriji; 1982.

The total of active learning classes	**Lectures:** 30
	Individual research work: 30

Teaching methods:

Lecture, interactive work, seminars, consultative teaching, research work

Grading system:

pre-exam: 30 ; exam (writen) 35, exam (oral) 35

University of Belgrade Faculty of Pharmacy	**DOCTORAL ACADEMIC STUDIES**	

Course title: Advanced Course of Pharmacognosy 2

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

Course status: Mandatory modules, module: Pharmacognosy

Semester: II	**Year of studies:** I
ECTS points: 5	**Course code:** ДФГ1ОМ3

Requirements: Advanced Course of Pharmacognosy 1

Course aims:

The aim of this course is the introduction to modern ways and methods of production, defining quality parameters and methods of quality control of plant raw material / herbal drugs / herbal drugs preparations for the pharmaceutical and related industries.

Course outcomes:

After completing the course, the student is able to participate in the improvement of plant materials, propose method of quality control of herbal drugs / herbal drug preparations, as well as use the research results to define quality parameters of new herbal drug / herbal drug preparations.

Course contents:

Theoretical study

Modern production and primary processing of plant raw materials used for the production of herbal drugs and herbal drug preparations and the isolation of the compounds for the pharmaceutical and related industries. Team work in the production of the high quality and large quantity of raw material under controlled agricultural conditions.

Consideration of the possibility of using wild plants and natural habitats for the collection of plant materials through the application of best practice collection of plants. Pointing out the various influences on the quality of plant materials and associated with the notion of geographical origin as a measure of uniqueness and quality.

Basic principles of agronomic production of medicinal plants and the most common ways in which it can contribute to improving the quality of manufactured herbal products. The most important aspects of good practice of the crop production relating to the medicinal plants. Examples of organic production.

Presentation of the possibilities of application of the in vitro culture of plant biomass, or a compound or complex of a specific biotransformation to produce specific compounds.

Quality control of herbal drugs / herbal drugs preparations / herbal products. Ways of defining quality parameters of new plant materials (herbal drug / herbal drugs preparation), based on the results obtained during the research process. Introduction to the basic legislation in this area.

Research work

Overview of the scientific literature and laboratory work in order to solve specific tasks and problems.

Recommended literature:

1. Evans WC. Trease and Evans Pharmacognosy. 16th ed. Edinburgh, London, New York, Philadelphia, St Louis, Sydney, Toronto: Elsevier; 2009.

2. Heinrich M, Barnes J, Gibbons S, Williamson E. Fundamental of Pharmacognosy and Phytotherapy. Edinburgh: Churchill Livingstone; 2004.

3. Liang XT, Fang WS. Medicinal Chemistry of Biaoctive Natural Products, Hoboken NJ: Wiley – Interscience; 2006.

4. Teuscher E, Melzig MF, Lindequist U. Biogene Arzneimittel. Stuttgart: Wissenschaftliche Verlagsgesellschaft mbH; 2004.

5. Hänsel R, Sticher O. Pharmakognosie - Phytopharmazie. Heidelberg: Springer Medizin Verlag; 2007.

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

7. Gupta MP, Handa SS, Vasisht S. (eds). Biological Screening of Plant Constituents (Training Manual). Trieste: ICS UNIDO; 2007

The total of active learning classes	**Lectures:** 30
	Individual research work: 30

Teaching methods:

Lectures, individual work with students, study research, terrain research, case study, seminars, presentation.

Grading system:

Pre-examination activities: 40 points

Exame (paper work/oral presentation): 60 points

University of Belgrade Faculty of Pharmacy	**DOCTORAL ACADEMIC STUDIES**	

Course title: Screening of Pharmacological Activity of Plant Isolates

Teachers: Silva Lj. Dobrić

Course status: Mandatory modules, module: Pharmacognosy

Semester: II	**Year of studies:** I
ECTS points: 5	**Course code:** ДФГ1ОМ4

Requirements: no

Course aims:

The aim of this course is to introduction student with basic principles of pharmacology and experimental screening methods in pharmacology with special emphasis on the pharmacological and toxicological studies of herbal drugs, herbal drug preparations and herbal remedies including processing and interpretation of the results and reports of pharmaco/toxicological and clinical trials.

Course outcomes:

After completing the course, student is able to acquisit basic knowledge in experimental and clinical pharmacology, as well as capacity to independently conduct pharmacological and toxicological studies of herbal drugs, herbal drug preparations and herbal remedies including processing and interpretation of the results and reports of pharmaco - toxicological and clinical trials.

Course contents:

General information on the organization of work in the pharmacological-toxicological laboratory and work with laboratory animals and biological systems. Good laboratory practice. Introduction to the methods of " screening pharmacological activity " that are applied in herbal drugs testing. “Iin silico", " in vitro " and " in vivo " methods. The antimicrobial activity. Antioxidant activity . Antiinflammatory activity . Antiulcer activity. Hepatoprotective activity. Immunomodulatory activity. Antinociceptive activity. Behavioral models. Toxicological tests (acute, subacute, chronic, reproductive toxicity, genotoxicity, mutagenesis, carcinogenesis).

Results processing and presentation methods. A critical review and adequate decision making

on literature data. Emphasis the specificity of herbal medicines and problems arising in their pharmacological-toxicological and clinical trials .

Planning and conducting experiments from selected pharmacological and toxicological models. Data processing and results presentation. A critical analysis of selected scientific aricles on pharmacological-toxicological screening of herbal drugs.

Recommended literature:

1. Williamson EM , Okpako DT , Evans FJ . Selection, Preparation and Pharmacological Evaluation of Plant Material. Chichester, New York , Brisbane, Toronto, Singapore : John Wiley & Sons; 1996.

2. Schulz V, Hänsel R , Tyler VE . Rational Phytotherapy . 4th ed . Berlin, Heidelberg, New York : Springer Verlag; 2001.

3. Barrett M. The Handbook of Clinically Tested Herbal Remedies , vol . 1-2 . New York, London , Oxford : The Haworth Herbal Press; 2004.

4. Gad SC, editor.. Animals Models in Toxicology. 2nd ed . Boca Raton, New York: Taylor & Francis Group; 2007.

5. Lee C-J, Lee LH, Wu CL , Lee BR, Chen M-L . Clinical Trials of Drugs and Biopharmaceuticals. Boca Raton, London: Taylor & Francis Group, 2006.

The total of active learning classes	**Lectures:** 30
	Individual research work: 30

Teaching methods:

Lectures, individual work with students, research, planning and conducting preclinical and clinical trials of herbal drugs, herbal drug preparations, and herbal remedies .

Grading system:

Pre-examination obligations: up to 30 points; the final exam: up to 70 points.

University of Belgrade Faculty of Pharmacy	**DOCTORAL ACADEMIC STUDIES**	

Course title: Selected Chapters of Botany

Teachers: Jančić B. Radiša, Lakušić S. Branislava

Course status: elective, module: Pharmacognosy

Semester: II	**Year of studies:** I
ECTS points: 5	**Course code:** ДФГ1И1

Requirements: no

Course aims:

Evolutionary morphology of plants. Primary and secondary metabolism - basic trends. Localization of primary and secondary metabolites in vegetative and reproductive organs and their biological roles. Secretion and secretory structures. Principles of taxonomy. Botanical nomenclature, the nomenclature type. Classification systems, structures and their significance information. Getting to know the most efficient systems for diagnostic taxon.

Course outcomes:

Knowledge of the morphological structure, their properties, functions, and adaptive significance. Understanding the role of primary and secondary metabolites, their adaptive significance and value in use. Finding your way in the nomenclature section of descriptions of taxon. The ability to use information stored in systems of classification, diagnosis belonging to a particular plant taxon using keys, iconography, herbarium.

Course contents:

Morphology of plants: vegetative and reproductive organs and their functions, the adaptive significance - features formed as a result of evolution by natural selection. Morphological features as taxonomic characters and their distribution among vascular plants. Homology and analogy in morphology, DeKandol rule, diagnostic characters. Primary and secondary metabolites - biological role and value in use. Location of secondary metabolites in tissues and organs, and connection with their use in metabolism (either directly or from reserves created). Taxonomic significance of primary and secondary metabolites. Secretory structures, the distribution in the vascular plants, the biological role of adaptive significance (attractants, repellents, bacterial and fungicial effect), possible use as taxonomic markers. Taxonomy (nomenclature, description, diagnosis). Taxonomic characters (type, value in use and manner of use). Definition of taxon. Classification systems (natural, phylogenetic, special), the specifics of their use and importance. The most modern classification systems. Scientific names of taxon (rule nomenclature type, holotype, syntype, lectotype, homonyms, synonyms). Use of the means of diagnostic (keys, iconography, herbarium, and related software).

Recommended literature:

1. Evert R. Esaus Plant Anatomy. 3rd ed. New Jersey: John Wiley & Sons, Inc., 2006.
2. Јанчић Р, Стојановић Д. Економска ботаника. Београд: Завод за издавање уџбеника, 2008.
3. Metcalfe CR, Chalk L. Anatomy of the Dicotyledons Vol I&II. London: Oxford, Clarendon Press, 1988.
4. Марин, П. Биохемијска и молекуларна систематика биљака. Београд: ННК Интернационал, 2003.
5. Jones SB, Luchsinger AE. Plant systematics. USA: McGraw-Hill, 1979.
6. Davis PH, Heywood VH. Principles of Angisperm taxonomy. Edinburgh and London: Oliver & Boyd, 1963.
7. Међународни ботанички кодекс. Загреб: SNL, 1987.
8. Јанчић, Р. Речник ботаничких морфолошких појмова, Београд: САНУ, 2010.
9. Applequist W. The indetification of medicinal plants. Missouri, St. Louis: Missouri Botanical Garden Press, 2006.
10. Јосифовић М, ед. Флора СРС, 1 – 10 том. Београд: САНУ, 1970.

The total of active learning classes	**Lectures:** 30
	Individual research work: 30

Teaching methods:

Lectures, individual work with students, study research, terrain research, seminars, presentation.

Grading system:

Pre-examination activities: 60 points

Exame (paper work/oral presentation): 40 points

University of Belgrade Faculty of Pharmacy	**DOCTORAL ACADEMIC STUDIES**	

Course title: Structure and Properties of Secondary Metabolites

Teachers: Vladimir M. Savić

Course status: elective, module: Pharmacognosy

Semester: I	**Year of studies:** I
ECTS points: 5	**Course code:** ДФГ1И2

Requirements: no

Course aims:

The aim of this course it to describe chemical transformations and metabolic pathways leading to secondary metabolites.

Course outcomes:

After completing the course, student is able to understand chemical transformations involved in the formation of secondary metabolites and metabolic pathways leading to various classes of compounds

Course contents:

Structures and properties of building blocks and mechanisms in the formations of secondary metabolites; alkylation (nucleophilic substitutions, electrophilic additions), Wagner-Meerwein rearrangement (stability and transformation of carbocations), aldol reactions, reactions of aldehydes/ketones and amines, Mannich reactions, transaminations, decarboxylation, redox processes.

Acetate pathway: synthesis of polyketides from acetates, cyclisation of polyketides leading to arenes; alkylation, phenol coupling, oxidative degradation of an aromatic ring, Diels Alder reactions in formation of polycyclic natural products.

Shikimate pathway: aromatic amino acids, cinnamic acid, lignans, coumarines, flavolignans, isoflavonoids.

Mevalonic and deoxyxylulose phosphate pathway: steroids as modified triterpenoids, stereochemical properties of steroids

Formation of alkaloids from amino acids pyrolidines and tropane alkaloids from ornithine; piperidine, quinolizidine and indolizine alkaloids from lysine; phenylethylamines, tetrahydroisoquinoline and other related alkaloids from tyrosine; indole, carboline, quinolone derived alkaloids from tryptophan;

Synthesis of selected natural products

Recommended literature:

Dewick PM. Medicinal Natural Products. Chichester: John Wiley and Sons; 2002.

original scientific articles

The total of active learning classes	**Lectures:** 30
	Individual research work: 30

Teaching methods:

Seminars, consultative teaching

Grading system:

pre-exam: 30 ; exam 35, seminar 35

University of Belgrade Faculty of Pharmacy	**DOCTORAL ACADEMIC STUDIES**	

Course title: Selected Chapters of Instrumental Methods

Teachers: Vesna S. Kuntić, Slavica M. Blagojević

Course status: elective, module: Pharmacognosy

Semester: II	**Year of studies:** I
ECTS points: 5	**Course code:** ДФГ1И3

Requirements: no

Course aims:

The aim of this course is to introduce student with theoretical principles of selected chromatographic, optical and electrochemical instrumental methods which are widely applied for the analysis of the medical plants and plant materials.

Course outcomes:

After completing the course, students are expected to comprehend the fundamental physical-chemical principles of several instrumental methods (chromatographic, optical and electrochemical) and be capable of choosing a particular analytical method (technique) to complete a required task for medical plant analysis and quality control of plant preparations.

Course contents:

Chromatography. General principles, branches of chromatography, types of column, detectors. Chromatograms. Modes of chromatography: Ion exchange, "flash" chromatography, gel filtration, thin layer (TLC), gas chromatography (GC) and liquid chromatography (HPLC) for analysis of plant extracts and essential oils.

Spectroscopic methods. The electromagnetic spectrum, interactions of electromagnetic radiation with matter. Molecular absorption spectrometry (UV-VIS and IR) in plant analysis. Atomic absorption spectrophotometry (techniques with and without flame); determination of traces of metal in crude samples. Emission spectrometry: fluorometry (fluorescence, phosphorescence).

Fundamentals of mass spectroscopy. Ionisation modes: electron impact, chemical ionisation, fast atom bombardment, plasma desorption ionisation, electrospray ionisation, ion spray ionisation, matrix-assisted laser desorption ionisation. Mass analyser: magnetic sector field, quadrupole, ion trap, time-of-flight. Ion detectors. Coupled systems: GC-MS, HPLC-MS for medical plant analysis.

Electrochemical methods: potentiometric titration, indicator electrode in potentiometric titration, titration curves. Application of potentiometric titration in quantitative analysis of phytochemicals.

Recommended literature:

1. Skoog, D., Holler, F., Nieman, T.: Principles of Instrumental Analysis. Saunders College Publishing, Philadelphia 1998.

2. Kaplan, L., Pesce, A.: Clinical chemistry: Theory, Analysis, Correlation. Mosby,1996.

3. Hoffman E, Stroobant B.: Mass spectrometry, Principles and Application. New York: J.Wiley 2002.

The total of active learning classes	**Lectures:** 30
	Individual research work: 30

Teaching methods:

Individual lectures, literature survay, research.

Grading system:

Pre-examination activities (seminar): 50 points

Exame (oral): 50 points

University of Belgrade Faculty of Pharmacy	**DOCTORAL ACADEMIC STUDIES**	

Course title: Principles of use of animals for scientific purposes

Teachers: Todorović M. Zoran, Savić M. Miroslav

Course status: elective, module: Pharmacognosy

Semester: II	**Year of studies:** I
ECTS points: 5	**Course code:** ДФГ1И4

Requirements: none

Course aims:

The aim of this course is to provide participants with knowledge about principles of breeding, handling and use of animals used for scientific purposes, including legislation in Serbia, European Union and world, as well as of anaesthesia and surgery of laboratory animals (wok in vivo).

Course outcomes:

By the end of this course participants will have gained an understanding of legislation and principles of breeding, handling and work with animals used for scientific purposes.

Course contents:

Legislation and ethical questions related to work with animals used for scientific purposes. 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 Faculty of Pharmacy	**DOCTORAL ACADEMIC STUDIES**	

Course title: Application of GC and HPLC for the Analyses of Plants Isolates

Teachers: Vele V. Tešević

Course status: elective, module: Pharmacognosy

Semester: III	**Year of studies:** II
ECTS points: 5	**Course code:** ДФГ2И1

Requirements: no

Course aims:

The aim of this course it to introduce student with application of chromatographic instrumental techniques - gas and liquid chromatography for the analysis of plant isolates.

Course outcomes:

After completing the course, student is able to analyze essential oils, vegetable waxes, phenolic compounds, sesquiterpenes, triterpenes, alkaloids and other metabolites of plants.

Course contents:

Introduction to the basic principles of chromatography. Basics of chromatographic methods with special emphasis on instrumental techniques: gas and liquid chromatography.

Gas chromatographic columns, detectors and injectors. Choice of operating conditions: temperature, flow.

The liquid chromatography column. Methods of Separation: reversed phase, normal, ion exchange and affinity chromatography. Choice of operating conditions: mobile phase composition, flow rate. Detectors in liquid chromatography.

Combination method: gas chromatography / mass spectrometry, liquid chromatography / mass spectrometry. Tandem mass spectrometry.

Isolation of essential oil distillation and simultaneous distillation and extraction. Isolation and extraction epicuticular waxes . Analysis of isolates by using a combination of gas chromatography and gas chromatography / mass spectrometry. Comparison of mass spectra with the library of spectra and the use of retention data for the identification of compounds in a mixture.

Extraction of the surface of flavones from plant material and the resulting analysis of the extract by liquid chromatography with UV detection, and sets performance liquid chromatography / mass spectrometry.

Recommended literature:

1. Linskens HF, Jackson JF. Modern Methods of Plant Analysis. Gas Chromatography/Mass Spectrometry. Berlin, Heidelberg, New York, Tokyo: Springer-Verlag; 1986. 2. Sandra P, Bicchi C. Capillary Gas Chromatography in Essential Oil Analysis. Heidelberg, Basel, New York: Dr. Alfred Heuthig Verlag; 1987. 3. Adams RP. Identification of Essential Oil Components by Gas Chromatography/Quadrupole Mass Spectroscopy. Illionis, USA: Allured Publishing Corporation; 2001. 4. Waksmundzka-Hajnos M, Sherma J (eds.). High Performance Liquid Chromatography in Phytochemical Analysis. Boca Raton, London, New York: Taylor & Francis Group, CRC Press; 2001.

The total of active learning classes	**Lectures:** 30
	Individual research work: 30

Teaching methods:

Lecture, interactive work, seminars, consultative teaching, research work

Grading system:

pre-exam: 30 ; exam (writen) 35, exam (oral) 35

University of Belgrade Faculty of Pharmacy	**DOCTORAL ACADEMIC STUDIES**	

Course title: Ecology of Plants

Teachers: Lakušić S. Branislava, Jančić B. Radiša

Course status: elective, module: Pharmacognosy

Semester: III	**Year of studies:** II
ECTS points: 5	**Course code:** ДФГ2И2

Requirements: no

Course aims:

The aim of this course is to introduce student with ecological processes that influence the structure, function and distribution of plants on Earth. Elucidate effects of ecological factors on the quantity and quality of specific metabolites (essential oils, flavonoids, alkaloids).

Course outcomes:

After completing the course, student is able to understand the impact of ecological factors on medicinal plants, understanding the relationship between habitat and populations of medicinal plants, and especially the understanding of the negative effects of anthropogenic factors on endangered plant species and biodiversity in general

Course contents:

Definition, the object of study, classification, and relationship to other sciences. Basic concepts: environment, habitat and the ecosystem. The concept of ecosystem components and processes. Principles of functioning of ecosystems. Global aspects of biogeochemical cycles. The ratio of plants to environmental conditions, life forms, plant adaptation, adaptive types. Ecological factors - abiotic and biotic. Types of effects ecological factors (distribution, formative, physiological, orientation, phenological). Levels of action of environmental factors (individual, population, community). The structure, dynamics and zoning of vegetation. Ecological features of the basic types of vegetation Serbia and the Balkan Peninsula. The relationship of ecology and environmental protection. Vulnerability and protection of biodiversity (rare, endemic, relict and endangered plant species). Sustainable use of medicinal plants.

Recommended literature:

1. Стевановић Б, Јанковић М. Екологија биљака са основама физиолошке екологије. Београд: ННК Интернационал, 2001.

2. Rodriguez E, Healey PL, Mehta I. Biology and chemistry of plant trichomes. New York: Plenum press, 1984.

3. Марин П. Биохемијска и молекуларна систематика биљака. Београд: ННК Интернационал, 2003.

4. Стевановић В, Васић В, едс. Биодиверзитет Југославије са прегледом врста од међународног значаја. Београд: Биолошки факултет и Еколибри, 1995.

5. Јовановић С, Лакушић Д, едс. Угрожене биљке Србије. Београд: Биолошки факултет Универзитета у Београду и ИП ННК Интернационал, 2006.

6. Стевановић В, ед. Црвена књига флоре Србије 1. Београд: Министарство за животну средину републике Србије, Биолошки факултет и Завод за заштиту природе републике Србије, 1999.

The total of active learning classes	**Lectures:** 30
	Individual research work: 30

Teaching methods:

Lectures, individual work with students, study research, terrain research, seminars, presentation.

Grading system:

Pre-examination activities: 60 points

Exame (paper work/oral presentation): 40 points

University of Belgrade Faculty of Pharmacy	**DOCTORAL ACADEMIC STUDIES**	

Course title: Non - medical Application of Herbal Drugs

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

Course status: elective, module: Pharmacognosy

Semester: III	**Year of studies:** II
ECTS points: 5	**Course code:** ДФГ2И3

Requirements: no

Course aims:

The aim of this course is getting to know the composition, effects and quality control of plant raw materials (herbal drugs / herbal drug preparations) used for making non-medical herbal products.

Course outcomes:

After completing the course, student knows and is able to propose a non-medical application of plant materials (herbal drugs / herbal drug preparations) based on the knowledge of their composition and effects, and to propose a way of controlling their quality.

Course contents:

Theoretical study

Getting to know the different possibilities of application of plant materials (herbal drugs and herbal drug preparations) in the food, cosmetic, parfimerijskoj industry, alcoholic and non-alcoholic beverages, paints and varnishes and related industries. Basic information about the production and the world market of vegetable raw materials (manufacturers, exporters and importers), categories of non-medical herbal products on the market, manufacturers of the final product. Examples of new and lesser-known herbal raw materials used for making non-medical herbal products. Information about the most important ingredients of plants (chemical structure, properties) for which these natural products are used. Plant materials and their isolated compounds as active, excipients and additives. Claims of safety and quality of herbal raw materials, depending on the product category. Quality control of herbal raw materials used for making non-medical herbal products. Introduction to the current legislation in this area.

Research work

Overview of the scientific literature and laboratory work in order to solve specific tasks and problems. The students will be discussed preliminary estimate possibilities of some plant material (which is the subject matter) for non-medical purposes, as well as the type, set up and implementation of experiments that would provide information about the feasibility of such an idea. Suggestions for characterization and definition of quality and safety profile of herbal products, depending on the product category for which it was intended.

Recommended literature:

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

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

3. Vasisht K, Kumar V. (eds). Trade and Production of Herbal Medicines and Natural Health Products. Trieste: ICS UNIDO; 2002.

4. Vasisht K, Kumar V. (eds). Medicinal Plants and their Utilization. Trieste: ICS UNIDO, 2003.

5. Teuscher E, Bauermann U, Werner M. Medicinal Spices. Stuttgart: Medpharm GmbH Scientific Publishers; 2006.

The total of active learning classes	**Lectures:** 30
	Individual research work: 30

Teaching methods:

Lectures, individual work with students, study research.

Grading system:

Pre-examination activities (seminar): 50 points

Exame (oral): 50 points

University of Belgrade Faculty of Pharmacy	**DOCTORAL ACADEMIC STUDIES**	

Course title: Formulation of Herbal Medicinal Products

Teachers: Milić-Aškrabić R. Jela, Parojčić V. Jelena, Ibrić R. Svetlana

Course status: elective, module: Pharmacognosy

Semester: III	**Year of studies:** II
ECTS points: 5	**Course code:** ДФГ2И4

Requirements: no

Course aims:

Introduction to the importance of formulation factors affecting herbal medicinal product performance and its biopharmaceutical characterization as the foundation for independent research work.

Course outcomes:

Understanding and application of pharmaceutical formulation principles in herbal preparation/ herbal medicinal product development and biopharmaceutical characterisation.

Course contents:

The types and characteristics of herbal drug dosage forms. Pharmaceutical adjuvents/excipients for pharmaceutical preparations/products. Factors taken into consideration when choosing excipients for particular pharmaceutical drug dosage form. Experimental design - principles and application in pharmaceutical development of herbal products. Manufacturing/production processes of solid drug dosage forms. Methods for pharmaceutical-technological and biopharmaceutical characterization of pharmaceutical solid dosage forms. Important factors for pharmaceutical preparations (herbal pharmaceutical products) stability.

Recommended literature:

1.Gibson M. Pharmaceutical preformulation and formulation, 2nd ed. Informa Healthcare, 2009;

2. Allen LV (ed.). Remington: The Science and Practice of Pharmacy. 22nd ed. Gurnee: Pharmaceutical Press; 2012.

3. Gaedcke F, Steinhoff B. Herbal Medicinal Products. Stutgart: Medpharm Scientific Publisher; 2003.

4. Rowe RC, Sheskey PJ, Owen SC (eds.). Handbook of Pharmaceutical Excipients. London, Washington: Pharmaceutical Press andAmerican Pharmacists Association; 2008.

5. Aulton ME. Pharmaceutics – The science of dosage form design. 2nd ed. Edingburgh: Churchill Livingstone; 2002. 6. Florence and Attwood. Physicochemical Principles of Pharmacy, Pharmaceutical press, 2006;

The total of active learning classes	**Lectures:** 30
	Individual research work: 30

Teaching methods:

Lectures, interactive sessions, practical exercises and seminars.

Grading system:

Pre-exam obligations: up to 30 points; Exam(written): up to 70 points.