

Name of the subject: HIGHER PLANT TAXONOMY		
Teacher(s): Dr. Goran Anačkov		
Status of the subject: Elective		
Number of ECTS points: 15		
Condition: none		
Goal of the subject Qualifying students for independent work in the taxonomic laboratories, dealing with problems in the taxonomy of higher plants. Mastering the techniques used in the taxonomy of plants, knowledge of International Code of Nomenclature for Algae, Fungi and Plants.		
Outcome of the subject Application of acquired knowledge in scientific research, active monitoring of literature and new results in the field of taxonomy of plants, self-creation of the working hypothesis and implementation of the research process in the taxonomy, the development of taxonomic thought and proper interpretation of results.		
Content of the subject <i>Theoretical lectures:</i> Relationships between systematic and taxonomy. Principles of taxonomy (classification, nomenclature, identification, biosystematics, experimental taxonomy, comparative biology, classification process and hierarchical systems). Taxonomical character. Concepts and categories (1. species, subspecies, variety, form; 2. genus; 3. family and higher categories). Taxonomical data – data types and taxonomical methods (morphological, anatomical, embryological, palynological, phytochemical, cytological and cytogenetical, molecular, genetical and population genetical, reproductive biology data, ecological). Taxonomical data - processing and interpretation, taxonomical data and different approaches in classification. International Code of Nomenclature for Algae, Fungi and Plants. Typification, Principles, Rules and Recommendations. Rules for description of the new taxon (Valid publication of names). <i>Practical lectures:</i> Analysis of taxonomical data, identification, selection, significance of data and their correlation. Data analysis methods and software support. Data analysis using International Code for Nomenclature, tasks and problems. The results of the practical classes will be presented in the form of a seminar paper.		
Recommended literature 1. Stuessy T.F. (2009): Plant Taxonomy, The Systematic Evaluation of Comparative Data, sec. edit.. Columbia University Press, New York. 2. Turland N.J. et al, eds. (2018): International Code of Nomenclature for algae, fungi and plants (Shenzhen Code). Koeltz Botanical Books, Glashütten. 3. Stuessy T.F., Crawford D.J., Soltis D.E., Soltis P.S. (2014): Plant Systematics, The Origin, Interpretation, and ordering of Plant Biodiversity, Koeltz Scientific Books, Königstein. 4. Simpson M.G. (2019): Plant Systematics, thrd ed. Elsevier Academic Press, Burlington, San Diego, London. 5. Šugar, I. <i>transl.</i> (1987): Međunarodni kodeks botaničke nomenklature. SNL, Zagreb. 6. Walters, D.R., Keil, D.J., Walters, B. Murrell, Z.E. (2002): Vascular Plant Taxonomy. Oxford and IBH Pub. New Delhi. Doctoral dissertations and masters theses in the field of molecular systematics of plants recommended by mentors, as well as scientific papers and websites with current issues in taxonomy and plant systematics.		
Number of active classes	Theory:5	Practice: 5
Methods of delivering lectures Lectures, individual consultations, lab work, seminar papers.		
Evaluation of knowledge (maximum number of points 100) Seminar paper 50 points Oral exam 50 points		

Name of the subject: INTRASPECIES VARIABILITY OF PLANTS		
Teacher(s): Dr. Goran Anačkov, Dr. Ružica Igić		
Status of the subject: Elective		
Number of ECTS points: 15		
Condition: none		
Goal of the subject Higher level in the plant taxonomy. Taxonomical, phylogenetical and evolutionary importance of plants intraspecies variability. Comprehending the skills of clear and valid selection of characters for determination of intraspecific taxa. Knowledge of techniques used in the detection of intraspecies variability.		
Outcome of the subject Application of acquired knowledge in scientific research, search and analysis of literature sources and newly published results in the field of plant taxonomy, independent defining of the working hypothesis and implementation of the research process in the taxonomy, the development of taxonomic philosophy and scientific interpretation of results.		
Content of the subject <i>Theoretical lectures:</i> Intraspecific categories legitimate by International Code of nomenclature for Algae, Fungi and Plants, principles of determining the new intraspecific categories. Forms of plants variability, such are: monomorphic, polymorphic and politypic species, importance of mutations and modifications in the plant variability. Phenotypic selection and evolutionary strategies of flowers. Ecological concept of intraspecific variability. Effects of colonization, metapopulation dynamics and flowers transformation. Floral design and the asymmetry evolution. Geographical concept in morphological variability in floral region. The hybrid zones and intraspecific variability. Problematic taxa. Parallel taxa by principles of subordination. Models of variable series. Phenocopies. <i>Practical lectures:</i> Based on fresh plant material, collected by student. On the practical lectures will be analyzed selected species with a pronounced variability based on already described intraspecies taxa. It will be determined the characters that differ from the typical character of species (taxon), and try to connect with some of the ecological factors that cause these changes. They highlight features that are not mentioned in the literature and are clearly visible and may have taxonomic significance. Results of student work will be presented as a seminar article.		
Recommended literature 1. Briggs D., Walters S.M. (2000): Plant variation and evolution, 3 rd ed. Cambridge University Press, Cambridge. 2. Harder L.D., Barrett S.C.H., eds. (2007): Ecology and Evolution of Flowers. Oxford University Press, Oxford. 3. Arnold M.L. (2012): Evolution Through Genetic Exchange. Oxford University Press, Oxford. Doctoral dissertations and masters theses in the field of molecular systematics of plants recommended by mentors, as well as scientific papers and websites with current issues in taxonomy and plant systematics.		
Number of active classes	Theory:5	Practice: 5
Methods of delivering lectures Lectures, individual consultations, lab work, seminar article.		
Evaluation of knowledge (maximum number of points 100) Seminar article 50 points Oral exam 50 points		

Name of the subject: EVOLUTION AND ANGIOSPERM PHYLOGENY		
Teacher(s): Dr. Goran Anačkov		
Status of the subject: elective		
Number of ECTS points: 15		
Condition: none		
Goal of the subject The highest level in the taxonomy of plants. Training students to recognize phylogenetic connections and relationships within Angiosperms.		
Outcome of the subject Formation of researchers in the field of plants taxonomy, with a developed philosophical thinking. Developing of thinking: analysis and synthesis. Versatility in plant taxonomy.		
Content of the subject <i>Theoretical lectures:</i> The evolutionary record and methods of reconstruction; Earliest forms of plants and the colonization of land; Formation and transformation of forest plant communities. Significant periods in the Plant evolution; Flowering plants origin and their development. Mass extinction and plants. Evolutionary alternations and ontogeny (prolongation, abbreviation, deviation, „neoteny“. Evolutionary trends in formation of vegetative organs, flowers (diversification) and inflorescences. Transformation of the pollengrains and megaspores. Evolution of fruits and seed. Mosaics and heterobatmy of characters. Polyploidy, parallel and convergent evolution in plants, the evolution of plant genome size. Angiosperm phylogeny: ANA group, Magnoliids plants, monocots, early eudicots, central core of eudicots, rosids and asteriids. <i>Practical lectures:</i> On the exercise will be analyzed phylogenetic tree of some plant divisions. Based on the characters of fossil ancestors and now-days representatives, will be determined the common and differential features, and will be point out the importance of atavistic phenomena in the plant world. Will be given access to the basic principles of the Telome theory as a basis of the phylogeny of vascular plants. It will be also emphasize the importance of ancestral plant groups for the origin of some progressive features.		
Recommended literature Soltis D., Soltis P., Endress P., Chase M.W., Manchester S., Judd W., Majure L., Mavrodiev E. (2018): Phylogeny and Evolution of the Angiosperms: Revised and Updated Edition. University of Chicago Press, Chicago. Willis K.J., McElwain J.C. (2014) : The Evolution of Plants, sec.ed. Oxford University Press, Oxford. Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F., Donoghue, M.J. (2002): Plant Systematics: A Phylogenetic Approach. Sinauer Associates, USA. Krassilov V.A. (1997): Angiosperm Origins: Morphological and Ecological Aspects. Paleontological Institute of the Russian Academy of Sciences, Sofia. Takhtajan, A. (1991): Evolutionary Trends in Flowering Plants. Columbia University Press, New York. Takhtajan, A. (1959): Die evolution der Angiospermen. Veb Gustav Fischer Verlag, Jena – The Serbian translation professor Pal Boža PhD – internal script. Stojković B., Tucić N. (2012): From molecules to organisms, molecular and phenotypic evolution. Službeni glasnik, Belgrade – in serbian. Doctoral dissertations and masters theses in the field of molecular systematics of plants recommended by mentors, as well as scientific papers and websites with current issues in taxonomy and plant systematics.		
Number of active classes	Theory:5	Practice: 5
Methods of delivering lectures Lectures, individual consultations, lab work, seminar papers.		
Evaluation of knowledge (maximum number of points 100) Seminar paper1 30 points Seminar paper 2 10 points Oral exam 60 points		

Name of the subject: PHYSIOLOGICAL PLANT ANATOMY		
Teacher(s): Dr. Jadranka Luković, Dr. Lana Zorić		
Status of the subject: Elective Course		
Number of ECTS points: 15		
Condition:		
Goal of the subject Getting knowledge about complexity and interactions between structural characteristics of tissues, organs, plant organism in a whole and plant physiological processes.		
Outcome of the subject After finishing this course students should obtain knowledge that would enable them to understand and follow actual investigations in this field.		
Content of the subject <i>Theoretical lectures</i> Interaction of structure and function. Vascular tissue: phloem structure and transport of assimilates. Xylem structure and water transport. Secretory tissue and types of secretion. Cranz anatomy of leaf and photosynthesis. Stomatal apparatus, gas exchange and transpiration. Dermal tissue characteristics and foliar absorption. Leaf vein endings and transport of assimilates. Anatomical changes of vegetative organs in relation to excessive or deficit mineral nutrition. Changes in the structure of plant organs induced by excessive or deficit presence of macro and microelements. <i>Practical lectures</i> The structure of practical work is in accordance with candidat's field of research and the subject of PhD thesis.		
Recommended literature Denffer, D., Ziegler, H. (1991): Ботаника. Морфологија и физиологија. Школска Књига, Загреб. Dickison C. W. (2000): Integrative plant anatomy, Harcourt academic press, New York, London. New publications and papers available on internet		
Number of active classes	Theory: 5	Practice: 5
Methods of delivering lectures lectures, practical work, student research work, consultations		
Evaluation of knowledge (maximum number of points 100)		
The exam is oral. Prerequisites for oral exam are: active involvement of students in experimental work on specific subjects dealing with physiological anatomy, written and presented student's practical work and read out of several scientific papers from this field. Practical work: 20 Seminar work: 30 Oral exam: 50		

Name of the subject: AEROBIOLOGY		
Teacher(s): Dr.Predrag Radišić, Dr. Branko Šikoparija		
Status of the subject: Elective		
Number of ECTS points: 15		
Condition: no		
Goal of the subject Introduction to aerobiology - a scientific discipline that studies biological particles suspended in atmosphere, their transport, emission, deposition and impact in ecosystems. Training on basic methods for sampling, analysis of samples and data analytics. Introduction to application of aerobiology results in medicine, agriculture, forestry, climate sciences and forensics.		
Outcome of the subject Enables work in laboratories that study bioaerosols and their use in allergology, plant protection, occupational health and atmospheric sciences.		
Content of the subject <i>Theoretical lectures</i> Definition and history of aerobiology. Diversity of bioaerosols, sources, emission, transport and sedimentation mechanisms so as the impact on environment. Introduction to common sampling methods and physical approaches to representative sampling including devices used in common practice. Notable attention is given to data analytics (i.e. forecasting for airborne pollen and fungal spores suspended in the atmosphere) and its application in medicine, plant protection, occupational health, agriculture, forestry, climatology and forensics. <i>Practical lectures</i> Training for using Rotorod, Durham, Andersen and Hirst type samplers. Work with samplers and analysis using optic microscope. Identification of the most important allergenic pollen (birch, grasses, mugwort, ragweed, olive). Identification of the most dominant airborne fungal spores (Cladosporium, Alternaria, Epicoccum).		
Recommended literature Шимић, С, Радишић, П., Шикопарија, Б. и Дулић, И. (2007): Палинологија. стр.1-93 Радишић, П. и Шикопарија, Б, (2012): О полену, У Игић, Р. (ед) Алергијске биљке. ПМФ Департман за биологију и екологију и „Врело” Друштво за исхрану и заштиту животне средине. 35-67. Sofiev, M., Bergman, C-K (eds.) Allergenic Pollen: A Review of the Production, Release, Distribution and Health Impacts. Springer Verlag, 2013. pp272. ISBN978-94-007-4880-4 Cox, C.S. and Wathes, C. S. (1995): Bioaerosols handbook. Lewis Publishers. 1-621.		
Number of active classes	Theory: 5	Practice: 5
Methods of delivering lectures Lectures, laboratory exercises, written essay and practical student project.		
Evaluation of knowledge (maximum number of points 100) Laboratory excercises 30 points; written essay on given topic 30: Practical student project: 40		

Name of the subject: BASIC AND MOLECULAR SYSTEMATICS AND ECOLOGY OF FUNGI		
Teacher(s): Dr. Maja Karaman, Dr. Vladislava Galović, Dr. Ivica Tamaš		
Status of the subject: Elective		
Number of ECTS points: 15		
Condition: No		
Goal of the subject : The course is designed to introduce students to modern basic principles in the systematics and ecology of fungi, as well as new molecular-technological platforms currently used in extensive application of molecular methods in various fields of mycology including genetics, systematics, ecology and biotechnology of fungi. Introducing a program of molecular methods in the study of fungal systematics, their taxonomic affiliation and phylogenetic relationship, as well as their environmental aspect, students have the opportunity to become familiar with the use of various types of biomolecules (DNA, RNAs) and molecular platforms (genomics, transcriptomics) that would make many advances in research to date.		
Outcome of the subject : Training students to handle with techniques that will enable them to make cultures collections of fungi of different systematic affiliation, preservation of cultures as a gene bank depot, DNA isolation, RNA; use of molecular platforms regarding the research preferences; training students to handle independently with master molecular procedures in the laboratory environment. Students would be able to learn how to use bioinformatics search engines and be able to independently interpret the results of molecular analysis as well as to independently form and use the fungal gene databases available on NCBI and other data bases sites.		
Content of the subject: <i>Theoretical part:</i> Through lectures, in this course students will become acquainted with contemporary trends in the field of basic and molecular systematics and ecology of fungi. Emphasis will be placed on different methods of sampling, which is the most important prerequisite to obtain a valid final result of molecular analyzes. Further on they will be able to learn different methods of isolation of different biomolecules from the fungi genome. Participants will be introduced with the standard PCR technique and its principles as well as various identification techniques like enzymatic reactions using endogenous nucleases, RFLP, sequencing, SNP, EF1, alpha tubulin, DNA barcoding techniques. In the case of sequence analyzes within molecular systematics and taxonomy as well as phylogeny in species identification, they would be introduced to the principles and use of different searching engines (BLAST, UNITE, FinchTV, MEGA 6.6, ClustalW, MAFFT, RaxML). Molecular ecology would clarify the role of different types of fungi in natural ecosystems, their diversity, as well as their basic life strategies. Particular attention would be paid to the molecular characterization of relationships and host-pathogen interactions and their immune responses. <i>Practical part:</i> Demonstration exercises: different methods of isolation of fungi from the natural environment, methods of cultivation and preservation for isolation of DNA and RNA from the fertile bodies of macrofungi, as well as from pure “ <i>in vitro</i> ” mycelium cultures from the collection. Mastering of PCR techniques, gel-electrophoretic identification of amplified target fragments, spectro-photometry and fragment purification as part of the preparation for sequencing parts of the genome of fungi, learning about the latest identification technologies (MALDI-TOF mass spectroscopy technology). The results processing would be directed towards the analysis of cladograms and phylogenetic trees as well as reading sequences after multiplication of the target genes and interpretation of their expression. <i>Theoretical exercises:</i> Laboratory part of nucleic acid isolation, PCR, electrophoresis, small volume spectrophotometry, calculation of nucleic acid purity and quality, preparation of agarose gel, purification from agarose gel. Working with search engines and bioinformatic analysis of results.		
Recommended literature <ol style="list-style-type: none"> 1. Application of PCR in Mycology. Eds. P. D. Bridge. CAB International, 1998. 2. Sepp Hochreiter. Bioinformatics Sequence Analysis and Phylogenetic lecture Notes. Bioinformatics I Sequence Analysis and Phylogenetics Institute of Bioinformatics, Johannes Kepler University Linz, 2013. 3. Lecture Notes Bioinformatics.ed., Canberra, 2006 4. Introduction to Computational Molecular Biology and Genomics. Princeton University Computer Science Dept., 1998. 5. The mycology of the Basidiomycetes. Canberra, 2006. 6. Quantitative Real-time PCR in Applied Microbiology. Caister Academic Press, Martin Filion Department of Biology, Université de Moncton, Canada, 2012 7. Pathogenic Fungi: Structural Biology and Taxonomy Caister Academic Press. Eds. Martin Filion Department of Biology, Université de Moncton, Canada, 2012. 8. Arora D. K. <i>Handbook of Fungal Biotechnology</i>. Marcel Dekker, Inc., New York, USA, 2004. 9. G. M. Muller, G. F. Bills, M. S. Foster. Biodiversity of Fungi, Inventory and Monitoring <i>Methods</i>. Elsevier Academic Press, Burlington, San Diego, London, 2004. 10. The Mycota. A comprehensive Treatise on Fungi as experimenta; System for Basic and Applied <i>Research</i>. eds.K.Esser,J.W.Bennett &H.D.Osiewacz. Vol X. Industrial applications. Springer-Verlag Berlin Heidelberg, 2002. 		
Number of active classes	Theory: 5	Practice: 5
Methods of delivering lectures: Lectures, demonstration exercises, seminars, consultations. With personal affinity, students choose a topic of the reveal type for their seminar work, which they prepare on the basis of standard and accessible literature.		
Evaluation of knowledge (maximum number of points 100)		
Design and defence of seminar paper: 10 points;written part: 40 points; oral part: 50 points.		

Name of the subject: BIOTECHNOLOGICAL APPLICATION OF MICROORGANISMS		
Teacher(s): Dr. Zorica Svirčev		
Status of the subject: Elective		
Number of ECTS points: 15		
Condition: Ecology of Microorganisms, Bacteriology, Algology and Micology		
Goal of the subject Connecting the prerequisites knowledge with the application possibilities in different fields of microbial biotechnology.		
Outcome of the subject Bearing in mind the plan and program of the past two biotechnology courses (Biotechnology in basic studies and Microbial Biotechnology of Microbiological module), the outcomes and tasks of the course match the detailed analysis and possibility of introducing microorganisms into different areas of biotechnology: food industry, agriculture, medicine and pharmacy, chemical and cosmetic industries, bioremediation of water and land ecosystems, astrobiology and other areas.		
Content of the subject <i>Theoretical lectures</i> Performed through individual work with the student / team, the course would cover all fields and wider application of microorganisms in useful technologies, which are related to the problems of the selected topic for PhD dissertation; introduce the students to the actual implementation of specific microorganisms in biotechnology (groups of microorganisms used in the dissertation), with special emphasis on the importance and role of genetic and metabolic engineering.		
Recommended literature 1. Svirčev Z. (2005): Microalgae and Cyanobacteria in Biotechnology. Faculty of Sciences, University of N. Sad (in Serbian). 2. Pejin D. (2003): Industrial Microbiology. University of Novi Sad, Faculty of Technology (in Serbian). 3. Đukić D., Jemcević V. (2003): Microbial Biotechnology. Dereta, Beograd (in Serbian). 4. Kuburović M., Stanojević M. (1997): Biotechnology. Smeits, Beograd (in Serbian). 5. Madigan MT., Martinko JM. (2006): BROCK – Biology of Microorganisms. Pearson, Prentice Hall (in English). 6. Duraković S., L Durakovic. (2003): Mycology in biotechnology. Kugler, Zagreb (in Croatian).		
Number of active classes	Theory: 5	Practice:5
Methods of delivering lectures Lectures, practicals, consultations, seminars, colloquia participation in scientific meetings and seminars, visiting microbiological laboratories and active participation in research projects. Student choose two topics for seminar work which should be elaborated using internet or standard literature sources. With the use of contemporary literature and equipment, as well as web site, the student would be referred to the latest knowledge in the field of application of microorganisms in biotechnology and related topics to the issue of his doctoral dissertation, with the development of a project and seminars requirement.		
Evaluation of knowledge (maximum number of points 100) During the semester students' seminar works will be evaluated, and remarks will be incorporated into summary remark making 60 points. Another 30 they will gather through the oral exam, and 10 through the evaluation of their experimental research work.		

Name of the subject: PHARMACEUTICAL BIOLOGY AND CHEMISTRY OF FUNGI AND LICHENS		
Teacher(s): Dr. Maja Karaman, Dr. Boris Pejin		
Status of the subject: Elective course		
Number of ECTS points: 15		
Condition: There are no requirements.		
Goal of the subject Students will be introduced to morphoanatomical, physiological and basic metabolic characteristics of fungi and lichens as the producers of bioactive natural products (primary and secondary metabolites).		
Outcome of the subject Students will master the fundamentals of Pharmaceutical Biology and Chemistry. They will be capable to recognise specific genera of fungi and lichens known to contain bioactive substances; to preliminarily determine their pharmacological potential applying standard experimental procedures; to design experiments focussing on the natural products from these organisms; to understand the principles of their isolation, chemical characterisation (both of nonvolatile and volatile substances) and determination of stereo- and computational parameters – SAR (Structure Activity Relationship) studies.		
Content of the subject <i>Theoretical lectures</i> Students will be introduced to modern trends in this particular field. The emphasis will be put on the chemistry, biosynthesis, isolation (including different extraction techniques) and identification (by structural instrumental methods such as NMR, IR, UV-VIS, GC, MS, GC-MS and HPLC) of the natural products from fungi and lichens; their ecological role and importance – Chemical and Biochemical Ecology; bioactive substances of pharmaceutical significance possessing antiradical, antioxidant, antimicrobial, anti-acetylcholinesterase (along with other pharmacological targets of relevance for Alzheimer's disease) and anti-hypertensive activities. Also, the cultivation of these organisms will be thoroughly discussed mainly due to the potential application of their bioactive natural products (substances) in pharmacy, medicine and cosmetics. <i>Practical classes</i> Isolation of fungal mycelia and principles of submerged cultures; Electrophoresis techniques; FTIR (Infrared spectroscopy with Fourier transform); GC-MS (Gas Chromatography – Mass Spectrometry); EPR (Electron Paramagnetic Resonance spectroscopy); Polarography (new methods). <i>Theoretical classes</i> Stereochemistry and Computational Chemistry, selected examples of SAR studies.		
Recommended literature 1. P. Stanforth. <i>Natural Product Chemistry at a Glance</i> . Blackwell Publishing Ltd, 2006. 2. <i>New Trends in Natural Product Chemistry</i> . eds. Atta-ur-Rahman & M. Iqbal Choudhary. Harwood Academic Publishers, 1998. 3. <i>Lichen Biology</i> . ed. T. H. Nash III. Cambridge University Press, 2008. 4. J. Mann. <i>Secondary Metabolism</i> . Oxford Chemistry Series, 1980. 5. P. L. Graham. <i>An Introduction to Medicinal Chemistry</i> . Oxford University Press, 2005. 6. E. L. Eliel, S. H. Wilen. <i>Stereochemistry of Organic Compounds</i> . Wiley, 1994. 7. Novel review articles published in leading international journals (<i>Natural Product Reports</i> , <i>Medicinal Research Reviews</i> , <i>Journal of Medicinal Chemistry</i> , <i>Journal of Natural Products</i> , <i>Phytochemistry</i> , etc.) 8. <i>CRC Handbook of Lichenology</i> . ed. M. Galun. CRC Press, Boca Raton, 1988. 9. D. K. Arora. <i>Handbook of Fungal Biotechnology</i> . Marcel Dekker, Inc., New York, USA, 2004. 10. G. M. Muller, G. F. Bills, M. S. Foster. <i>Biodiversity of Fungi, Inventory and Monitoring Methods</i> . Elsevier Academic Press, Burlington, San Diego, London, 2004. 11. <i>The Mycota. A comprehensive Treatise on Fungi as experimenta; System for Basic and Applied Research</i> . eds. K. Esser, J. W. Bennett & H. D. Osiewacz. Vol X. Industrial applications. Springer-Verlag Berlin Heidelberg, 2002.		
Number of active classes	Theory: 5	Practice: 5
Methods of delivering lectures		
Lectures, Practical Classes, Term Paper, Student Consultations (Tutorial)		
Evaluation of knowledge (maximum number of points 100)		
Term Paper – 10 points, Written Exam – 40 points, Oral Exam – 50 points		

Name of the subject: BIOCHEMICAL METHODS IN MICROBIOLOGY		
Teacher(s): Dr. Dragan Radnović		
Status of the subject: elective		
Number of ECTS points: 15		
Condition: course selection is conditioned by prior consultations with the subject teacher in order to achieve the optimum form of engagement and certain subject tasks which in one part of the planned activities should be directed to the subject of the candidate's doctoral dissertation		
Goal of the subject The objective of the course is to acquire knowledge in the field of methodology for the study of metabolism and functional structure of microorganisms and to connect them with the current and potential possibilities of biotechnological application of microorganisms.		
Outcome of the subject After successful completion of pre-exam and exam obligations, the student should be able to: - Explain the principle of biochemical methods used in microbiological research - Independently perform and use appropriate biochemical methods that are necessary in investigation of microbial properties - independently plans, realizes and processes the results obtained by applying appropriate biochemical methods		
Content of the subject <i>Theoretical lectures</i> The concept and significance of biochemical methods applied in microbiology. Investigation of biochemical activities of microorganisms such as: use of different sources of nitrogen, extracellular enzymatic activity of microorganisms (dehydrogenase activity, amylolytic, cellulolytic, proteolytic activity, extracellular degradation of hydrocarbons and other substrates), testing of catabolism of proteins, carbohydrates and lipid metabolites, respectively their end products or intermediates. Application of specific biochemical properties in the detection of particular groups of microorganisms. Modern automated methods for rapid detection of biochemical properties of an unknown isolate. Application of chromatographic methods in microbiology. Methods for purification and identification of active metabolites such as antibiotics and bioactive proteins (enzymatic activity). <i>Practical lectures</i> Team and independent work in the laboratory on current project tasks with the purpose of applying different biochemical methods in determining enzyme activities at the microbial community level by determining the biochemical properties of individual pure isolates, and determining their phenotypic similarity based on the results obtained using different biochemical methods.		
Recommended literature Harley, J., Prescott, L. (2002): Laboratory Exercises in Microbiology, Fifth Edition. The McGraw-Hill Companies, 2002 ISBN-10: 0072333456. Benson, T. (2001) Microbiological Applications Laboratory Manual in General Microbiology. 8th Edition, The McGraw-Hill, New York. Paterson, R.R.M., Bridge, P.D. (1994): Biochemical techniques for filamentous fungi. IMI Technical Handbooks, No. 1. CAB International, Surrey, UK. Fox, A., Larsson, L., Morgan, S.L., Odham, G. (1990): Analytical Microbiology Methods. Chromatography and Mass Spectrometry. Springer Science+Business Media, Llc. ISBN 978-1-4899-3566-3. V.K. Gupta et al. (eds.) (2013): Laboratory Protocols in Fungal Biology: Current Methods in Fungal Biology, in: Fungal Biology, DOI 10.1007/978-1-4614-2356-0_19, Springer Science+Business Media, LLC 2013 Review of the recent articles related to biochemical methods applied in microbiology		
Number of active classes	Theory:5	Practice:5
Methods of delivering lectures: Classes are taught according to a system of consultations in defined units. In agreement with the teacher and the mentor, the student selects a topic for a seminar paper that relates to biochemical methods in microbiology with the obligation to search the Internet and / or standard library documentation. Seminar work involves presentation on a given topic in the form of a presentation before a group and subject teacher and a defense at the end of the presentation. Journal club - presentation and discussion of scientific work in the field. Practical work is performed in the laboratory and through working visits to laboratories that have modern equipment that supports certain biochemical methods.		
Evaluation of knowledge (maximum number of points 100): Assignment - up to 30, Seminar up to 30, Project Presentation of scientific work up to 10. Oral exam up to 30 points		

Name of the subject: SELECTED TOPICS IN MYCOLOGY		
Teacher(s): Dr. Maja Karaman		
Status of the subject: Elective		
Number of ECTS points: 15		
Condition: -		
Goal The goal of the course is to upgrade knowledge in the basic fields of mycology (anatomy and morphology of fungi, ultra structure of the fungal cell, ecology of fungi, physiology and metabolism of fungi, genetics of fungi; reproduction and distribution; role of fungi in ecosystems; mycorrhizae; fungi as plant and animal pathogens within medical mycology and as agents of biological control; use of fungi in industrial fermentations; diversity and protection of fungi, taxonomy of fungi at the level of molecular markers) to basic courses in microbiology, biology of algae and fungi, systematic of algae and fungi and mycology and aims to introduce the basic principles of these mycological fields and conservation of natural resources, as well as biotechnology and growing of mushrooms.		
Outcome of the subject Students would become familiar with the importance of fungi, primarily members of the Ascomycota and Basidiomycota division, but also with molds and yeasts in nature and for humans within applied mycology. They would also be introduced to the ecophysiology of fungi as a necessary pre-requisite for their cultivation in modern technological processes. They would study the role of macrofungi in the circulation of matter and the flow of energy through ecosystems and the importance of fungi in nature and for humans, with special reference to forest phytopathology and protection of fungal diversity, then fungi as healthy foods, producers of bioactive substances used in industrial mycology: antibiotics, antioxidants, alkaloids; immunomodulators. Special consideration was given to their key role in processes of biodegradation, bioremediation and bioindication within the protection of the environment.		
Content of the subject <i>Theoretical lectures</i> 1) anatomy and morphology of fungi, ultra structure of the cell of fungi, 2) physiology and metabolism of fungi, 3) ecology of fungi, 4) genetics of fungi and taxonomy of fungi at the level of molecular markers; 5) propagation and distribution; 6) the role of fungi in ecosystems; mycorrhizae; fungi as plant pathogens in forest ecosystems, 7) animal and human pathogens within medical mycology, 8) fungi as biological control agents; 9) use of mushrooms in industrial fermentations; 10) Diversity and protection of fungi <i>Study research;</i> work in the field of mycology, which is within the topic of the doctoral dissertation		
Recommended literature 1. Turnet W. B.: Fungal metabolites . Academic press, London, 1971. 2. Eriksson K.-E.L., Blanchette R.A., Ander P: Microbial and Enzymatic Degradation of Wood and Wood Components . Springer-Verlag, 1990. 3. Kendrick, B. (2001): Fifth kingdom . 3 rd Edition. Mycologue Publications, Sidney, Canada. 4. Deacon, J. (2005): Fungal biology . 4th Edition, Blackwell Publishing Ltd. 5. Paterson, R.R.M., Bridge, P.D. (1994): Biochemical techniques for filamentous fungi . IMI Technical Handbooks, No. 1. CAB International, Surrey, UK. 6. Duraković S. i Duraković JI: Mikologija u biotehnologiji . Sveučilište u Zagrebu, 2003. 7. Dix, J.N. & Webster J. (1995): Fungal ecology . Chapman & Hall, London, Glasgow, Weinheim, New York, Tokyo, Melbourne, Madras. 8. Duraković, S. (1996): Primjenjena mikrobiologija . Prehrambeno tehnološki inženjering. Udžbenici Sveučilišta u Zagrebu. Zagreb. 35-58 p.p. 9. Muller, G. M., Bills, G. F., Foster, M. S. (2004) Biodiversity of FUNGI, Inventory and Monitoring Methods , Elsevier Academic Press, Burlington, San Diego, London. 10. Kavanagh K, editor. Fungi: Biology and application . Chichester: Wiley; 2005. 11. Handbook of fungal Biotechnology 2nd Ed Arora D, Marcel Dekker, New York, 2004.		
Number of active classes	Theory:5	Practice: 5
Methods of delivering lectures Lectures / consultations, laboratory work.		
Evaluation of knowledge (maximum number of points 100) Laboratory Project 40; Seminar paper 20; Oral exam 40		

Name of the subject: CODE OF ZOOLOGICAL NOMENCLATURE		
Teacher(s): Dr. Ivo Karaman, Dr. Mladen Horvatić		
Status of the subject: Elective		
Number of ECTS points: 15		
Condition: -		
Goal Introduction to the principles and rules of zoological procedures and zoological nomenclature. Knowledge of these contents as a prerequisite for taxonomic work and results publication.		
Outcome of the subject Mastering and training students for practical application of the Zoological Nomenclature Code.		
Content of the subject <i>Theoretical lectures</i> ICZN International Commission on Zoological Nomenclature, history and scope of work. Zoological nomenclature (definition, scope, exceptions, independence). Adoptability of a specific name in zoological nomenclature. Names of taxa above the species level. Binomial nomenclature rules. Inserted names (subgenus names, species group and subspecies names). Types of taxonomic publications. Criteria of publication. Criteria of availability. Date of publication. Validity of names and nomenclature acts. Formation and treatment of names. Family, genus, species – groups nominal taxa and their names. Authorship. Homonymy. The type concept. Regulations.		
Recommended literature INTERNATIONAL CODE OF ZOOLOGICAL NOMENCLATURE Fourth Edition adopted by the International Union of Biological Sciences The provisions of this Code supersede those of the previous editions with effect from 1 January 2000. International Trust for Zoological Nomenclature 1999 c/o The Natural History Museum - Cromwell Road - London SW7 5BD - UK		
Number of active classes	Theory: 5	Practice: 5
Methods of delivering lectures Interactive methods *Submission of seminar paper		
Evaluation of knowledge (maximum number of points 100) Seminar paper 30 Exam 70		

Name of the subject: SPECIAL INVERTEBRATE TAXONOMY		
Teacher(s): Dr. Snežana Radenković, Dr. Ivo Karaman		
Status of the subject: elective		
Number of ECTS points: 15		
Condition: no		
Goal of the subject Introduction to principles in taxonomy of different invertebrate groups. Methods in taxonomy (genetic-biochemical, physiological, ethological, ecological, electron microscopy, etc.) and the range of their application in particular, studied groups of invertebrates. Because of the huge biodiversity, approaches and techniques in the taxonomy are very different and the task of this course is to master the methods and principles in the taxonomy of selected groups of invertebrates, especially specific groups that are the subject of the PhD dissertation.		
Outcome of the subject Through this course, students acquire knowledge about the the taxonomy of particular groups of invertebrates.		
Content of the subject <i>Theoretical lectures</i> Review of criteria and characters in the taxonomy of selected groups of invertebrates. Classes and evaluation of characters. Quantitative analysis of the characters. Taxonomic approach to the invertebrate group which is subject of PhD dissertation, the characters, the criteria and techniques.		
Recommended literature 1. Randall T. Schuh: „Biological Systematics. Principles and applications“. Cornell University Press, Ithaca and London, 2000. Different literature sources (monographs and papers) of invertebrate groups that are subjects of this course.		
Number of active classes	Theory: 5	Practice: 5
Methods of delivering lectures Interactive methods. Preparation and defense of seminar papers by given and / or selected topics.		
Evaluation of knowledge (maximum number of points 100) seminar work 30 points; oral exam 70 points		

Name of the subject: MEDICAL ZOOLOGY		
Teacher(s): Dr.Olivera Bjelić Čabrilo, Dr. Dušan Lalošević		
Status of the subject: elective		
Number of ECTS points: 15		
Condition: none		
Goal of the subject Students will understand the significance of animal and human cohabitation, and the risks it carries for human health.		
Outcome of the subject Postulates of laboratory work dealing with biological materials, identification of animal agents that cause or spread human diseases.		
Content of the subject <i>Theoretical lectures</i> Significance of medical zoology, medical geography and tropical medicine. Theory of natural endemic areas of diseases. Vogralik's chain. Venomous animals and their pathological significance. First aid in cases of injury by a venomous animal. Protozoa of medical significance. Biohelminths. Geohelminths. Arthropod vectors of infective and parasitic diseases of humans. Urban ecology. <i>Practical lectures</i> Identification of animal agent species. Preparation of helminth microscopic slides for species identification. Studies of anthroponotic helminth species in animals living in man-made ecosystems. Rearing of laboratory animals and their application in diagnosing infective diseases.		
Recommended literature 1. Peters W. Atlas of Tropical Medicine and Parasitology. 6 th ed. Mosby Publ, 2006. 2. Nabarro L. et al. Peters' Atlas of Tropical Medicine and Parasitology, 7th Ed., Elsevier, 2018. 3. Boyd JF. The Pathology of Human Viral Infections and Associated Conditions, University of Glasgow Press, Glasgow, 2004. 4. Palmer SR et al. Oxford Textbook of Zoonoses.Oxford University Press, 2011. 5. Milutinović M i sar. Krpelji (Acari: Ixodidae, Argasidae) Srbije. Sprska akademija nauka i umetnosti ; knj. 670. Odeljenje hemijskih i bioloških nauka ; knj. 7, 2012. 6. Lalošević D, Lalošević V. Toksokarijaza – Larva migrans kod čoveka i životinja. Zadužbina Andrejević (posebna izdanja), Beograd, 2008, ISBN 978-86-7244-702-6 7. Lalošević V. Parazitološki praktikum. Novi Sad: Poljoprivredni fakultet, 2008. 8. Lalošević V, Ćirković M, Lalošević D, Mihajlović-Ukropina M, Rajković D. Parazitologija.Novi Sad: Poljoprivredni fakultet, 2005. All available scientific papers relating to the course subject, in line with the student's interest.		
Number of active classes	Theory: 5	Practice: 5
Methods of delivering lectures Lectures, practical and theoretical work in the lab. * research papers on selected and/or given topics		
Evaluation of knowledge (maximum number of points 100) Colloquium 20 Oral exam 50 Research paper 30		

Name of the subject: APPLIED ICHTHYOLOGY		
Teacher(s): Dr. Branko Miljanović, Dr. Desanka Kostić		
Status of the subject: elective		
Number of ECTS points: 15		
Condition:		
Goal of the subject The goal of the subject is to familiarise students with the biology of fish species mostly used for stocking and that are commonly bred in fishponds; fish production in rivers, lakes and accumulations; with aquaculture basics; intensifying fish production in fresh waters, stocking; the role of ichthyofauna in preservation and improvement of quality of hydro-accumulations; drafting fish production management plans.		
Outcome of the subject The students should acquire theoretical and practical knowledge for work in fisheries and appropriate institutions.		
Content of the subject <i>Theoretical lectures</i> The biology of fish species mostly used for stocking and biology of species that are commonly bred in fishponds. River areas in Serbia; lake areas in Serbia; accumulative lake areas in Serbia; aquaculture; fishponds; planned management of open waters. Fish production in rivers, lakes, accumulations. Intensifying fish production in fresh waters: stocking. The role of ichthyofauna in preservation and improvement of quality of hydro-accumulations. Drafting fish production management plan. <i>Practical lectures</i> Field work		
Recommended literature <ol style="list-style-type: none"> 1. Soldatović, B., Zimonjić, D. (1988): Biologija i gajenje riba. Naučna knjiga Beograd. 2. Jevtić, J. (1989): Život slatkovodnih vrsta riba. Naučna knjiga Beograd. 3. Grginčević, M., Pujin, V. (1998): Hidrobiologija. Ekološki pokret grada Novog Sada. 4. Bojčić i sar. (1982): Slatkovodno ribarstvo. Ribozajednica Zagreb, Jugoslovenska medicinska naklada Zagreb. 5. Hristić, Dj., Bunjevac, I (1991): Gajenje slatkovodnih riba. Gradjevinska knjiga. Beograd. 6. Ćirković, M., Jovanović, B., Maletin, S. (2002): Ribarstvo. Univerzitet u Novom Sadu, Poljoprivredni fakultet. 7. Zaštita životne sredine pri intenzivnom gajenju riba. Univerzitet u Novom Sadu – Prirodno-matematički fakultet – Institut za biologiju i Ekološki pokret grada Novog Sada. Novi Sad, 1999. 8. Hidroakumulacije – multidisciplinarni pristup održivom razvoju. Monografija - urednici prof. dr Aleksandar Ivanc i mr Branko Miljanović. Prirodno-matematički fakultet Novi Sad, Ministarstvo za zaštitu prirodnih bogatstava i životne sredine., Zavod za zaštitu zdravlja "Timok" Zaječar, JVP "Srbija vode", JVP "Vode Vojvodine". Novi Sad, 2003. 9 .The Freshwater Fishes of Europe. Aula Verlag. Wiesbaden. All available papers from the given field that correlate to the interest of the PhD students.		
Number of active classes	Theory: 5	Practice: 5
Methods of delivering lectures Theoretical classes: Oral presentation with the aid of modern techniques, active teaching Field work		
Evaluation of knowledge (maximum number of points 100) Seminars 60 Oral exam 40		

Name of the subject: BIOLOGICAL ANTHROPOLOGY		
Teacher(s): Dr. Tatjana Pavlica, Dr. Rada Rakić		
Status of the subject: Elective Course		
Number of ECTS points: 15		
Condition: -		
Goal of the subject		
To acquire knowledge on complexity of human organism and structure of human populations; Individual and population anthropological traits and the influence of different factors on human habitat establishment.		
Outcome of the subject		
Students are capable of using acquired knowledge in their research which includes planning skills, conducting research and accurate interpretation and presentation of results.		
Content of the subject		
<i>Theoretical lectures</i>		
Introduction to anthropology. Methods of anthropological investigations. Paleoanthropology. Somatology, Fundamental investigations of racial traits of modern man. Dermatoglyphics. Odontology. Blood groups and biochemical variability. Anthropogenesis. Anthropological traits of particular world populations.		
<i>Practical lectures</i>		
Recommended literature		
<ol style="list-style-type: none"> 1. Harrison G.A., Tanner J.M., Pilbeam D.R., Baker P.T.: Human Biology, An introduction to human evolution, variation, growth, and adaptability, Oxford University Press, 1988. 2. Knußmann R: Anthropologie, Handbuch der vergglichenen Biologie des Menschen, Gustav Fischer Verlag, Stuttgart - New York 1988. 3. Терако Л.И, Саливон И.И: Основы современной Антропологии, Минск Университетское, 1989 4. Mohun Dženet, Човек, свеобухватни визуелни водич, Уредник, Младинска књига Београд 2004. 5. Muehlenbei M.П. 2010 Human evolutionary biology, Cambridge University Press. 6. Crawford M. 2007. Anthropological genetics, Cambridge University Press 		
Number of active classes	Theory: 5	Practice: 5
Methods of delivering lectures		
Seminar papers and consultations by defined units. The students themselves or in agreement with the teacher choose topics for seminar work.		
Evaluation of knowledge (maximum number of points 100)		
Seminar paper earns 70 points, while the student earns 30 points at the final examination		

Name of the subject: CELL DETERMINATION AND DIFFERENTIATION		
Teacher(s): Dr. Jelena Marković		
Status of the subject: Elective		
Number of ECTS points: 15		
Condition: Course of Cell Biology and Histology with embryology		
Goal of the subject This course has goal to provide detailed insight in mechanisms of animal cell determination and differentiation.		
Outcome of the subject Acquiring knowledge about mechanisms of cell determination and differentiation, that will contribute to biological education of students and provide theoretical basis to students who decide to conduct scientific research in this area.		
Content of the subject <i>Theoretical lectures</i> Principles of cell determination and differentiation. Potency of embryonic cells. Extracellular matrix. Integrins. Effects of cell communication, cytoskeleton and extracellular matrix on cell differentiation. Mechanisms of cell differentiated stage maintenance. Determination of zygote division plan. Coordination of cell proliferation and determination of cell fate. Differentiation of liver cells. Differentiation and renewal of epithelial cells. Differentiation of blood cells. Differentiation of germe cells. Differentiation and regeneration of skeletal muscle. Determination of vertebrate body axis. Stem cells. Application of stem cells in medicine (stem cell engineering). Tumor-related genes. Mitogen proteins. <i>Practical lectures</i> Seminar papers representing themes presented during lectures; literature - research and review papers.		
Recommended literature 1. Kalthoff, K. Analysis of Biological Development McGraw Hill, New York, 2001. 2. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., Walter, P. Molecular Biology of the Cell. Garland Science, 2002. 3. Carlson, B. M. Human Embryology and Developmental Biology. Elsevier Health Sciences, 2014.		
Number of active classes	Theory: 5	Practice: 5
Methods of delivering lectures Lectures, seminar		
Evaluation of knowledge (maximum number of points 100)		
Pre-exam obligation Seminar 30 points Final exam Oral exam 70 points		

Name of the subject: SELECTED TOPICS IN BACTERIOLOGY		
Teacher(s): Dr. Petar Knežević		
Status of the subject: Elective		
Number of ECTS points: 15		
Condition: -		
Goal of the subject The objective of the course is to acquire a high level of knowledge in the field of bacteriology, primarily in the field of student's interest or in connection with her/his doctoral dissertation. The goal is also to enable the student for independent scientific-research work through study research (seminar paper) in the field of bacteriology.		
Outcome of the subject After the course, the student will be able to engage in scientific research in the field of bacteriology, and will be able to define the problem, select adequate literature and methods for solving the problem, process the results and draw valid conclusions.		
Content of the subject <i>Theoretical lectures</i> Required topics: Ultrastructure of bacteria. Overview of bacterial metabolic pathways. Intercellular communication. Genetics and genomics of bacteria. Classical and modern methods in bacteriology. Bacterial taxonomy and diversity. Selected Topics: Selection by candidate and teacher arrangement. <i>Practical lectures</i> -		
Recommended literature Basic literature: Madigan, M.T., Mrtinko, J.M., Bender, K.S., Buckley, D.S., Stahl, D.A., Brock, T. Brock Biology of Microorganisms. 14th Edition, Pearson, 2014. Additional literature in agreement between student and subject teacher, in accordance with study research work.		
Number of active classes	Theory: 5	Practice: 5
Methods of delivering lectures Presentations, consultations and individual work		
Evaluation of knowledge (maximum number of points 100) Oral exam: 50 Study research: 50		

Name of the subject: SELECTED TOPICS IN VIROLOGY		
Teacher(s): Dr. Petar Knežević		
Status of the subject: Elective		
Number of ECTS points: 15		
Condition: -		
Goal of the subject The objective of the course is to acquire a high level of knowledge in the field of virology, primarily in the field of student's interest or in connection with his doctoral dissertation. The goal is also to enable the student for independent scientific-research work through study research (seminar paper) in the field of virology.		
Outcome of the subject After the course, the student will be able to engage in scientific research in the field of virology, and will be able to define the problem, select adequate literature and methods for solving the problem, process the results and draw valid conclusions.		
Content of the subject <i>Theoretical lectures</i> Required topics: Virion structure. Virus multiplication. Classical and contemporary virological methods. Classification of viruses. Representative groups of viruses. Selected Topics: Selection by Candidate and Teacher Arrangement. <i>Practical lectures</i> -		
Recommended literature Cann, A. Principles of Molecular Virology. 6th edition, Academic Press, 2015.		
Number of active classes	Theory: 5	Practice: 5
Methods of delivering lectures Presentations, consultations and individual work		
Evaluation of knowledge (maximum number of points 100) Oral exam: 50 Study research: 50		

Name of the subject: BIOMEDICAL IMPORTANT PRODUCTS OF ALGAE		
Teacher(s): Dr. Jelica Simeunović		
Status of the subject: Elective		
Number of ECTS points: 15		
Condition: -		
Goal The main goal of the course is to systematize knowledge about biomedical important algal products and biomass and their possible application in order to improve human health.		
Outcome of the subject Acquiring knowledge about algal metabolism and bioactive compounds of different groups of micro- and macro-algae, their mechanisms of action, presence in the environment, methods of detection, their medical significance and possibilities of therapeutic uses, as well as in fields such as pharmaceutical, nutritional, cosmetic and others.		
Content of the subject <i>Theoretical lectures</i> Introductory section on algae; Biochemical characteristics and metabolic diversity of algae; Biomedical and pharmacological significant algae groups; Biomedical significant algal metabolites - division, structure and function: pigments, proteins, lectins, polysaccharides, fatty acids, polyphenols, toxins, etc .; Antioxidant compounds originating from algae; Algal products with antimicrobial activity; Algal products with anti-inflammatory effects; Immunomodulatory compounds originating from algae; Anticancer and cytotoxic compounds derived from algae; Algal compounds with anticoagulant effect; Algal products with effect on the cardiovascular system (hypolipidemic compounds); Algae and digestive tract health; Algae and neurodegenerative diseases; Dermatological important compounds derived from algae; Detection methods for certain biomedically relevant algae products. <i>Practical lectures</i>		
Recommended literature <ol style="list-style-type: none"> 1. Therapeutic and Nutritional Uses of Algae, 1st edition, Leonel Pereira (Ed.), CRC Press, Published February 1, 2018, ISBN 9781498755382, p. 640. 2. Microalgae in Health and Disease Prevention, 1st Edition, Ira Levine Joël Fleurence (Eds) Academic Press, July 2018, ISBN: 9780128114056 (eBook ISBN: 9780128114063), p. 354. 3. Seaweed Polysaccharides, Isolation, Biological and Biomedical Applications, 1st Edition. Jayachandran Venkatesan Sukumaran and Anil Se-Kwon Kim (Eds.). Elsevier, 1st June 2017, ISBN: 9780128098165 (eBook ISBN: 9780128098172), p. 408. 4. Phycology, Fourth edition, Robert Edward Lee. Cambridge University Press The Edinburgh Building, Cambridge CB28RU, UK. 2008, ISBN-13978-0-511-38669-5 e-book, p.547. 5. The Algae World. Dinabandhu Sahoo and Joseph Seckbach (Eds.), Springer Science+Business Media Dordrecht 2015, DOI https://doi.org/10.1007/978-94-017-7321-8; Print ISBN 978-94-017-7320-1 (Online ISBN 978-94-017-7321-8), p.581. 6. Handbook of Marine Macroalgae: Biotechnology and Applied Phycology. Se-Kwon Kim (Ed), A John Wiley & Sons, Ltd. November 2011, Print ISBN: 9780470979181 (Online ISBN: 9781119977087), DOI: 10.1002/9781119977087. 7. Algae, 2nd edition, Linda E. Graham and Lee W. Wilcox (eds.). Publisher: Benjamin Cummings; 2008, ISBN-10: 0321559657, p.720. 		
Number of active classes	Theory: 5	Practice: 5
Methods of delivering lectures Consultations, PP presentations, seminar papers with the obligation to search the Internet and / or standard library documentation, by defined topics).		
Evaluation of knowledge (maximum number of points 100) seminar work: 50 oral exam: 50		

Name of the subject: METAGENOMICS OF MICROBIAL COMMUNITIES		
Teacher(s): Dr. Ivica Tamaš		
Status of the subject: Elective		
Number of ECTS points: 15		
Condition: A prior consultation with the subject teacher.		
Goal of the subject A detailed outline of the principles of metagenomic analysis of the microbial communities including a bioinformatic analysis of the sequences on the basis of sequence similarities. Laboratory aspects such as DNA extraction from the environmental samples, primers design, samples preparation for Next Generation Sequencing, description of the existing NGS platforms (Illumina, PacBio, IonTorrent, etc.)		
Outcome of the subject Gaining a knowledge about the latest trends in microbial ecology using molecular techniques and Next Generation Sequencing.		
Content of the subject <i>Theoretical lectures</i> Methodology of samples preparation from a variety of environments. Bioinformatic analysis of the sequences using different bioinformatic tools. <i>Practical lectures</i> Bioinformatic analysis of the chosen sequences from the public data basis (https://www.ncbi.nlm.nih.gov/bioproject?term=metagenomes).		
Recommended literature De Bruijn F. J. (2011): Handbook of Molecular Microbial Ecology I. John Wiley & sons, Inc. Hoboken, New Jersey 2. De Bruijn F. J. (2011): Handbook of Molecular Microbial Ecology II Metagenomics in Different Habitats, Wiley-Blackwell Ian L. Pepper, Charles P. Gerba, Terry J. Gentry (2014): Environmental Microbiology, third edition, Academic Press, San Diego		
Number of active classes	Theory: 5	Practice: 5
Methods of delivering lectures Consultations with the subject teacher, computer classes (a variety of bioinformatic tools currently used for sequence analysis), individual computer work from home.		
Evaluation of knowledge (maximum number of points 100) Assignment - up to 30, Seminar up to 30, Project Presentation of scientific work up to 10. Oral exam up to 30 points		

Name of the subject: MOLECULAR EVOLUTION AND PHYLOGENY OF MICROORGANISMS		
Teacher(s): Dr. Ivica Tamaš		
Status of the subject: Elective		
Number of ECTS points: 15		
Condition: A prior consultation with the subject teacher.		
Goal of the subject The latest trends in molecular evolution and phylogenetic analysis of microorganisms, in particular 16rRNA based. Application of a variety of bioinformatic tools for sequence analysis such as detection of evolutionary changes in sequences and software packages for phylogenetic reconstructions (phylogenetic trees).		
Outcome of the subject Gaining knowledge about the latest trends in molecular evolution. Performing independently phylogenetic reconstructions of individual microorganisms, as well as microbial communities: 1. selection of the adequate phylogenetic markers (16 rRNA, ribosomal proteins, house-keeping genes, etc.) 2. mining of the public data bases for the sequences of interest 3. multiple sequences alignments using available software tools 4. construction of phylogenetic trees, as well as interpretation of the obtained results		
Content of the subject <i>Theoretical lectures</i> The dynamics of the evolutionary changes that have been introduced into sequences, sequence evolution, mutations, genomics, comparative genomics, phylogenetic reconstructions, applicable software for sequence analysis. <i>Practical lectures</i> Phylogenetic analysis of the chosen sequences from the public data basis, either from individual microorganisms or metagenomes (https://www.ncbi.nlm.nih.gov/bioproject?term=metagenomes).		
Recommended literature De Bruijn F. J. (2011): Handbook of Molecular Microbial Ecology I. John Wiley & sons, Inc. Hoboken, New Jersey 2. De Bruijn F. J. (2011): Handbook of Molecular Microbial Ecology II Metagenomics in Different Habitats, Wiley-Blackwell 3. Ian L. Pepper, Charles P. Gerba, Terry J. Gentry (2014): Environmental Microbiology, third edition, Academic Press, San Diego		
Number of active classes	Theory: 5	Practice: 5
Methods of delivering lectures Consultations with the subject teacher, computer classes (a variety of bioinformatic tools currently used for sequence analysis), individual computer work from home.		
Evaluation of knowledge (maximum number of points 100) Assignment - up to 30, Seminar up to 30, Project Presentation of scientific work up to 10. Oral exam up to 30 points		

Name of the subject: ANIMAL CONSERVATION		
Teacher(s): Dr. Ante Vujić, Dr. Snežana Radenković		
Status of the subject: Elective		
Number of ECTS points: 15		
Condition: no		
Goal of the subject The main objective of the course involves the adoption of knowledge on methods of protecting endangered species and their practical conservation. On the one hand by preserving habitat and considering the components of their survival, and on the other through managing populations, understanding their structure, setting conservation priorities. The task of the course is learning about the practice of protection of endangered species in the world and in our country and development of projects of active protection of certain species at risk of extinction.		
Outcome of the subject At the end of the course the student will be qualified to engage in practical projects related to conservation and preservation of endangered species of animals.		
Content of the subject <i>Theoretical lectures</i> The conservation of animal species and populations. The loss of genetic diversity in small populations. Problems of populations conservation. The problem of allochthonous species. Invasive populations. Influence of habitat. Influence of the disease. Conservation of habitats and landscapes. Species and habitats they prefer. International and national legislation regarding the protection of species. International organizations. The conservation of species in Serbia. <i>Practical lectures</i> Identification of priorities in the conservation of animal species. Conservation and management: examples of strategies for conservation of the species of selected groups of organisms. Conservation planning, protection of species based on habitat, principles, criteria for evaluating plans. Invertebrate conservation. Conservation of amphibians. Conservation of reptiles. Conservation of birds. Conservation of mammals. Active Protection. Introduction of endangered species in the field, in the characteristic ecosystems, threat assessment factors in the field, distinguishing anthropogenic factors of degradation processes and succession. Preparation of individual conservation project about selected species or species groups.		
Recommended literature H. Resit Akçakaya, Mark A. Burgman, Oskar Kindvall, Chris C. Wood, Per Sjogren-Gulve, Jeff S. Hatfield, Michael A. McCarthy (2004): Species Conservation and Management: Case Studie. Oxford University Press. Gregg Elliott, Mary Chase, Geoff Geupel, and Ellie Cohen Developing and implementing an adaptive conservation strategy: A guide for improving adaptive management and sharing the learning among conservation practitioners. PRBO Conservation Science. IUCN (1980): World conservation Strategy. Akçakaya, H. R., Burgman, M. A., Kindvall, O., Wood, C. C., Sjögren-Gulve, P., Hatfield, J. S., McCarthy, M. A. (2004): Species Conservation and Management, Case Studies. Oxford University Press. Gosling, L. M., Sutherland, W. J. (2000): Behaviour and Conservation (Conservation Biology). Cambridge University Press. Gittleman, J. L., Funk, S. M., MacDonald, D. W. (2001): Carnovire Conservation (Conservation Biology). Cambridge University Press. Internet: http://www.eelink.net/EndSpp/index.html , http://www.worldwildlife.org/endangered/ , http://endangered.fws.gov/ , http://www.redlist.org/ , http://www.endangeredspecie.com/ , http://fwie.fw.vt.edu/rhgiles/speciessm/ , http://www.invasivespecies.gov/ , http://www.resourceafrica.org/cites/		
Number of active classes	Theory: 5	Practice: 5
Methods of delivering lectures Video presentation, seminar preparation and defense. *Preparation and defense of the project in the field of conservation of the species or group of species.		
Evaluation of knowledge (maximum number of points 100) seminar work 30 points; project presentation 70 points		

Name of the subject: CONSERVATION BIOLOGY		
Teacher(s): Dr. Vesna Milankov		
Status of the subject: Elective		
Number of ECTS points: 15		
Condition: -		
Goal The interdisciplinary course Conservation Biology aims at broadening students' knowledge about the biological diversity crisis and maintaining the diversity from the aspect of evolutionary conservation biology.		
Outcome of the subject Acquiring the knowledge and skills in studying spatial structure and dynamics of fragmented populations and evolutionary consequences of the loss of genetic diversity and habitat reduction.		
Content of the subject Introduction to Evolutionary Conservation Biology: environmental changes and evolutionary responses; Theory of extinction; Response to environmental changes: adaptation or extinction; Genetic variability and life history evolution; Environmental stress and quantitative genetic variability; Evolutionary Genetics in small populations: adaptive evolution and origin of diversity: conservation and speciation; Evolutionary deterioration, collapse and suicide; Evolutionarily significant units, management units and determination of genetically divergent population fragments; Metapopulation genetics: selection and drift in metapopulations, metapopulation and Coalescent theory; Evolutionary dynamics in metapopulations; Evolution in heterogeneous environments; Genetic rescue of endangered populations; Inbreeding depression and outbreeding depression; Forensic identification of species and wildlife products.		
Recommended literature <ol style="list-style-type: none"> 1. Ferriere, R., Dickmann, U., Couvet, D. 2004. Evolutionary conservation biology. Cambridge University Press. 2. Hanski, I., Gaggiotti, O.E. 2004. Ecology, Genetics, and Evolution of Metapopulations. Elsevier Academic Press. 3. Frankham, R. et al. 2017. Genetic management of fragmented animal and plant populations. Oxford University Press. 		
Number of active classes	Theory: 5	Practice: 5
Methods of delivering lectures Oral, seminar paper writing, analyzing papers published in relevant journals		
Evaluation of knowledge (maximum number of points 100) Oral exam 40, Seminar paper 60		

Name of the subject: EVOLUTIONARY GENETICS		
Teacher(s): Dr.Vesna Milankov		
Status of the subject: Elective		
Number of ECTS points: 15		
Condition: -		
Goal The course aim is a comprehensive understanding of biological phenomena.		
Outcome of the subject In the light of the recent evidence, the students acquire advanced and broader knowledge of evolutionary phenomena		
Content of the subject <i>Theoretical lectures</i> The principles of evolutionary genetics; Molecular evolution: selection detection at molecular level, rate of molecular evolution, new gene, new functions, the evolution of multigene families, gene genealogy; Evolutionary developmental biology; Evolutionary epigenetics; Evolutionary quantitative genetics; Genetics of speciation: the evolution of reproductive isolation mechanisms; Genetics of complex polymorphism: parasitism and antibiotic resistance.		
Recommended literature <ol style="list-style-type: none"> 1. Coyne, J.A., Orr, H.A. (2004) Speciation. Sinauer Associates, Inc. 2. Evolutionary genetics. Concepts and case studies. Eds. Fox, C.W., Wolf, J.B. 2006. Oxford University Press 		
Number of active classes	Theory: 5	Practice: 5
Methods of delivering lectures Oral, seminar paper writing, analyzing papers published in relevant journals		
Evaluation of knowledge (maximum number of points 100) Oral exam 40, Seminar paper 60		

Name of the subject: EVOLUTION AND PHENOTYPIC PLASTICITY		
Teacher(s): Dr. Jasmina Ludoški		
Status of the subject: Elective		
Number of ECTS points: 15		
Condition: -		
Goal The course Evolution and Phenotypic Plasticity aims at studying the phenomenon of phenotypic plasticity, mechanisms and processes that cause and shape this phenomenon, as well as its evolutionary significance. The course integrates the knowledge in ecological genetics, developmental biology and theory of evolution with the aim of comprehending how the interaction between genetic and environmental factors shapes organisms.		
Outcome of the subject Acquiring the knowledge and critical comprehension of the processes of adaptive evolution of phenotypes.		
Content of the subject <i>Theoretical lectures</i> Phenotypic plasticity: the concept, the norm of reaction; Studying and comprehending phenotypic plasticity: empirical approach; Historical overview of studying phenotypic plasticity; Genetics of phenotypic plasticity: genetic variability of plasticity, genetic constraints, plasticity and heterozygosity, plasticity and developmental (in)stability, canalization and homeostasis; Molecular biology of phenotypic plasticity: molecular bases of phenotypic plasticity, concept of plasticity genes; Developmental biology of phenotypic plasticity: mechanisms of developmental plasticity, adaptive significance; Ecology of phenotypic plasticity: phenotypic plasticity as adaptive strategy, adaptive phenotypic plasticity – empirical examples; Behaviour and phenotypic plasticity: theoretical framework, case studies; Evolution of phenotypic plasticity: approaches to modelling the interaction genotype-environment; Theoretical biology of phenotypic plasticity; Phenotypic plasticity as central concept in evolutionary biology. <i>Student research</i> Analysis of phenotypic variability on selected groups of animals and plants.		
Recommended literature 1. Pigliucci, M (2001) Phenotypic plasticity: beyond nature and nurture. The Johns Hopkins University Press. 2. Scientific papers		
Number of active classes	Theory: 5	Practice: 5
Methods of delivering lectures Oral, seminar paper writing, analyzing papers published in relevant journals		
Evaluation of knowledge (maximum number of points 100) Oram exam (70), Seminar paper (30)		

Name of the subject: INTEGRATIVE TAXONOMY		
Teacher(s): Dr. Ante Vujić, Dr. Jelena Ačanski		
Status of the subject: elective		
Number of ECTS points: 15		
Condition: none		
Goal of the subject The main objective of the subject is to emphasize the importance of taxonomy as a biological discipline with an important role in biodiversity conservation, as well as a species as a basic unit of taxonomy. The subject focus is on an integrative taxonomy approach which is using several different methods in species identification (molecular marker analysis, comparative morphology, geometric morphometrics, as well as data on species distribution and habitat biogeographic features). Besides this, the subject will provide basic knowledge of collecting and storage of zoological material, its classification, terms in zoological nomenclature, and evaluation of taxonomic characters.		
Outcome of the subject The course Integrative taxonomy will provide the basis of integrative taxonomy principles and students will learn to independently apply integrative taxonomy methods to address specific taxonomic issues		
Content of the subject <i>Theoretical lectures</i> - The basics of zoological nomenclature, systematics and integrative taxonomy. Significance and types of taxonomic characters. Morphological matrix and its application. Application of geometric morphometric and molecular markers in taxonomic studies. Basics of DNA Barcoding. Molecular methods in defining cryptic species. <i>Practical lectures</i> - Understanding the most common methods used in integrative taxonomy: traditional morphological analyzes and the use of taxonomic keys for species identification, geometric-morphometric and molecular data analyzes.		
Recommended literature <ol style="list-style-type: none"> Knapp S. In: The New Taxonomy. Wheeler QD, editor. CRC Press, Taylor and Francis Group; 2008. Taxonomy as a team sport; pp. 33–53. The International Code of Zoological Nomenclature. http://iczn.org/iczn/index.jsp# Verma, A. Principles of Animal Taxonomy. Morgan & Claypool, 2015, UK; pp. 404. Balfour, A. & Fasso, D. Principles of Plant and Animal Taxonomy. Syrawood Publishing House, 2016, USA; pp. 263. Templeton AR. Species and speciation: Geography, population structure, ecology, and gene trees. In: (Howard DJ, Berlocher SH (eds.) Endless Forms: Species and Speciation. New York, NY:Oxford University Press;1989. p.32-41, de Queiroz K. The general lineage concept of species, species criteria, and the process of speciation. In: DJ Howard, Berlocher SH (eds.) Endless Forms: Species and Speciation. Oxford University Press;1998. p.57-75. Zelditch, M.L., Swiderski, D.L. and Sheets, H.D., 2012. Geometric morphometrics for biologists: a primer. Academic Press. Selected scientific papers published in international journals 		
Number of active classes	Theory: 5	Practice: 5
Methods of delivering lectures Video presentation, interactive discussion, consultations.		
Evaluation of knowledge (maximum number of points 100) Oral exam (40), Term paper (60).		

Name of the subject: BIOLOGY OF AQUATIC VASCULAR PLANTS		
Teacher(s): Dr. Dragana Vukov		
Status of the subject: Elective		
Number of ECTS points: 15		
Condition: -		
Goal of the subject To acquire knowledge on different aspects of comparative biology of freshwater and marine vascular plants.		
Outcome of the subject Setting the foundation for individual research.		
Content of the subject <i>Theoretical lectures</i> Features of aquatic vascular plants. Features of the aquatic environment. Structure and physiology of emergent leaves. Structure and physiology of floating leaves. Structure and physiology of submerged organs. Structure and physiology of underground organs. Free-floating forms. Polymorphic vegetative organs and heterophylly. Sexual reproduction. Vegetative reproduction and perennation. Some aspects of the geography of aquatic vascular plants. The growth of hydrophyte communities and their interaction with the aquatic environment. The problem of aquatic weeds. The control of aquatic weeds. The aesthetic and economic value of aquatic vascular plants. <i>Practical lectures - research</i> 1. Current trends in research of aquatic vascular plants 2. Designing of the research project and planning of the experiment 3. Research/experiment 4. Analyses of the results 5. Preparation of the seminar paper		
Recommended literature SCULTHORPE, D.C. (1967): The Biology of Aquatic Vascular Plants. Edvard Arnold (Publishers) Ltd. London. HUTCHINSON, G. E. (1975): A treatise on limnology, v. 3. Limnological botany. John Wiley & Sons, New York, London, Sydney, and Toronto. COOK, C.D.K. (1991): Aquatic Plant Book. SPB Academic Publishing, The Hague, The Netherlands.		
Number of active classes	Theory: 5	Practice: 5
Methods of delivering lectures Lectures/consultations, field-work, work in the laboratory.		
Evaluation of knowledge (maximum number of points 100) Oral exam: 50 Seminar paper: 30 Presentation of the seminar paper: 20		

Name of the subject: SPECIAL PLANT ANATOMY		
Teacher(s): Dr. Jadranka Luković, Dr. Lana Zorić		
Status of the subject: Elective Course		
Number of ECTS points: 15		
Condition:		
Goal of the subject Getting knowledge of anatomical characteristics that have diagnostic character, and their application in comparative anatomical analysis of selected families and genera.		
Outcome of the subject Student should be able to successfully apply the knowledge from this field in identification and determination of some taxa and taxonomic groups of different level.		
Content of the subject <i>Theoretical lectures</i> Getting knowledge about anatomical characters of taxonomic importance. Diagnostic anatomical characters of vegetative organs of dicotyledon and monocotyledon plants. Diagnostic characters of reproductive organs of flowering plants. Analysis of anatomical diagnostic characters of selected families of flowering plants. <i>Practical lectures</i> The structure of practical work is in accordance with candidate's field of research and the subject of PhD thesis.		
Recommended literature Carlquist S. (1961): Comparative Plant Anatomy, Holt, Rinehart and Winston, New York. Carlquist S. (1988): Comparative wood anatomy. Springer-Verlag, Heidelberg Dickison C. W. (2000): Integrative plant anatomy, Harcourt academic press, New York, London. Foster A.S. & Gifford E.M. (1974): Comparative Morphology of Vascular Plants (2 nd edn), W.H. Freeman&Co.San Francisco Metcalfe C.R.&Chalk L. (1950): Anatomy of Dicotyledons, vols I&II, Clarendon Press, Oxford. Metcalfe C.R.(1960): Anatomy of Monocotyledons, I <i>Gramineae</i> New literature and published papers available on internet		
Number of active classes	Theory: 5	Practice: 5
Methods of delivering lectures lectures, practical work, student research work, consultations		
Evaluation of knowledge (maximum number of points 100) The exam is oral. Prerequisites for oral exam are: active involvement of students in experimental work on specific subjects dealing with special plant anatomy, written and presented student's practical work and read out of several scientific papers from this field. Practical work: 20 Seminar work: 30 Oral exam: 50		

Course Title: PHYTOREMEDIATION		
Professor: Dr. Milan Borišev, Dr. Slobodanka Pajević		
Status of the subject: Elective		
Number of ECTS: 15		
Prerequisites: -		
Course Objective: Getting students familiar with application of phytoremediation, and the followup physiological processes which underline these applications. Specific metabolic properties, and growth forms of plant species which are selected as a useful tools in this technology. Types of specific ecosystem pollution which is suitable for this process of remediation.		
Course Outcome: By learning theoretical and practical examples in the phytoremediation field, students will become aware with one specific aspect of applied plant physiology. Specific parts of plant metabolism will be analysed within specific plant species which are metabolically compatible with according pollutants in the environment. Students will went through different methods of analyses aiming to assess phytoremediation potential of different plant forms and plant taxons.		
Course Content: Theory: Pollution sources. Pollutant types. Ecosystems and human health in relation to pollutants. Interaction of various pollutant species and plants. Metabolic specificity of plant species and forms in phytoremediation. Application potential of plants in remediation. Phytoremediation types. Economical and technological demands in phytoremediation. Methods of experimental analyses in phytoremediation. Current development of phytoremediation. Molecular markers in phytoremediation. Research practice: Analyses of pollutant content in plant samples collected at polluted sites. Designing experiments for analyses of phytoremediation potential in controlled conditions. Analyses of molecular indicators in phytoremediation.		
Recommended literature: Ansari A.A., Gill S.S., Gill R., Lanza G.R., Newman L. (Eds). 2016. Phytoremediation. Management of Environmental Contaminants, vol. 3., Springer International Publishing Switzerland ISBN 978-3-319-40146-1. DOI 10.1007/978-3-319-40148-5 Slobodanka Pajević, Milan Borišev, Nataša Nikolić, Danijela D. Arsenov, Saša Orlović, Milan Župunski (2016): Phytoextraction of Heavy Metals by Fast-Growing Trees: A Review. In: Phytoremediation: Management of environmental contaminants, vol. 3 (Abid Ali Ansari, Sarvajeet Singh Gill, Ritu Gill, Guy R. Lanza, Lee Newman, eds.). Springer International Publishing Switzerland, pp. 29-64. ISBN 978-3-319-40146-1. DOI 10.1007/978-3-319-40148-5 Sana Ashraf, Qasim Ali, Zahir Ahmad Zahir, Sobia Ashraf, Hafiz Naeem Asghar, Phytoremediation: Environmentally sustainable way for reclamation of heavy metal polluted soils, Ecotoxicology and Environmental Safety, Volume 174, 2019, Pages 714-727, ISSN 0147-6513 Karen E. Gerhardt, Perry D. Gerwing, Bruce M. Greenberg, Opinion: Taking phytoremediation from proven technology to accepted practice, Plant Science, Volume 256, 2017, Pages 170-185, ISSN 0168-9452.		
Total hours:	Lectures: 5	Student research work: 5
Methods of instruction: Theoretical lectures, mentor work, consultations, writing review papers, literature survey, laboratory practice under supervision, demonstration of laboratory procedures		
Assessment (maximum number of points 100)		
Requirements Student activity 10 points, Writing essays 40 points, Oral exam 50 points		

Course title: METHODS IN PHYTOCENOLOGICAL RESEARCH		
Teachers: Dr. Dragana Vukov, Dr. Ružica Igić		
Course status: elective		
Number of ECTS: 15		
Condition: -		
Objective of the course: The aim of this course is to learn about values and diversity, as well as basic methods of survey of plant communities.		
Outcome of the course Within the course, students will be introduced to traditional and new methods of sampling and analysis of vegetation data and trained in their implementation.		
Contents of the course <i>Theoretical lectures</i> Introduction to the basic vegetation types of the Republic of Serbia. Introduction to basic methodological approaches to the vegetation survey. Braun-Blanquet approach in vegetation survey. Formation of databases. Analyzes of large vegetation data sets. Use of software tools in vegetation analysis. Additional data in large scale vegetation analyzes. Vegetation classification with different software tools. Interpretation of data obtained by numerical classification of vegetation data. Formal definition of traditional and new syntaxonomical categories. <i>Practical lectures</i> Practical lectures involves plant material in order to learn about the diversity of the basic vegetation types in Serbia. As part of the practical lectures, field research will be also realized. Main topics of practical lectures are: basic methods of vegetation sampling; phytocenological recording by Braun-Blanquet method; data entry and digitization; updating and editing the vegetation database; methods in the numerical classification of vegetation data; practice of classified data; presentation and interpretation of results.		
References: 1. Mucina et al.. (2016): Vegetation of Europe: hierarchical floristic classification system of vascular plant, bryophyte, lichen, and algal communities. - Applied Vegetation Science 19 (Suppl. 1): 3–264. 2. Tichý, L. 2002. JUICE, software for vegetation classification. Journal of Vegetation Science. 13:451–453. 3. Lepš, J., Šmilauer, P. 2003. Multivariate Analysis of Ecological data using CANOCO. Cambridge University Press. Cambridge. 4. McCune, B., Mefford, M.J. 1999. PC-ORD. Multivariate analysis of Ecological Data, Version 5.0 for Windows. - MjM Software Design, Gleneden Beach. 5. Hill M. O., Šmilauer P. 2005. TWINSpan for Windows version 2.3. – Centre for Ecology & Hydrology, Huntingdon, and University of South Bohemia, České Budějovice.		
Number of active teaching hours	Theory: 5	Practice: 5
Teaching methods Lectures and practical classes (individual and group work of students). Lectures, lab work, colloquiums, field work, seminar work on selected topics.		
Knowledge score (maximum points 100)		
Pre-exam obligations Practical lectures 20 Colloquiums 10 Seminar work 10 Final exam Written exam 30 Oral exam 30		

Name of the subject: METHODS IN BRYOLOGY		
Teacher(s): Dr. Miloš Ilić		
Status of the subject: Elective		
Number of ECTS points: 15		
Condition: -		
Goal of the subject Acquiring knowledge about methodology in different aspects of briological researches with particular emphasis on choosing the appropriate method.		
Outcome of the subject Students are able to independently use different methods in bryophyte researches.		
Content of the subject <i>Theoretical lectures</i> Morphology of bryophytes; Diversity and ecological characteristics of bryophytes; Bryophyte roles in ecosystem functioning; Defining research goals and selecting adequate sampling sites; Field sampling methods; Laboratory techniques: Slide preparation; Field and laboratory identification of bryophytes; Herbaria and bryophyte collections; Quantitative approach in bryophyte ecology; Quantitative sampling of ground bryophytes; Quantitative sampling of epiphytic bryophytes; Quantitative sampling of epilithic and epixylic bryophytes; Diversity measures; Basic statistical methods in bryophyte researches; Multivariate analysis; Statistical methods in bryophyte community detection. <i>Practical lectures</i> Defining research goals as well as choosing the appropriate methodological approach in accordance with the candidate's interests and the topic of the doctoral thesis.		
Recommended literature Veljić, M., Vukov, D., Sabovljević, M. 2018. Biologija briofita I: morfologija i sistematika. Biološki fakultet Univerziteta u Beogradu, Prirodno-matematički fakultet Univerziteta u Novom Sadu. Beograd-Novu Sad. Vanderpoorten, A., Goffinet, B. 2009. Introduction to bryophytes. Cambridge University Press Goffinet, B., Shaw, J. 2000. Bryophyte biology. Cambridge University Press. New York Glime, J. M. 2017. Bryophyte ecology. Available online at: http://www.bryoecol.mtu.edu/ Smith, A. (ed.) 1982. Bryophyte ecology. Springer Netherlands. Atherton, I., Bosanquet, S., Lawley, M. 2010. Mosses and liverworts of Britain and Ireland-a field guide. British Bryological Society, UK. Casas, C., Bruges, M., Cros, R. M., Sérgio, C. 2006. Handbook of mosses of the Iberian Peninsula and the Balearic Islands. Illustrated keys to genera and species. Barcelona. Casas, C., Bruges, M., Cros, R. M., Sérgio, C., Infante, M. 2009. Handbook of liverworts and hornworts of the Iberian Peninsula and the Balearic Islands. Illustrated keys to genera and species, Barcelona. Smith, A. J. E. 1990. The Liverworts of Britain and Ireland. Cambridge University Press, Cambridge. Smith, A. J. E. 2004. The Moss Flora of Britain and Ireland. Cambridge University Press, New York.		
Number of active classes	Theory: 5	Practice: 5
Methods of delivering lectures Lectures, consultations, field and laboratory work, student essay.		
Evaluation of knowledge (maximum number of points 100) Oral exam: 50 Essay: 50		

Name of the subject: PREPARATION OF DOCTORAL DISSERTATION		
Teacher(s): -		
Status of the subject: Obligatory		
Number of ECTS points: 20		
Condition: The doctoral dissertation is defended after passing the exams in all subjects and after fulfilling all the obligations determined by the study program. It consists of the preparation and public defense of the doctoral dissertation. The doctoral dissertation is submitted and produced during the second or third year of doctoral studies. The application procedure, the conditions for drafting and the manner of defending the doctoral dissertation are laid down in the Statute and the corresponding acts of the Faculty of Science and the University.		
Goal The doctoral dissertation is a student's independent research work and represents a synthesis of theoretical knowledge and practical work through which the student acquires the ability for scientifically based interpretation of experimental data from a selected narrow scientific field of Biology.		
Outcome of the subject Through the process of developing and defending a doctoral dissertation, the student gains the ability of <ul style="list-style-type: none"> - independent collection of information and data from professional and scientific literature; - logical thinking, formulation of working hypotheses and goals of the dissertation and drawing conclusions; - placing different scientific and professional information, giving opinions and exchanging ideas; - planning and carrying out experimental work; - team research work; - scientifically based interpretation of experimental data and obtained results; - successful application of the principles of good laboratory practice in the planning, execution and control of experiments; - successful synthesis of relevant scientific data with conclusions drawn. 		
Content of the subject As a rule, the doctoral dissertation contains the following chapters: Content, Introduction, Objective, Literature Review, Material and Methods, Results, Discussion, Conclusions, Literature. In addition to the aforementioned chapters, each doctoral dissertation contains a biography of the candidate and key documentation in Serbian and English. In the case of teaching in English, the doctoral dissertation is written in English with a broader statement in the Serbian language and legends of pictures and tables in the Serbian language. In addition to the above elements, the doctoral dissertation may contain additional elements such as List of Tables, List of Figures, Attachments, List of Abbreviations, etc.		
Recommended literature Relevant scientific and professional literature in the field of doctoral dissertation.		
Number of active classes	Theory:-	Practice: -
Methods of delivering lectures <ul style="list-style-type: none"> - collecting and studying literature - collecting data for experimental work -planning and performing experiments -data processing -writing and oral defense of the doctoral dissertation 		
Evaluation of knowledge (maximum number of points 100) <ol style="list-style-type: none"> 1. The doctoral dissertation is defended before the Commission. 2. The dissertation defense is oral and public. 3. The day, place and time of the defense of the doctoral dissertation shall be published on the notice board of the relevant Department and / or on the Faculty website at least three days before the defense. 4. Upon the defense of the doctoral dissertation, the Commission shall withdraw and then make a public announcement decision on whether the dissertation was successfully defended. 5. The Commission for the Defense of the Doctoral Dissertation shall decide by a majority vote. 		

Name of the subject: MATHEMATICAL AND STATISTICAL METHODS IN BIOLOGICAL RESEARCH		
Teacher(s): Dr.Vladimir Kostić		
Status of the subject: Elective		
Number of ECTS points: 15		
Condition: -		
Goal of the subject Enabling students to independently use basic modern mathematical and statistical methods in research through the integration of theoretical knowledge and the development of programming skills to analyze empirical data and perform scientific reasoning.		
Outcome of the subject Students will master techniques of mathematical modeling with differential equations and techniques of multivariate statistical analysis, as well as their implementation on selected biological and ecological phenomena using the software package R.		
Content of the subject <i>Theoretical lectures</i> Introduction to Scientific Modeling - deterministic and statistical models. Mathematical modeling of dynamic processes via differential equations. Model of empirical food webs - model setup, analysis, simulations and conclusions. Basics of statistical modeling. Descriptive data research techniques (EDA) - descriptive statistics in biology and ecology, tables, charts. Basic tests of univariate statistical analysis. Basic tests of multivariate statistical analysis. Cluster analysis. Principal component analysis and factor analysis. <i>Practical lectures</i> Introduction to R programming language. Data preparation and processing in R Studio environment. Programming basics in R. Writing algorithms in R for scientific computation - determining the stability indicators of empirical food webs. Descriptive statistical methods in R. Univariate statistical analysis in R. Multivariate statistical analysis in R.		
Recommended literature <ol style="list-style-type: none"> 1. K. Soetaert, P. M. J. Herman, A Practical Guide Ecological Modeling: Using R as a Simulation Platform, Springer (2008) 2. D. Borcard, F. Gillet, P. Legendre, Numerical Ecology with R, Springer (2018) 3. C. Dyltham, Choosing and Using Statistics – A Biologists’s Guide, Wiley-Blackwell (2011) 		
Number of active classes	Theory: 5	Practice: 5
Methods of delivering lectures Within theoretical lectures, starting with an understanding of key mathematical and statistical models in biological research, tools for their deeper analysis are gradually introduced, and finally guidelines for independent scientific research are proposed. Practical training consists of working on a computer in the R programming language using the R Studio package.		
Evaluation of knowledge (maximum number of points 100) Knowledge assessment is in the form of presentation of a self-realized project and consists of an oral exam of theoretical knowledge (50 points) and mastered programming skills in R (50 points).		

Name of the subject RESEARCH METHODOLOGY		
Teacher(s): Dr. Vesna Milankov		
Status of the subject: Elective		
Number of ECTS points: 15		
Condition: -		
Goal The course aims at enabling students for presenting research results, writing research articles and a PhD thesis and evaluating the scientific research.		
Outcome of the subject Competent presentation and publication of scientific information. Research competence.		
Content of the subject <i>Theoretical lectures</i> Modern methods of collecting information and processing and analyzing research data in biological disciplines. Methods and techniques of researching and presenting results. Writing and presenting a doctoral thesis and a research article. Preparing manuscripts for publication – from manuscript writing to publishing. Digital data and e-publications. Forms of scientific publications. Scientometrics. Ranking research publications. Reviewing articles. Evaluation of reserchers and publications. Ethics in science – The codex of good scientific practice. Abuses of science. Logic errors. General and subject-specific scientific methods. Analysis of relevant scientific publications.		
Recommended literature Briscoe, M.H. (1996) Preparing scientific illustrations. 2 nd ed. Springer-Verlag, New York. Ebel, H.F., Bliefert, C., Russez, W.E. (2004) The art of scientific writing. Wiley-VCH Verlag GmbH & Co. KGaA. Milankov, V. & Jakšić P. (2007) Методологија научноистраживачког рада у биолошким дисциплинама. ПМФ. (уџбеник) [Research methodology in biological disciplines.Faculty of Sciences.textbook]		
Number of active classes	Theory: 5	Practice: 5
Methods of delivering lectures Oral and database searching in computer lab.		
Evaluation of knowledge (maximum number of points 100) Pre-exam obligations: 30 Oral exam: 70		

Name of the subject: PREPARATION OF A SCIENTIFIC PAPER FOR PUBLICATION IN A JOURNAL FROM THE SCI LIST		
Teacher(s): -		
Status of the subject: Obligatory		
Number of ECTS points: 10		
Condition: -		
Goal Independent student scientific-research work through which the ability to synthesize theoretical knowledge and practical work and present the results to the international scientific community is acquired.		
Outcome of the subject Through the process of writing a scientific paper for publication in a journal from the SCI list, the student acquires the ability of: <ul style="list-style-type: none"> - independent collection of information and data from professional and scientific literature; - logical thinking, formulation of working hypotheses, goals and drawing conclusions; - placing various scientific and professional information, giving opinions and exchanging ideas; - scientifically based interpretation of experimental data and obtained results; - successful synthesis of relevant scientific data with conclusions. 		
Content of the subject The student is obliged to publish at least 1 scientific paper in a journal on the SCI list, in the field of the topic of the doctoral dissertation, which contains the results obtained by working on the doctoral dissertation and on which the student is the first author.		
Recommended literature Relevant scientific and professional literature in the field of the topic of the doctoral dissertation		
Number of active classes	Theory:	Practice: 20
Methods of delivering lectures -collection and study of literature -processing the results of research work in the field of the topic of the doctoral dissertation -writing a scientific paper and active participation in the process of submitting a paper to a journal from the SCI list		
Evaluation of knowledge (maximum number of points 100) After accepting a scientific paper for publication in a journal from the SCI list, the student advisor or mentor of a doctoral student submits proof to the Student Services that the paper has been accepted and / or a printed version of the published paper, thus giving the student the maximum number of points and ECTS.		

Name of the subject: SEMINAR I		
Teacher(s):		
Status of the subject: Obligatory		
Number of ECTS points: 30		
Condition: -		
Goal The objective of the course is to acquaint students with the most up-to-date methods and results in the relevant narrow scientific field of research, as well as training them in the planning and preparation of the doctoral dissertation.		
Outcome of the subject The final outcome of the course is the successful preparation and realization of research work leading to the preparation of a doctoral dissertation.		
Content of the subject <p>The seminar is a thematic, narrowly oriented, specialized form of teaching that is conducted in specific terms with students, and is in the direct function of research leading to the preparation of a doctoral dissertation. The program of work of each seminar is formed in accordance with the needs of the preparation of doctoral dissertations and depends on the topic, structure and complexity of the doctoral dissertation. Seminars are the basis of study research work. The student, in consultation with the advisor, prepares Seminar I in the form of a presentation, which includes the presentation and explanation of the topic of the doctoral dissertation in the light of the literature and presentation of the methods that will be used during the research work.</p> <p>The defense of the seminar will be conducted in joint terms. The student defends the seminar publicly before a five-member committee nominated by the Departmental Council for each school year and before the PhD students attending the course.</p>		
Recommended literature Scientific and professional literature in the field of doctoral dissertation subject as agreed with the advisor (mentor).		
Number of active classes	Theory:	Practice: 20
Methods of delivering lectures The basic form of teaching at the seminar is the independent research work of the student, which is realized in agreement with the advisor (mentor).		
Evaluation of knowledge (maximum number of points 100) Preparation of the presentation - 30 points Seminar defense - 70 points		

Name of the subject: SEMINAR II		
Teacher(s):		
Status of the subject: Obligatory		
Number of ECTS points: 30		
Condition: -		
Goal		
The objective of the course is to train the student to prepare a doctoral dissertation.		
Outcome of the subject		
The final outcome of the course is a critical analysis of the results in order to successfully complete the doctoral dissertation.		
Content of the subject		
<p>The seminar is a thematic, narrowly oriented, specialized form of teaching that is conducted in defined terms with students, and is in the direct function of developing a doctoral dissertation. The program of work of each seminar is formed in accordance with the needs of developing a specific doctoral dissertation and depends on the topic, structure and complexity of the doctoral dissertation. The student, in consultation with the advisor (mentor), prepares Seminar II in the form of a presentation that includes presentation of the results obtained during the doctoral dissertation, their critical discussion and conclusions.</p> <p>The defense of the seminar will be conducted in joint terms. The student defends the seminar publicly before a five-member committee nominated by the Departmental Council for each school year and before the PhD students attending the course.</p>		
Recommended literature		
Scientific and professional literature in the field of doctoral dissertation subject to agreement with the advisor (mentor).		
Number of active classes	Theory:	Practice:20
Methods of delivering lectures		
The basic form of teaching at the seminar is the independent research work of the student, which is realized in agreement with the advisor (mentor).		
Evaluation of knowledge (maximum number of points 100)		
Preparation of the presentation - 30 points		
Seminar defense - 70 points		