University *of Ljubljana*

Interdisciplinary Doctoral Programme of BIOSCIENCES

Science of life – Science for life

Ljubljana, 2019

University *of Ljubljana*

Biotechnical Faculty
Faculty of ***Electrical Engineering***
Faculty of ***Computer and Information Sciences***
Faculty of ***Mechanical Engineering***
Faculty of ***Health Sciences***

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Introduction into the Doctoral Programme of Biosciences

The Interdisciplinary Doctoral Study Programme of Biosciences is a joint project of five faculties of the University of Ljubljana: the Biotechnical Faculty (BF) in the role of the coordinator of the programme and the Faculty of Electrical Engineering (FE), the Faculty of Computer and Information Science (FRI), the Faculty of Mechanical Engineering (FS), and the Faculty of Health Sciences (ZF) as co-implementers of the programme. In the past decade and a half, scientific achievements in the field of basic and applied biosciences lead to essential changes and corrections to the theories that had been valid for decades. They have opened entirely new horizons in the study of the basic laws of the functioning of biological systems and enabled the development of applications we could scarcely imagine a few decades ago. The fast development in numerous fields of biological research and the expanding range of possibilities for the use of new discoveries are reflected in the growing need for basic and applied knowledge of them in modern societies, which also dictates a suitable reform of doctoral study programmes. The Interdisciplinary Doctoral Programme of Biosciences, together with taking into account the Bologna guidelines on quality, combines science and experience from the fields of agronomy, agrifood microbiology, bioinformatics, bioengineering in health sciences, biology, biotechnology, economics of natural resources, management of forest ecosystems, horticulture, landscape architecture, wood and biocomposites, nanosciences, nutrition, technical systems in biotechniques, protection of the natural heritage, cell sciences, animal sciences, and food science. The need for high quality and up-to-date doctoral study programmes offering suitable knowledge from the scientific spheres that are being developed at various members of the University of Ljubljana is additionally dictated by the fast and extensive development of these fields and their impact on important areas of our life such as food and nutrition, health, environment and renewable energy sources, to name a few.

The essential element of the programme is connecting the contents from the field of biosciences on the level of the University of Ljubljana. Special attention is given to new, boundary fields of research that are often overlooked by the wider public and not suitably represented in the first and second cycle study programmes. The Doctoral Study Programme of Biosciences is a response of the Biotechnical Faculty and associated partners to the challenges of the time. With the commitment of domestic experts and visiting experts from abroad, the programme offers a selection of the most up-to-date knowledge in the related scientific fields available in Slovenia. Beside the five co-implementers, other members of the University of Ljubljana and the leading Slovene research institutes contribute to the programme as well, offering their research environments to be used for training of doctoral candidates. The main focus of the doctoral studies is research work, interdisciplinary approach, and cooperation of internationally established domestic and foreign experts. Taking into account the recommendations of the European University Association (EUA), the programme envisages the international exchange of students and, as a condition for ensuring the international comparability of high-quality doctoral work, a publication of at least one scientific article in an internationally recognised scientific journal is required, containing a part of the candidate's research results. Particular emphasis is placed on close cooperation between doctoral students and mentors, which gives the programme a personal touch and enables the candidates, in agreement with their mentors, to design a personal programme of education best suited to their ambitions.

Prof. Dr. Peter Dovč
(President of the Programme Council for Biosciences)

1 GENERAL INFORMATION ON THE PROGRAMME

The Interdisciplinary Doctoral Study Programme of Biosciences is a third cycle study programme of the Bologna Process. It lasts for four years and grants 240 credit points. The study programme consists of an organised educational part amounting to 60 credit points and individual research work for the doctoral thesis awarding the remaining 180 credit points.

The study requirements of the programme are in accordance with the Higher Education Act and Criteria for Accreditation of Higher Education Institutions and Study Programmes adopted by the Council of RS for Higher Education and assessed according to the European Credit Transfer System (ECTS). This enables a direct inclusion of parts of the programme in the international exchange between universities in the countries that use the ECTS system as well.

The programme awards the academic title **DOCTOR OF SCIENCE** in the following scientific fields:

- agronomy
- agrifood microbiology
- bioinformatics
- bioingeneering in health sciences
- biology
- biotechnology
- economics of natural resources
- management of forest ecosystems
- horticulture
- landscape architecture
- wood and biocomposites
- nanosciences
- nutrition
- technical systems in biotechniques
- protection of the natural heritage
- cell sciences
- animal science and food science

The Interdisciplinary Doctoral Study Programme of Biosciences is provided by the following members of the University of Ljubljana:

- **Biotechnical Faculty**, Jamnikarjeva 101, Ljubljana
- **Faculty of Electrical Engineering**, Tržaška cesta 25, Ljubljana
- **Faculty of Computer and Information Science**, Večna pot 113, Ljubljana
- **Faculty of Mechanical Engineering**, Aškerčeva 6, Ljubljana
- **Faculty of Health Sciences**, Zdravstvena pot 5, Ljubljana

The Biotechnical Faculty coordinates the following scientific fields (15): agronomy, agrifood microbiology, biology, bioingeneering in health sciences, cell sciences, biotechnology, economics of natural resources, managing of forest ecosystems, horticulture, landscape architecture, wood and biocomposites, nutrition, protection of the natural heritage, animal sciences and food science. The Faculty of Electrical Engineering coordinates the scientific field of nanosciences. The Faculty of Computer and Information Science coordinates the scientific field of bioinformatics and the Faculty of Mechanical Engineering coordinates the scientific field of technical systems in biotechniques.

The doctoral student submits the application for the approval of the theme and title of their doctoral thesis to the faculty which coordinates the scientific field the doctoral student is enrolled in.

2 FUNDAMENTAL GOALS AND COMPETENCES OVERVIEW

The fundamental goal of the Doctoral Study Programme of Biosciences is educating highly-qualified specialists for each of the included scientific fields of study.

The programme aims at qualifying the doctoral students for creative and independent scientific research and solving challenging scientific problems. The students will broaden their basic knowledge of the selected fields of study and acquire problem-solving tools; they will be qualified for a critical approach to answering complex scientific research questions, for the development of new research methods and utilisation of new technologies and discoveries. The students will learn to use scientific literature and follow new discoveries in their scientific field. They will be qualified for obtaining and leading or coordinating scientific research projects and will be able to present their results to the general public. The candidates will be capable of communicating with experts from other academic fields.

The study programme encompasses traditional scientific fields in life sciences supplemented with new ones resulting from the development of new technologies and social changes.

3 INFORMATION ON INTERNATIONAL COOPERATION OF THE COLLABORATIONG HIGHER EDUCATION INSTITUTIONS

Biotechnical faculty

http://www.bf.uni-lj.si/dekanat/mednarodna-dejavnost/

Faculty of Electrical Engineering

http://www.fe.uni-lj.si/studij_na_fakulteti/mednarodne_izmenjave/
http://www.fe.uni-lj.si/raziskovanje_in_razvoj/mednarodno_sodelovanje/

Faculty of Computer and Information Science

http://izmenjave.fri.uni-lj.si/

Faculty of Mechanical Engineering

http://www.fs.uni-lj.si/studijska_dejavnost2/mednarodne_izmenjave/predstavitev/
http://www.fs.uni-lj.si/raziskovalna_dejavnost/mednarodni_projekti/

Faculty of Health Sciences

http://www2.zf.uni-lj.si/si/

University of Ljubljana

http://www.uni-lj.si/mednarodno_sodelovanje_in_izmenjave/

4 INFORMATION ON RESEARCH PROGRAMS, PROJECTS AND AGREEMENTS

The information is available on the webpages listed below:

Biotechnical faculty

http://www.bf.uni-lj.si/dekanat/porocila/letna-porocila/
http://www.bf.uni-lj.si/dekanat/raziskovalno-delo/raziskovalni-programi-programske-skupine/
http://www.sicris.si/search/org.aspx?opt=4&lang=slv&id=2642

Faculty of Electrical Engineering

http://www.fe.uni-lj.si/raziskovanje_in_razvoj/raziskovalni_programi/
http://www.sicris.si/search/org.aspx?opt=4&lang=slv&id=758

Faculty of Computer and Information Science

http://www.fri.uni-lj.si/si/raziskave/projekti/
http://www.sicris.si/search/org.aspx?opt=4&lang=slv&id=758

Faculty of Mechanical Engineering

http://www.fs.uni-lj.si/raziskovalna_dejavnost/nacionalni_projekti/
http://www.fs.uni-lj.si/raziskovalna_dejavnost/mednarodni_projekti/
http://www.sicris.si/search/org.aspx?opt=4&lang=slv&id=693

Faculty of Health Sciences

http://www2.zf.uni-lj.si/si/raziskovalniinstitut4-1/raziskovalni-projekti4-1-2/projektivteku4-1-2-1
http://www.sicris.si/search/org.aspx?opt=4&lang=slv&id=628

5 PRESENTATION OF SCIENTIFIC FIELDS

5.1 AGRONOMY

Modern agronomy focuses not only on plant cultivation, but also on a wider understanding of the environment in which the cultivation takes place. The scientific field of agronomy introduces the postgraduate students to the research of interactions between agricultural production and other environmental human activities. The main focus of agronomy is studying the laws of structure and functioning of agricultural and other ecosystems, the reaction of plants and other cohabiting organisms to abiotic and biotic environmental factors and agricultural technology. The programme includes studying and analysing the effects of global environmental changes and pollution on plants, soil and climate and researching new technologies enabling sustainable development of agriculture and related activities as well as preserving biodiversity and environment.

All the mentioned contents are covered by 15 courses. The interdisciplinary oriented study plan enables the students to gain a comprehensive understanding of the field of study, which is important given the complexity of (agro)ecosystems. On the other hand, the elective courses enable the students to focus on a specific area of interest. The competences gained from methodological subjects prepare the doctorate students for independent research of agroecosystems.

Prof. Dr. Dominik Vodnik
Coordinator for Agronomy

5.2 AGRIFOOD MICROBIOLOGY

The scientific field of agrifood microbiology is intended for students interested in the workings of microorganisms in agroecosystems and food processing industry. The programme offers the newest discoveries in the related scientific fields from molecular to environmental microbiology. This includes in-depth knowledge of modern microbiological methods and techniques, structure and dynamics of microbial genomes, sociomicrobiology of microbe interactions in models and complex systems such as ground, water, plants, microbes and food. It introduces the students to the role of microbe interactions for the containment of harmful microorganisms, acquirement of new biologically active molecules, and development of biopesticides and probiotics. Furthermore, the students will be provided with in-depth understanding of the structure of microbial biofilms, molecular characteristics and applicable characteristics of polymers connecting cells in a biofilm as well as problems and solutions related to harmful biofilms and the processes of providing safe and microbiologically irreproachable food. The programme offers a wide array of knowledge necessary for natural agriculture, especially concerning the use of newest technologies for the acquisition of energy from agrifood waste (methane, hydrogen), new biotechnological solutions for the production of bioethanol, biobutanol, mineral fertilizers, and the usage of bioremediation technologies and new trends of acquiring medication precursors from processing agrifood waste. The programme connects both production and processing role of microbiology in the production of food. In this way, we offer a detailed insight in the role of microorganisms from the production to the consumer in producing and processing healthy and high-quality food.

Prof. Dr. Ines Mandić Mulec
Coordinator for Agrifood Microbiolog

5.3 BIOINFORMATICS

How similar are living beings? What are the genetic differences between people? Are people really the descendants of the Neanderthals? How can animal species adapt to the living environment? Damage to what genes is responsible for the appearance of different illnesses? Can the side effects of medicines be predicted from their structural properties?

All these questions can today be answered by bioinformatics. In recent decades, with the development of genomics and other molecular experimental techniques, researchers have obtained a large amount of data from the field of molecular biology. Techniques used in bioinformatics enable us to suitably process these data, to search them for informative patterns and to analyse them in order to improve understanding of biological processes. Typically, bioinformatics is used in the following areas: the arrangement of sequences of proteins and nucleic acids, the search for genes, the composition of genomes from short sequences, the phylogenetic analysis, the forecasting of protein structures and active parts of proteins, the analysis of gene expression, the process of genetic networks, the analysis of data on polymorphisms and protein interactions, and in the modelling of biological processes and evolution.

The scientific field of bioinformatics is intended for students of two different profiles: the students with prior knowledge of biomedicine will be instructed in the use of modern computer applications for solving problems in these areas. The programme will similarly be of interest to students from technical faculties, especially for the students of computer science, who will learn to apply their computer knowledge to the increasingly attractive field of bioinformatics.

Assist. Prof. Dr. Tomaž Curk
Coordinator for Bioinformatics

5.4 BIOENGINEERING IN HEALTH SCIENCES

The study programme of Bioengineering in Health Sciences is intended for graduates from different faculties who wish to devote themselves to research and/or engineering in the field of health sciences. The contents include the study of mechanisms of health maintenance in relation to environmental impacts, new materials, and new procedures. Environmental impacts include ecological engineering, the design of ecosystem services, cleaning of polluted water, the use of ecotechnologies, the assessment of the quality of water, soil and air, biocompatibility of materials for prostheses and orthoses, and the effects of photocatalytic materials and materials used for laboratory equipment in research- and clinical medicine. The interactions of nanostructured surfaces, which play an important role, are also considered. Another subject of this field of study is the design and production of microfluidic devices and lab-on-chip systems, and their use in bioanalytics of bioprocesses, in the development and in production of pharmaceuticals, and in diagnostics. Furthermore, the field of study focuses on the construction of biomechanical models of the locomotor system, and the related planning of operations based on the prediction of biomechanical parameters in addition to optimization of shape and implementation of prostheses and orthoses. In short, the subject of Bioengineering in Health Sciences is any impact on health which can be studied using scientific methods. The field is therefore suitable for all who wish

to contribute to health maintenance, treatment of diseases, and preventive measures with the use of scientific methods. Bioengineering in Health Sciences promotes life- and environment-friendly methods and high ethical standards.

Prof. Dr. Veronika Kralj Iglič
Coordinator for Bioengineering in Health Sciences

5.5 BIOLOGY

Biology is one of the central scientific fields in natural sciences. It offers knowledge about animals, plants, microorganisms, and fungi and their mutual interactions in relation to the environment. Biology deals with all levels of biological organisation, from molecules to ecosystems. The phenomenon of new scientific fields emerging does not reduce the role of biology, but quite the opposite. The need for an all-encompassing view of life, in which molecules and ecosystems intertwine to form a dynamic and rounded-up whole, gives biology ever greater importance. The scientific field of Biology in study programme of Biosciences is planned in such a way that it covers the broadest view of life and offers an understanding of the dynamic, changeable and transitory nature of living beings. This knowledge is of vital importance for many human activities, including interventions in the environment, interventions in the genome, production of chemicals and materials organisms have never come in contact with before, and interventions in ecosystems, which have inconceivable consequences. We know that survival on this planet will depend on our responsible behaviour. A precondition for this is familiarity and understanding of biological systems and their interconnection and interdependence.

Prof. Dr. Marko Kreft
Coordinator for Biology

5.6 BIOTECHNOLOGY

The scientific field of Biotechnology offers students in-depth knowledge of microbial, plant, animal, and human physiological processes that can be modulated using biotechnological methods in order to improve the quality of organisms or for production of certain substances. The three major areas of Biotechnology are covered extensively by the subjects of Microbial Biotechnology, Plant Biotechnology, and Animal Biotechnology. Microbial Biotechnology focuses on industrially relevant methods of metabolic, biosynthetic, and protein engineering using the recombinant DNA while promoting the development of new and improved bioprocesses for the production of generic products. It offers a comparative overview of the most significant industrial microorganisms, the newest host strains in addition to the most modern methods and approaches still in development yet already being adopted by the industry. Plant Biotechnology addresses various biotechnological methods of plant breeding and improvement using morphological, biochemical, and DNA markers. Strategies for genetic modification of plants for the improvement of their agronomic properties, biotic and abiotic stress resistance, higher quality, drug production, and other components will be presented. The biosafety issue of genetically modified organisms, diagnostics of plant pathogens, and the use of genomic data resources from model plant organisms will be discussed. Animal Biotechnology presents the development of animal biotechnology with emphasis on transgenesis methods and molecular markers for managing animal genetic resources as well as immunity technologies, epigenetic mechanisms regulating gene expression, development of animal models for the purposes of biomedical studies, and management of extensive databases and genomic selection. Elective courses offer themes that complement and provide additional information on the three major subjects. Theoretical courses provide students with in-depth knowledge of specific processes and technologies, while individual research courses introduce them to the most modern lab methods and techniques, which they can apply to the experimental part of their research.

Prof. Dr. Mojca Narat
Coordinator for Biotechnology

5.7 ECONOMICS OF NATURAL RESOURCES

The aim of the doctoral study programme of Economics of Natural Resources is to qualify doctoral students for creative and high-quality research work concerning social aspects of life sciences. It applies a wide range of knowledge of social sciences, particularly economics, to nutrition and wood chain, bioeconomy, rural development, and environmental protection. We undertake challenges stemming from the management of natural, human, and capital resources related to biological and biotechnical processes. Particular emphasis is laid on studying the social aspects of managing natural resources and the role of the state.

Primarily, the programme is intended to qualify students for in-depth empirical work enabling them participation in the international knowledge exchange and scientific publishing. Within the framework of an extensive methodological subject (Methodology of economic and social sciences in biosciences) the students are introduced to the planning of research work, methods of obtaining and processing data, and the use of quantitative and qualitative methods. Methodological knowledge can be extended by two additional courses in the field of operational research and multivariate statistical methods.

In addition, the programme offers a selection of three courses covering the research fields that are expected to be frequently selected as the topic of the doctoral thesis. The first focuses on biochemistry, analysing options for biotechnological innovations in light of business and national economy development. The second offers possibilities for economic and sociologic research in the field of rural development. The third discusses the theory and methods concerning the behaviour of consumers in relation to nutrition, wood, and other material goods produced by biotechnological processes and systems.

If a candidate decides to write the thesis in the field of Economics of Natural Resources, the collective of professors and potential mentors encourages them to further expand their knowledge with a choice of subjects from comparable doctoral programmes at home and abroad.

Prof. Dr. Luka Juvančič
Coordinator for Economics of Natural Resources

5.8 HORTICULTURE

The scientific field of Horticulture covers fruit growing, viticulture, horticulture, ornamental plants, and medicinal plants. It is the fastest growing agronomic branch in- and outside of Europe regarding quality of the existing and new horticultural products and contribution to more pleasant living conditions. The students will be acquainted with various aspects of horticulture, especially its role in Slovenia and worldwide, the contemporary results in the field of plant propagation and development, cultivation of functional and safe food, and modern biotechnological methods of plant breeding. The importance of various groups of primary and secondary metabolites in horticultural plants as well as synthetic paths with key regulations and groups of substances and their importance within stress, disease, and pest resistance mechanisms will be presented. Additionally, biotic and abiotic factors and technologies of production that influence the content of biologically active substances as well as the growing importance of secondary metabolites within fruit for human health will be discussed.

Students who have not yet attended horticultural courses are available for elective contents from the field of fruit growing, viticulture, and horticulture, and ornamental plants.

Prof. Dr. Robert Veberič
Coordinator for Horticulture

5.9 LANDSCAPE ARCHITECTURE

he doctoral study programme in the scientific field of Landscape Architecture is intended to qualify students for the research work in this field. The two fundamental areas of research are the theory of the profession, for instance the theory of design, form, structure, landscape samples, etc. and the methodology of the profession focusing on research and development of new planning procedures/methods. Even though landscape planning is technically not considered a research activity, the responsibility towards public and the complexity of problems require substantiated and credible decisions based on the results of research activity. As one of the planning activities, landscape architecture connects knowledge of various natural science and social science disciplines, such as geomorphology, ecology, hydrology, spatial sociology, ecological psychology, etc. When solving landscape planning problems, specific needs for new discoveries often arise, which are addressed by individual research fields using their own research methods. The doctoral study programme in the field of Landscape Architecture is directed to recognising these needs and developing a capacity to use the scientific instruments of various scientific disciplines for the needs of landscape planning.

Assoc. Prof. Dr. Valentina Schmitzer
Coordinator for Landscape Architecture

5.10 WOOD AND BIOCOMPOSITES

Wood is certainly the oldest high-tech natural and renewable polymer composite, which contains exceptional properties and enables virtually unlimited methods of use.

The scientific field of Wood and Biocomposites is defined by elective theoretical and individual research courses, which enable the acquisition of in-depth knowledge of properties and technologies of the production, processing and use of wood, wood composites and similar ligno-cellulose materials. The individual research courses provide further insight into the contents of the selected fields of research with the support of high-quality research equipment.

The programme focuses on contemporary research studies of wood formation supported by dendrochronological and climate-related contents further developed by studies related to the quality changes of wood, structure and properties of wood composites, durability and resistance of material, and mechanical properties of wood and wood-based material with emphasis on their use in civil engineering. Doctoral students will have the opportunity to expand their knowledge of formulation and development of wood composites, modern processes of biotechnological and chemical processing of wood, synthesis and use of compounds with high added value such as nanocellulose, modern biocidal and non-biocidal wood protection, use of nanomaterials in wood processing, and evaluation of the life cycle of biocomposites and wood products.

Upon the completion of the study programme, candidates will be capable of creative independent research work in the wide interdisciplinary field of wood processing. They will be qualified to recognise and solve fundamental scientific problems, to cooperate in the elite international research projects, and to contribute to the added value of the economy.

Prof. Dr. Primož Oven
Coordinator for Wood and Biocomposites

5.11 NANOSCIENCES

New technologies, which include nanotechnology, will undoubtedly shape our future. Many believe that we have already entered the nano-era, since products of nanotechnology can be found in many products intended for everyday use. Nanotechnologies are established in the pharmaceutical, cosmetic, electro-technical, textile and food industries. Nanoproducts have long had indispensable importance in computer science, informatics, space technology, etc. Nanotechnological products have in common that, because of their small size, they have numerous special properties that are different from the properties of macroscopic bodies, and these properties can be used for practical purposes. The question is continuously raised, of course, of their safety for humans and the environment. The field of Nanosciences within the study programme of Biosciences combines familiarisation with the properties and production of nanoparticles and nanomaterials and understanding of the interactions between biological systems and products of nanotechnology as well as aspects of their safe use. The field of nanosciences is explicitly interdisciplinary. Each candidate will expand their knowledge of their own basic field of study (physics, biology, pharmacy, medicine, electrotechnology, nutrition, etc.) while getting acquainted with other aspects common to all fields of nanosciences. By the end of their studies, candidates enrolled in the programme will gain a better understanding of physical, chemical, technological, and biological properties and possibilities of the use of nanoparticles and nanomaterials. Numerous scientists will be actively included as lecturers or co-mentors in the implementation of studies in the field of Nanosciences. The aim of the new scientific field at the University of Ljubljana is to enable its candidates contact with world's leading experts in the field of nanosciences and the possibility of cooperation with foreign universities and institutions. Upon the completion of studies, candidates will be universally educated professionals capable of cooperating in top projects in the field of nanosciences at home and abroad.

Prof. DDr. Aleš Iglič
Coordinator for Nanosciences

5.12 NUTRITION

Research in the field of nutrition is gaining ever greater importance, since it provides the basis for the development of new products and planning of the nutrition chain from production to use. It provides the basis for planning policies in the field of agriculture, food and pharmaceutical industries, health protection and preventive medicine.

Nutrition is an explicitly interdisciplinary science and the doctoral study programme in the field of Nutrition is thus also planned in this way. Within the framework of the major courses, the students refresh and supplement their knowledge of the basics of nutrition and nutritional biochemistry. In both areas, lecturers from various fields offer extensive knowledge of the biochemical basis, nutritional research, and the foundations of clinical nutrition. In addition, elective subjects enable doctoral students the acquisition of in-depth basis in fields that are directly related to the topic of their doctoral thesis. Within the framework of lectures, seminary and laboratory research work and consultations, students expand their knowledge in the field of topical research problems of human and animal nutrition. The main aim of doctoral work is mastering modern research methods in nutrition, developing a critical approach and understanding processes in the development of nutrition sciences.

Assoc. Prof. Dr. Jasna Bertoncelj
Coordinator for Nutrition

5.13 TECHNICAL SYSTEMS IN BIOTECHNIQUES

The programme is interdisciplinary and provides a direct link with the fundamental research work in biotechniques, the definition of processes, and the development of all types of technical systems that enable substitutes in nature. It is compatible both with biotechnical and with natural science technical profile. An individual professional commission adapts the programme to each student that has completed the second cycle, which enables supplementing knowledge from the other field. Due to suitably qualified research personnel, we enable studies in the fields of agricultural, forestry, wood science and food processing professions.

A student from the field of biotechnology first obtains basic knowledge regarding the problems of machines and equipment. They are then introduced to the basic research and development characteristics shared by biotechnology and techniques.

A student from the field of techniques first obtains knowledge of the basic biotechnical contents. They are then introduced to the basic research and development characteristics shared by techniques and biotechnology.

We must particularly emphasize contents that refer directly to the overall development of innovative technical systems, based on an iterative process of construction with the use of the golden loop.

In the second year, a student chooses, together with the mentor, specific contents that enable a quality insight into the specific knowledge required for research into technical systems for satisfying functions of natural processes.

Prof. Dr. Iztok Golobič
Coordinator for Technical Systems in Biotechniques

5.14 MANAGEMENT OF FOREST ECOSYSTEMS

The doctoral study programme of Management of Forest Ecosystems enables the expansion of knowledge of the nature of forest ecosystems, their administration and management in line with the three principles of modern forestry – sustainability, close-to-nature structure and multi-functionality.

The courses provide a wide range of knowledge of the ecology of forest ecosystems and their management, which includes technical as well as social aspects.

Forests cover 60 % of the entire territory of Slovenia and the importance of forests for their environmental, production, and social effects is on the increase. Consequently, studying the Management of Forest Ecosystems offers a unique challenge; successful management requires overall familiarity with forest ecosystems and their components on various spatial levels – composition, landscape, and regional level – as well as knowledge of adapted management and technological procedures.

The doctoral study programme qualifies the candidates to solve development problems and to carry out independent scientific, development, pedagogic, and highly professional tasks in the field of forestry and renewable forest resources. Upon the completion of the programme, they are granted the title of Doctor of Science in the field of Management of Forest Ecosystems.

Prof. Dr. Klemen Jerina
Coordinator for Management of Forest Ecosystems

5.15 PROTECTION OF THE NATURAL HERITAGE

The framework of the Protection of the Natural Heritage is fairly broad, ranging from geomorphology and biology to social sciences applied to nature conservation. The focus is on rapid assessment and monitoring methods for estimating the conservation status of plant and animal species, ecosystems, as well as natural features, and the application of legal and management measures in and outside protected areas. Special emphasise is in communication skills and in management of the participation process with various stakeholders as a key issue for successfully achieving nature conservation goals.

The broader concept sets the scene for many possibilities for specialisation in a particular applicative work, which is organised on an individual level.

There are active connections with other similar study programmes in Europe.

Assist. Prof. Dr. Mojca Nastran
Coordinator for Protection of the Natural Heritage

5.16 ANIMAL SCIENCE

The doctoral study programme in the field of Animal Science is intended to qualify a wide circle of experts for research, development, and pedagogic work in the fields of quantitative genetics, selection, ethology, and technology of breeding animals. Knowledge of the impact of breeding animals on the environment and quality of animal products is also included.

The field of selection deals with questions of obtaining information for the genetic assessment of animals in increase, experiments or laboratories. It includes knowledge from the field of information technology, which we use in obtaining, communicating, storing and processing data in data collections. Contents for forecasting genetic values, both from phenotypic and genetic information, determining bio-economic theses, procedures of selection and monitoring the effects of individual measures on a population, are emphasized. The field also covers knowledge of monitoring and directing small populations, which are met both with local populations as well as in specialised nuclei.

The field of ethology is based on familiarity with the body language of animals, since these signs enable us to recognise how the animals feel and interpret changes in the state of health of individual animals or groups. Physiological research is also often connected with observation in order better to understand the responses of animals and to make use of them in overcoming deficiencies in various environments and systems of breeding. The aim of such research is increasingly connected with monitoring the effects of elements of well-being on the increase of animals.

The technology of breeding animals has greatly changed recently because of changes to the environment, awareness of the negative influences of breeding animals in the environment, stricter ethological standards, and greater market and economic pressures. With the increased use of domestic sources in animal care, we reduce the negative impact on the environment. On the other hand, this demands deviation from general recipes in breeding animals and the development of friendly technologies adapted to the environment. It is necessary to adapt to natural, social and market conditions, and solutions must guarantee sustainable development. The research in this field is therefore often interdisciplinary.

In all fields, the development of basic knowledge and its transfer into practice are emphasized. Both in studies and in individual research work, we strive for international cooperation and cooperation with users. There are possibilities of employment of graduates in educational institutions, public services, animal breeding research, development, and professional institutes, specialised advisory services and development departments of agricultural, food, and pharmaceutical companies.

Prof. Dr. Milena Kovač
Coordinator of Animal Sciences

5.17 CELL SCIENCES

Cell Sciences are based on cell biology, which is an explicitly dynamic, integrative field of science the aim of which is to recognise the structure and functions of eukaryotic cells in normal and diseased states. The subject of research is individual cells in cell culture and cells as part of tissue and organs. The scientific field of Cell Sciences is planned so that it communicates knowledge of the dynamic nature of cell structures in connection with secretion, division, differentiation and cell death, mainly concerning the distribution of the endomembrane system, organisation of the cytoskeleten of intercellular communication and physiological renewal of tissue. Sections from the fields of molecular cell and systemic physiology enable understanding of strategies for transforming the functioning of cells with engineering approaches and biotechnical methods. The program includes sections on the functioning of selected toxins and the dynamics of metals in regulatory cell processes and the functioning of affected cells.

The interdisciplinary scientific field of Cell Sciences has been planned by higher education teachers in cooperation with chairs and laboratories of the Biology Department UL, the Biotechnical Faculty, Institute of Pathophysiology of the Medical Faculty UL, Institute of Cell Biology of the Medical Faculty UL, National Institute of Biology, Biomedical Scientific Centre of Cells and the Jožef Stefan Institute.

The program provides excellent research opportunities and an interdisciplinary approach to the field of Cell Sciences. It is intended for students who wish to obtain theoretical and methodological knowledge in the field of cell biology, molecular physiology and the biology of membranes and toxins.

Assist. Prof. Dr. Nada Žnidaršič
Coordinator of Cell Sciences

5.18 FOOD SCIENCE

The doctoral study programme in the field of Food Science enables acquisition of new knowledge in the interdisciplinary field of food science. The interdisciplinary approach is intended to motivate the inclusion of graduates of Food Science, Nutrition, and many other complementary fields and encourage innovativeness of research for the transfer of knowledge and the development of contemporary trends in the production and supply chain of foods. Study is oriented to foods, technologies and processes that enable sustainable development, rational energy use, water, raw materials and thus preserving the environment and, at the same time, satisfy modern human food requirements. The consumer, who is aware of the importance of food for their health and quality of life, demands the development of safe, nutritious, tasty and in all aspects attractive and also the most long-lasting foods. These can derive from tradition (e.g., regional foods) or modern (bio)technologies (e.g., GMOs). Development challenges already commence at the beginning of the chain – e.g. in the cultivation of agricultural raw materials or breeding livestock, with the development and control of production- processing processes, with the introduction of new methods of checking quality and traceability in the agro-food chain, with better understanding of the causes and consequences of pathogens and toxic factors as a result of man's interventions or natural processes (e.g., the presence of chemical contaminants, increased allergenic properties of food components or the resistance and virulence of pathogenic organisms). Development, and thus also study, includes models for ensuring greater quality and safety in the cultivation, processing and distribution of foods, with the involvement of all links, including the consumer. This remains the critical point of the whole chain, since s/he must be educated, and innovative food products must be offered so that s/he recognises and buys them. All the mentioned fields will be a challenge for the doctoral students of food science in their studies and scientific research work.

Prof. Dr. Sonja Smole Možina
Coordinator for Food Sciences

6 STUDY CONDITIONS

6.1 CONDITIONS FOR ENROLMENT AND CRITERIA FOR THE SELECTION OF CANDIDATES

6.1.1 CONDITIONS FOR ENROLMENT

Graduates of the following study programmes may enrol in the Interdisciplinary Doctoral Study Programme of Biosciences:

- Second cycle study programmes;
- Study programmes which qualify students for professions regulated by European Union directives (physicians, veterinary surgeons, dentists and pharmacists) and which are evaluated with at least 300 credit points;
- Study programmes for gaining specialisations who, prior to this, have completed higher professional programmes. Additional study requirements for individual fields amounting to 30 to 60 credit points may be specified for candidates by the competent commission. Candidates must complete the requirements prior to enrolment;
- Study programmes for obtaining a Master of Science degree or specialisation after completion of a study programme for obtaining a university qualification. Candidates will be assigned study requirements to an extent of 60 credit points. Study requirements will be determined by the competent commission in agreement with the supervisor;
- Study programmes for obtaining a university qualification;
- Graduates of other domestic or foreign universities in compliance with the prescribed conditions that apply for students of RS.

Equivalence of previously obtained education abroad shall be established in a procedure of recognition of foreign qualifications for further education in compliance with the Statute of the University of Ljubljana. More information about the procedure can be found at: http://www.uni-lj.si/study/useful_information/recognition_of_foreign_education/

6.1.2 CRITERIA FOR SELECTION FOR LIMITED ENROLMENT

1. Success in higher education studies to date

The average grade of studies (without the diploma grade) is scored:
Average success is scored linearly, by the formula: **4 x grade – 20**.

Calculation of average grade:

The average grade of previous higher education studies of students who have completed university education, in which they enrolled before 11 June 2004, or 1st and 2nd cycles of study or a single study program or specialization after completion of higher professional studies, is calculated by weighting, namely such that the average grade of each cycle of study is weighted by the number of years of study in a particular cycle, summed for all completed cycles together and divided by the total number of years of study.

2. Research or professional work, awards

a) A scientific article, monograph or patent accepted into procedure in RS (Cobiss type 1.01 –, 1.02, 1.03, 1.16, 2.01, 2.18) – up to 5 points (first authorship 5 points, co-authorship 2 points)

b) Active participation at a scientific conference (Cobiss type 1.06, 1.08, 1.10, 1.12) – 2 points

c) Professional article in the field of study (Cobiss type 1.04) – 2 points

d) Awards connected with study; on the university level (5 points); on the level of a member, or other award (2 points)

The maximum number of points that a student can obtain is 40. If the composite score according to the above criteria exceeds 40 points, the student shall receive a maximum of 40 points. In the event of restricted enrolment, candidates with a higher total number of points will be selected.

If there are a number of students at the lower boundary with the same number of points, they will be invited for an interview and candidates will be selected from among them.

The decision on the acceptance of candidates shall be made by the Program Council of Biosciences.

6.2 RECOGNISING KNOWLEDGE AND SKILLS OBTAINED PRIOR TO ADMISSION TO THE PROGRAMME

Knowledge and skills obtained through formal, informal and experience learning prior to admission to the programme will be recognised during selection with limited admission in accordance with the Criteria for Accreditation of Study Programmes. The programme council will decide on recognition of knowledge and skills obtained by a candidate prior to admission to the programme on the basis of a written request from the candidate and submitted evidence (certificates and other documents) which show successfully obtained knowledge and the content of such knowledge. If there is no limited admission in an individual study year, the extent and content of such knowledge and skills will be evaluated by the ECTS and may, on the basis of the judgement of the programme council, replace one or a part of a subject selected in doctoral studies in Biosciences amounting to 5 credit points.

In recognising such knowledge and skills, the following will be taken into account:

- Professional specialisation;
- Other diploma from a higher education institution which is thematically linked to the field of doctoral study;
- Published scientific work, patents, etc.;
- Professional further training which is possible to evaluate in terms of credits.

6.3 CONDITIONS FOR ADVANCEMENT THROUGH THE PROGRAMME

The condition for advancement from the 1st to the 2nd year of doctoral studies in Biosciences is the completion of requirements to the extent of at least 45 credit points.

The condition for advancement from the 2nd to the 3rd year is completion of all obligations from the 1st and 2nd years of study, in which are included:

- All exams passed from the 1st and 2nd years of doctoral studies;
- Individual research work completed to a total extent of 70 ECTS;
- the confirmation of the positive assessment of the proposed doctoral dissertation theme and topic by their Committee for the follow-up of a doctoral student from the senate of the Faculty which coordinates the scientific field the doctoral student is enrolled in.

The condition for advancement from the 3rd to the 4th year is completion of all obligations from the first three years of study and obtained the approval of the proposed doctoral dissertation topic by the University Senate.

The final, 4th year, is devoted to individual research work and the preparation and defence of a doctoral dissertation.

In the event of a student, for justifiable reasons, not completing the study requirements, s/he must present a request to the programme council for the holding over of status. The request must be accompanied by documentary evidence of the reasons for student status to be held over.

6.4 THE CONDITIONS OF YEAR REPETITION

The student can repeat a year once in the course of the programme.

The repetition of the final, fourth year, is not possible.

A student must gain at least 10 credits points to be able to repeat the first year of the doctoral study programme Biosciences. This amount does not include the points gained for individual research work and/or a presentation of the doctoral thesis topic.

To qualify for the repetition of the second year, a student must gather at least 25 credit points. This amount does not include the points gained for individual research work and/or a presentation of the doctoral thesis topic.

The requirement for repeating the third year is completion of all study obligations of the first and second year of study.

6.5 CHANGING SCIENTIFIC FIELD OF STUDY

Students can change the selected scientific field of study up until the moment they file the application for the approval of the doctoral thesis topic. Any such requests are decided on by the Bioscience program council.

6.6 CONDITIONS FOR COMPLETION OF STUDY

The condition for completion and obtaining the scientific title of doctor of science is that the candidate successfully completes all study requirements specified in the programme, is enrolled in all

four years of doctoral study, and successfully defends a doctoral dissertation. According to the Statute of the University of Ljubljana, a student also has the right to a faster advancement or preliminary completion of study.

A doctoral student is required to publish at least one scientific article from the field of the doctorate in an internationally recognised journal on the SCI index, or exceptionally SSCI index or AHCI and has an impact factor. A doctoral student must be the first author of the article. The scientific article must be published or accepted for publication before the candidate hands in the doctoral dissertation for assessment.

6.7 OBTAINING THE SCIENTIFIC TITLE

The interdisciplinary doctoral study program in Biosciences enables a student to obtain the scientific title of doctor of science, with the scientific field cited on the doctoral diploma.

6.8 TRANSFER BETWEEN STUDY PROGRAMMES

Transfer between study programmes shall be considered to be cessation of student education in the study programme in which the student was enrolled and continuation of education in the interdisciplinary doctoral programme in Biosciences. Requests from candidates for transfer to the doctoral studies in Biosciences will be dealt with individually by the programme council in compliance with the Statute UL.

Transfer between various study programmes for obtaining the same level of education is possible if at least half of the requirements for enrolment in the new study programme, which the candidate performed in the first study programme, can be recognised.

The interdisciplinary doctoral study programme in Biosciences is planned in such a way that it enables domestic and international exchange on all levels of implementation of the programme, from research and experimental work to the exchange of subjects with comparable programmes of other universities on the basis of international contracts and bilateral agreements. International exchange is also possible through the cooperation of visiting professors to member providers of studies and cooperation in programmes of mobility for students. The programme is also open to foreign students. Cooperation with other higher education and research institutions abroad takes place within the framework of scientific research projects, through the cooperation of foreign professors in individual subject (co)mentorship and cooperation in assessment and defences of doctoral dissertations.

Providers of the programme cooperate with numerous foreign universities with which they have concluded agreements on cooperation. The programme council decides on the comparability of the quality of programme subjects of other universities. International exchange takes place on the basis of international projects and agreements signed by the University of Ljubljana and its members.

6.9 IMPLEMENTATION OF THE STUDY PROGRAMME

The interdisciplinary doctoral study programme Biosciences is implemented as a part-time study.

7 TUITION FEE

The tuition fee is paid for each year separately, i.e. for each year a student enters for the first time. The cost of the fee is determined by the price list of the University of Ljubljana for each year separately. The price list can be found on the official page of the University: http://www.uni-lj.si/study/price_list/

8 SUPERVISING

The candidates must choose a supervisor before they enrol in the 1st year of the doctoral study programme.

The supervisor assists the candidate in preparing a study plan, submitting the thesis topic and writing the doctoral thesis. The supervisor (co-supervisor, if suggested) is ultimately determined in the process of confirmation of the doctoral thesis topic.

The supervisor (co-supervisor) for the elaboration of the doctoral dissertation may be a person who holds the title of teacher in higher education or scientific associate and has proven research activity with suitable scientific bibliography in the field of the theme of the doctoral dissertation. The minimum condition for proven research activity of a (co)supervisor is a bibliography of the last five years that achieves 150 points according to SICRISS and A1/2 higher then 0 points. With research bound to laboratory work, the supervisor must guarantee the availability of research capacities or research infrastructure.

A supervisor (co-supervisor) may be a foreign expert with a title that can be compared with Slovene teaching or scientific titles.

The supervisor of a doctoral candidate must be employed at the University of Ljubljana (UL). If a supervisor is, exceptionally, from another institution (foreign or domestic), a co-supervisor from the UL must be appointed and a suitable explanation of this provided.

A supervisor (co-supervisor) may also be a person with suitable habilitation from another institution (domestic or foreign), if he/she is cooperating in a doctoral programme being (co)provided by the UL, or if he/she is employed at an institution (domestic or foreign) with which the UL has concluded a suitable agreement or contract on cooperation.

A supervisor may have a maximum of six doctoral candidates in doctoral studies, who are enrolled in the doctoral programme and regularly progress in them. Doctoral candidates who have performed all obligations of the doctoral study programme except defending the doctoral dissertation, and from the start of the year of the doctoral study programme more than four years have already passed, shall not be counted in this number. This limitation shall not apply to co-supervisors.

The list of potential supervisors is published on the webpage of the doctoral study programme Biosciences: www.bioznanosti.si.

9 STRUCTURE OF THE STUDY PROGRAMME

The study programme consists of organised learning (lectures, practicals, presentations of themes of doctoral dissertations etc.) amounting to 60 credit points (ECTS), while the remaining 180 points are devoted to individual research work for the doctoral dissertation.

The programme consists of two types of elective subjects:

1. Theoretical subjects (5 or 10 ECTS)
2. Individual research subjects (5 or 10 ECTS)

A doctoral student, together with the supervisor, chooses subjects from the selection of all the subject included in the programme. The study plan is approved by the coordinator of the scientific field of study the doctoral student is enrolled into. The choice of other subjects is possible from among all other elective subjects and from the syllabuses of other comparable programmes of domestic and foreign universities that have programmes evaluated by the ECTS or other systems that enable assessment of comparability. In the 1st and the 2nd year, the students can select courses from other programmes amounting to up to 15 ECTS. A doctoral student chooses subjects in relation to the research field of the doctoral dissertation.

9.1 CONTENT STRUCTURE OF THE PROGRAMME

First year:

- Elective subjects (choice possible among the chosen or another scientific field) – 30 ECTS
- Individual research work (30 ECTS)

Total 60 ECTS

The doctoral student chooses 30 ECTS from subjects in the following manner:

The subjects are chosen in accordance with the supervisor based on the candidate's research area. The study plan is confirmed by the coordinator of the selected scientific field of study.

Doctoral students may already attend presentations of the themes of doctoral dissertations of other doctorands in their first year of study. Participation in at least three presentations is a prerequisite for applying for a doctoral dissertation theme in the second year of study.

Second year:

- Elective subjects (15 ECTS)
- Successful presentation of theme of doctoral dissertation (5 ECTS)
- Individual research work (40 ECTS)

Total 60 ECTS

In the second year, a doctoral student chooses elective subjects to a total extent of 15 ECTS: subjects shall be chosen in agreement with the supervisor and in relation to the field of the research work. The study plan is confirmed by the coordinator of the selected scientific field of study.

A doctoral student hands in an application for approval of the theme and title of a doctoral thesis by the start of the summer semester in the second year of study the member institution holding

the programme and being responsible for the coordination of the scientific field of study the candidate is enrolled in (see chapter 1).

By the time of submission of the application for approval of the theme and title of their doctoral dissertation, a doctoral student must have attended the presentation of at least three themes of doctoral dissertations of other doctorands. At the time of submission of his application, she or he shall attach evidence (form) by which she or he proves participation in the presentations of themes.

Third year:

- Individual research work (60 ECTS)

Total 60 ECTS

The content of the 3rd year shall relate to research work and preparation of scientific article.

Fourth year:

- Individual research work (50 ECTS)
- Successful presentation of doctoral dissertation prior to defence (5 ECTS)
- Preparation of a doctoral dissertation and public defence (5 ECTS)

Total 60 ECTS

The content of the 4th year shall relate to research work and preparation and defence of the doctoral dissertation.

9.1.1 ENSURING MOBILITY

Doctoral students may, during the 1st and 2nd years, with the agreement of supervisors and coordinators of the field, select a total of 15 ECTS elective content from other programmes of UL, comparable programmes of other Slovene or foreign universities and from subjects for which the University of Ljubljana will invite applications and which will enable the candidate to gain special knowledge and generic skills. Participation in international competitions and summer schools which have a program of credit points and which conclude with a test of knowledge, is also encouraged. Exceptionally, a doctoral student may, with the agreement of the supervisor and field coordinator, also choose more contents from other study programmes.

Students may ask for a recognition of an exam they intend to pass abroad or in the frame of international student exchange programmes in the following manner:

1. A doctoral student studying abroad in the frame of international student exchange programmes (Erasmus+, CEEPUS, NFM...) is required write a formal request in cooperation with their supervisor **before they travel abroad**. In the request, the student explains which of the subjects offered abroad would they like to exchange for the subjects from the selection of "Interdisciplinary Doctoral Study Programme in Biosciences". The request contains an application for "Learning agreement for studies" and must be co-signed by the student's supervisor. The request and the form must be sent to the Student Office for the 3rd Bologna Cycle of the Biotechnical Faculty, which confirms the reception and sends them to the coordinator of the field of study the student is enrolled in.

2. The coordinator of the scientific field reviews the request and the application form "Learning agreement for studies" and informs the Programme Council of their approval/denial of the request.
3. After the request has been positively reviewed by the Programme Council, the coordinator of the scientific field signs the student's "Learning agreement for studies". The student sends the copy of the signed and stamped application form to the Office for Research Activity and International Cooperation of the Biotechnical Faculty.
4. The signed form "Learning agreement for studies" ensures that the selected courses the student will successfully complete in the frame of international exchange programmes will also be recognized by the Biosciences study programme.
5. Upon the completion of the study obligations at a foreign university, the student must receive an official document confirming a successful conclusion of qualifications, i.e. Transcript of records (e.g. on a successfully passed exam), which should include a numbered grade (in %). The supervisor suggests the numbered grade in accordance with the grading norms and the Statute of the University of Ljubljana, which is entered in the student's index. The copy of Transcript of records, the copy of the recognition of successfully passed exams and the copy of the certificate on the successful exchange must be sent to the Office for Research Activity and International Cooperation of the Biotechnical Faculty.

If the student files the requests shortly after the last regular session of the Programme Council of Biosciences but needs confirmation before the next regular session, their request is discussed at a correspondence session of the Council (between two regular sessions).

The coordinators of the scientific fields covered by Biosciences are also the coordinators for the 3rd cycle exchange students who come to Slovenia and select subjects from the Interdisciplinary Study Programme in Biosciences.

9.2 SUBJECT STRUCTURE OF THE PROGRAMME

9.2.1 MODES AND METHODS OF IMPLEMENTATION OF THE STUDY PROGRAMME

The doctoral study programme is organized and implemented according to the credit system principle. The study comprises lectures, seminars, consultations, individual learning and active participation in research processes. If there are less than 5 students registered for a course, the course is carried out as consultations. A student discusses the arrangement of consultations with the professor responsible for the course. When 5 or more than 5 students are registered for the course, lectures are organized, the timetables of lectures are published on the website: www.bioznanosti.si.

9.2.2 THE LIST OF SUBJECTS

Scientific fields each contain a number of elective subjects. Doctoral students can choose from

among **theoretical** and **individual research** subjects. Each scientific field contains a theoretical subject amounting to 10 ECTS. The contents of subjects are chosen on the basis of the research work of the persons responsible and providers of the subjects, who, for individual teaching plans, are represented by six scientific articles in the field covered by the subject.

Study plans of the subjects are published on the website: www.bioznanosti.si. Individual research subjects are carried out in the laboratories of departments and institutes, clinics and other research units of course lecturers.

List of theoretical elective subjects

NUMBER	COURSE TITLE	LECTURERS	ECTS
	AGRONOMY		
01-1-01	**Analysis of Organic and Inorganic Polutants in Ecosystems**	*Veber Marjan*	5
01-1-02	**Biometeorological Modeling**	*Kajfež-Bogataj Lučka* *Črepinšek Zalika*	5
01-1-03	**Biotic Interactions in Agroecosystems and Plant Protection**	*Trdan Stanislav* *Celar Aco Franci* *Dermastia Marina*	10
01-1-04	**Determination of Plant Pests and Diseases**	*Trdan Stanislav* *Ravnikar Maja*	5
01-1-05	**Functional Plant Ecology and Environmental Changes**	*Batič Franc* *Jeran Zvonka*	5
01-1-06	**Soil Health and Functioning**	*Leštan Domen* *Grčman Helena*	10
01-1-07	**Interactions Between Genotypes and Environment in the Agricultural Plants**	*Luthar Zlata* *Rozman Ludvik*	5
01-1-08	**Information Searching and Paper Writing**	*Bartol Tomaž*	5
01-1-09	**Measurement of Physical, Chemical and Biological Properies of Soil**	*Leštan Domen* *Zupanc Vesna*	10
01-1-10	**Methods in Plant Ecophysiology and Ecology of Terrestrial Ecosystems**	*Vodnik Dominik* *Eler Klemen* *Šircelj Helena*	10
01-1-11	**Microbial Ecology of Agroecosystems**	*Stopar David* *Maček Irena*	5
01-1-12	**Pesticide Risk Assessment and Management**	*Suhadolc Marjetka*	5
01-1-13	**Climate Change**	*Kajfež-Bogataj Lučka*	5
01-1-14	**Statistical Methods for Data Analysis**	*Košmelj Katarina* *Kastelec Damijana*	5
01-1-15	**Water as a Natural Resource for Agriculture**	*Pintar Marina*	5
	AGRIFOOD MICROBIOLOGY		
02-1-01	**Biofilms**	*Stopar David* *Mandić Mulec Ines* *Smole Možina Sonja*	5
02-1-02	**Dynamics of Microbial Genomes in Agro-Food Systems**	*Starčič Erjavec Marjanca* *Žgur-Bertok Darja*	5
02-1-03	**Microbiology of Food**	*Smole Možina Sonja* *Rupnik Maja*	5
02-1-04	**Microbial Products and Energy from Agro-Food Waste**	*Marinšek Logar Romana* *Vodovnik Maša*	10
	BIOINFORMATICS		
03-1-01	**Bioinformatics Tools and Databases**	*Jakše Jernej* *Jerala Roman* *Kunej Tanja* *Petrovič Uroš*	10
03-1-02	**Introduction to data science**	*Zupan Blaž* *Demšar Janez*	5
03-1-03	**Topics in Biology for Non-Biologists**	*Dermastia Marina* *Turk Tom*	5
03-1-04	**Computational Biology**	*Mraz Miha* *Belič Aleš* *Moškon Miha*	5
03-1-05	**Image Acquisition and Computer-Assisted Analysis**	*Pernuš Franjo* *Likar Boštjan*	5
	BIOINGENEERING IN HEALTH SCIENCES		
04-1-01	**Biocompatible Materials**	*Jenko Monika*	5

Interdisciplinary Doctoral Programme of **BIOSCIENCES**

04-1-02	**Biomechanics and Biophysics in Health Sciences**	*Kralj-Iglič Veronika* *Iglič Aleš* *Veranič Peter* *Bohinc Klemen*	10
04-1-03	**Ecological Engineering**	*Griessler- Bulc Tjaša*	5
04-1-04	**Disinfection Materials in Health Sciences**	*Trebše Polonca*	5
04-1-05	**Microfluidic Devices in Bioengineering**	*Žnidaršič Plazl Polona*	5
04-1-06	**Public health aspects of surfaces hygiene**	*Fink Rok* *Jevšnik Mojca* *Oder Martina* *Ovca Andrej*	5
04-1-07	**Oxidative stress and methods for its detection**	*Poljšak Borut* *Jamnik Polona* *Milisav Irina*	5

BIOLOGY

05-1-01	**Biological Education**	*Tomažič Iztok*	5
05-1-02	**Ecology**	*Gaberščik Alenka* *Čarni Andraž* *Debeljak Marko* *Germ Mateja* *Kos Ivan* *Likar Matevž* *Skrbinšek Tomaž* *Urbanič Gorazd* *Vrezec Al*	10
05-1-03	**Physiology and Morphology – An Integrative Approach**	*Kreft Marko* *Regvar Marjana* *Štrus Jasna* *Bulog Boris* *Drobne Damjana* *Zidar Primož* *Čokl Andrej* *Virant-Doberlet Meta* *Glavan Gordana* *Gruden Kristina* *Vogel-Mikuš Katarina* *Golja Petra*	10

05-1-04	**Geographic Information Systems as a Research Tool for Biology and Nature Conservation**	*Zagmajster Maja* *Skrbinšek Tomaž*	5
05-1-05	**Protein-Nucleic Acid Interaction**	*Butala Matej* *Kostanjšek Rok*	5
05-1-06	**Molecular and Systems Biolology**	*Gunde-Cimerman Nina* *Sepčič Kristina* *Gruden Kristina* *Bavec Aljoša* *Rogelj Boris* *Gostinčar Cene* *Glavač Damjan* *Poklar-Ulrih Nataša* *Dermastia Marina* *Serša Gregor* *Čemažar Maja*	10
05-1-07	**Systematic and Evolutionary Biology**	*Trontelj Peter* *Fišer Cene* *Frajman Božo* *Gunde-Cimerman Nina* *Kuntner Matjaž* *Prevorčnik Simona*	10
05-1-08	**Statistical Analysis of Biological Data**	*Blejec Andrej*	5

BIOTECHNOLOGY

06-1-01	**Animal Biotechnology**	*Dovč Peter* *Narat Mojca* *Kunej Tanja* *Horvat Simon* *Gorjanc Gregor*	10
06-1-02	**Biodiagnostics and Biosensors**	*Kos Janko*	5
06-1-03	**Bioprocess Engineering of Biologic Macromolecules, Viruses and Cells**	*Podgornik Aleš* *Žnidaršič Plazl Polona* *Plazl Igor*	5
06-1-04	**Bioreaction Engineering**	*Plazl Igor*	5
06-1-05	**Fungal Pre-Treatment of Lignocelulosic Substates**	*Humar Miha*	5
06-1-06	**Host-Pathogen Interactions**	*Narat Mojca* *Dovč Peter*	5

06-1-07	**Microbial Biotechnology**	*Petković Hrvoje* *Benčina Mojca*	10
06-1-09	**Planning of Research Activities, Reporting and Project Proposals**	*Bohanec Borut*	5
06-1-10	**Natural Medicines from Fungi, Plants and Animals**	*Sepčić Kristina* *Gregori Andrej* *Štrukelj Borut* *Kreft Samo*	5
06-1-11	**Next Generation of Molecular Markers**	*Štajner Nataša* *Jakše Jernej*	5
06-1-12	**Plant Biotechnology**	*Štajner Nataša* *Bohanec Borut* *Žel Jana* *Ravnikar Maja*	10
06-1-13	**Modern Biological Medicines**	*Štrukelj Borut*	5
06-1-14	**Modern Biotechnological Methods**	*Križaj Igor* *Komel Radovan*	5
06-1-15	**Modern Methods for Optimization of Commercial Microorganisms**	*Legiša Matic*	5

EKONOMICS OF NATURAL RESOURCES

07-1-01	**Bioeconomy, Innovation and Management of Systems in Life Sciences**	*Juvančič Luka*	5
07-1-02	**Economic and Sociological Aspects of Rural Development**	*Udovč Andrej* *Černič Istenič Majda*	5
07-1-03	**Mathematical Models and Operations Research in Biosciences**	*Zadnik Stirn Lidija*	5
07-1-04	**Methodology of Economic and Social Sciences in Biosciences**	*Erjavec Emil*	10
07-1-05	**Multivariate Statistical Methods**	*Košmelj Katarina* *Kastelec Damijana*	5
07-1-06	**Consumer Behaviour and Marketing Strategies in Biosciences**	*Oblak Leon* *Dmitrović Tanja*	5

HORTICULTURE

08-1-01	**Horticulture**	*Štampar Franci* *Lešnik Mario*	10
08-1-02	**Selected Topics of Vegetable Production**	*Kacjan Maršić Nina*	5
08-1-03	**Selected Topics in Viticulture and Nursery**	*Rusjan Denis*	5

08-1-04	**Extraction and Analitical Methods of Plants Secondary Metabolites**	*Veberič Robert* *Mikulič Petkovšek Maja*	5
08-1-05	**Specific Topics in Ornamental Plants**	*Osterc Gregor*	5
08-1-06	**Primary and Secondary Metabolism of Horticultural Plants**	*Veberič Robert* *Mikulič Petkovšek Maja*	10
08-1-07	**Sustainable Technological Measures in Fruit Production**	*Štampar Franci*	5

LANDSCAPE ARCHITECTURE

09-1-01	**Selected Chapters from the Theory of Design**	*Kučan Ana*	10
09-1-02	**Strategic Planning and Policy Analysis**	*Golobič Mojca*	10

WOOD AND BIOCOMPOSITES

10-1-01	**Wood and Lignocellulosic Materials for Building Applications**	*Humar Miha* *Petrič Marko* *Medved Sergej*	10
10-1-02	**Wood, Bark and Climate**	*Čufar Katarina* *Gričar Jožica* *Kajfež-Bogataj Lučka*	5
10-1-03	**High Value Added Compounds from Woody Biomass**	*Oven Primož* *Likozar Blaž* *Poljanšek Ida*	5
10-1-04	**Mycoremediation**	*Pohleven Franc*	5
10-1-05	**Development and Lca Analysis of New Product in Wood Industry**	*Oblak Leon* *Kitek Kuzman Manja*	5
10-1-06	**Rheology and Curing Kinetics of Wood Adhesives**	*Šernek Milan*	5

NANOSCIENCES

11-1-01	**Biophysics of Membranes and Biological Nanostructures**	*Kralj-Iglič Veronika* *Iglič Aleš*	10
11-1-02	**Colloids**	*Kogej Ksenija*	5
11-1-03	**Micro/Nano Technologies and Structures**	*Amon Slavko*	5
11-1-04	**Nanotechnology and Bio-Nano Interactions**	*Drobne Damjana* *Kralj-Iglič Veronika* *Kogej Ksenija* *Kristl Julijana* *Remškar Maja* *Jemec Kokalj Anita*	10

NUTRITION

12-1-01	**Molecular Biology Methods in Nutrition and Food Science**	*Jamnik Polona* *Smole Možina Sonja* *Žel Jana* *Klančnik Anja*	5
12-1-02	**Clinical nutrition**	*Benedik Evgen*	5
12-1-03	**Nutrition**	*Salobir Janez* *Rogelj Irena* *Filder Mis Nataša*	10
12-1-04	**Nutrition of Ruminants and Non-Ruminants**	*Salobir Janez* *Verbič Jože*	5
12-1-05	**Nutritional Biochemistry**	*Poklar Ulrih Nataša* *Battelino Tadej*	10
12-1-06	**Probiotics**	*Rogelj Irena*	5

TECHNICAL SYSTEMS IN BIOTECHNIQUES

13-1-01	**Bioprocess Techniques**	*Golobič Iztok*	5
13-1-02	**Product Innovation**	*Žavbi Roman*	5
13-1-03	**Safety Criteria**	*Jerman Boris*	5
13-1-04	**Measurement in Agriculture**	*Kutin Jože*	5
13-1-05	**Processes and Mechanisation**	*Tavčar Jože*	10
13-1-06	**Technical Information Systems**	*Tavčar Jože*	5
13-1-07	**Technologies in Meat Production and Processing**	*Demšar Lea*	5

MANAGEMENT OF FOREST ECOSYSTEMS

14-1-01	**Dendroecology, Growth and Structure Characteristics of Forest Stands**	*Levanič Tomislav* *Klopčič Matija*	5
14-1-02	**Dendrology and Forest Genetic Resources**	*Brus Robert*	5
14-1-03	**Physiology of Forest Trees and Interactions in Forest Soils**	*Kraigher Hojka*	5
14-1-04	**Forest Techniques and Forest Work**	*Potočnik Igor* *Krč Janez*	5
14-1-05	**Methods of Ecological Modelling**	*Debeljak Marko*	5

14-1-06	**Research in Forest Phytosociology and Silviculture**	*Diaci Jurij* *Rozman Andrej* *Roženbergar Dušan*	10
14-1-07	**Research on Forest Mycology: Significance and Application of Fungi**	*Jurc Dušan*	5
14-1-08	**Research Methods Used in Wildlife Ecology and Management**	*Jerina Klemen*	5
14-1-09	**Forest Ecosystem Management**	*Bončina Andrej* *Jerina Klemen* *Mikoš Matjaž* *Ficko Andrej*	10
14-1-10	**Forest Protection**	*Jurc Maja*	5

PROTECTION OF NATURAL HERITAGE

15-1-01	**Applied Methods in Protection of Natural Heritage**	*Nagel Andrew Thomas*	10
15-1-02	**Conservation of Local Elements of Natural Heritage Within Wider European Context**	*Kos Ivan*	5

ANIMAL SCIENCE

16-1-01	**Anthrozoology**	*Zupan Manja*	5
16-1-02	**Advanced Animal Husbandy**	*Terčič Dušan*	5
16-1-03	**Quantitative and Statistical Genetics**	*Kovač Milena*	10
16-1-04	**Assessment of Animal Welfare**	*Jordan Dušanka*	5
16-1-05	**Animal Production Systems**	*Simčič Mojca*	10

CELL SCIENCES

17-1-01	**Biological Signal Analysis**	*Kreft Marko* *Belušič Gregor*	5
17-1-02	**Dynamics of Cell Architecture**	*Štrus Jasna* *Žnidaršič Nada* *Erdani Kreft Mateja* *Romih Rok* *Miloš Vittori*	10
17-1-03	**Correlative Microscopy**	*Erdani Kreft Mateja*	5
17-1-04	**Methods in Live Cell Imaging**	*Veranič Peter*	5

17-1-05	**Microscopy and Image Analysis of Biological Samples** *Simultaneous inscription with the subject 17-2-02 is not possible*	*Kostanjšek Rok* *Žnidaršič Nada* *Kreft Marko*	5
17-1-06	**Molecular Physiology**	*Zorec Robert* *Kreft Marko*	10
17-1-07	**Toxins and Biomembranes**	*Turk Tom* *Sepčić Kristina* *Križaj Igor* *Anderluh Gregor*	10

FOOD SCIENCE

18-1-01	**Physical-Biochemical Methods**	*Poklar Ulrih Nataša* *Anderluh Gregor* *Plavec Janez*	5
18-1-02	**Food Quality and Safety**	*Smole Možina Sonja* *Abramovič Helena* *Bertoncelj Jasna* *Jeršek Barbka* *Žel Jana*	10
18-1-03	**Interaction of Sensory and Instrumental Methods**	*Korošec Mojca* *Košmerl Tatjana*	5
18-1-04	**New Technologies in Food of Animal Origin**	*Demšar Lea* *Žlender Božidar* *Rogelj Irena*	5
18-1-05	**Contemporary Technologies of Plant Food**	*Hribar Janez* *Vidrih Rajko*	5

List of individual research elective subjects

NUMBER	COURSE TITLE	LECTURERS	ECTS
AGRONOMY			
01-2-01	**Research Work In the Field of Plant Protection**	Trdan Stanislav	10
AGRIFOOD MICROBIOLOGY			
02-2-01	**Methods In Microbiology In Agro-Food Industry**	Turk Martina Zalar Polona Gunde-Cimerman Nina Mandić Mulec Ines Smole Možina Sonja Marinšek-Logar Romana Klančnik Anja	5
02-2-02	**Sociomicrobiology**	*Mandić Mulec Ines* *Kraigher Barbara* *Gostinčar Cene*	10
BIOINFORMATICS			
03-2-01	**Bioinformatics Algorithms**	Curk Tomaž Zupan Blaž	5
BIOTECHNOLOGY			
06-2-01	**Immunological Experiments and Techniques**	Narat Mojca	5
06-2-02	**Global Analysis of Genome, Transcriptome and Proteome**	Jamnik Polona Jakše Jernej Štajner Nataša	5
WOOD AND BIOCOMPOSITES			
10-2-01	**Selected Methods for Characterisation of Wood and Lignocellulosic Composites**	Humar Miha	5
ANIMAL SCIENCE			
16-2-01	**The Quality of the Products of Animal Origin**	Klopčič Marija	5

CELL SCIENCES			
17-2-01	**Electrophysiology In Nanometer Scale**	Zorec Robert Kreft Marko Chowdhury H. Helena	5
17-2-02	**Microscopy and Image Analysis of Biological Samples – Project Work** *Simultaneous inscription with the subject 17-1-05 is not possible*	Kostanjšek Rok Žnidaršič Nada Kreft Marko	10
17-2-03	**Special Techniques of Electron Microscopy**	Romih Rok	5
17-2-04	**Live Cell Imaging – Practical Course**	Veranič Peter	10
FOOD SCIENCE			
18-2-01	**Antioxidants**	Abramovič Helena	5

9.3 METHODS OF ASSESSMENT

In accordance with the Statute UL, success in exams will be evaluated by grades from 1-10 whereby grades from 6 to 10 will be considered pass grades. There are no partial examinations in subjects. The grades consist of one number.

Examinations under the programme will be written or oral, or a grade may be obtained in entirety through seminar tasks or projects.

9.4 CHANGING / ABANDONING SELECTED COURSE

A student of the doctoral study programme Biosciences can apply for a change of the selected course only if they have not yet attended lectures or consultations. The request is confirmed or denied by the programme council of Biosciences and signed by the student, the supervisor, the coordinator of the course the student wishes to abandon and the coordinator of the course they wish to enrol into.

10 ORGANISATION AND IMPLEMENTATION OF INTERDISCIPLINARY DOCTORAL STUDIES IN BIOSCIENCES

10.1 RULES ON THE ORGANISATION OF STUDIES

Doctoral studies in Biosciences are regulated by the Regulation on doctoral studies by which is specified the manner and organisation of the implementation of a doctoral study programme.

- The University publishes a call for applications for admission to the doctoral study programme Biosciences. The call for applications must be in compliance with Statute of the University of Ljubljana.
- The Biotechnical Faculty collects applications from students for admission, and delivers them for review and confirmation by the Programme Council.
- Prior to admission, the student chooses a supervisor from the range of higher education teachers or scientific workers working in a field which is connected to the student's selected scientific field. Together they choose subjects and specify the scientific orientation of studies.
- At the time of enrolment in the 1st year of doctoral study, the student signs a contract on carrying out studies.
- The Biotechnical Faculty enrols all the accepted candidates. All the procedures tied to the acquisition of scientific titles are led by the coordinator of the scientific field.
- The Biotechnical Faculty organises and ensures the implementation of the doctoral programme in terms of keeping records in connection with studies and students, organising and ensuring the implementation of lectures and other study requirements for subjects (lecturers, premises, timetables, informing lecturers and students etc.).
- A written agreement is concluded for each student by which is determined which obligations (subjects) the student will undertake at another faculty, and when s/he will undertake them (coordination of obligations in terms of time is necessary). Evaluation of obligations (no. of credit points) and costs connected with the implementation of programmes at other faculties.
- Member lecturers, in cooperation with supervisors, ensure the undisturbed research work of the student.

- The procedure for registering themes for a doctoral dissertation is conducted by the Senate of the faculty that is coordinating the field in which the student is enrolled. The theme of the doctoral dissertation is confirmed by the Senate of the University of Ljubljana.
- On the proposal of the member faculty in which the candidate has successfully defended the doctoral dissertation, the Rector promotes the candidate to Doctor of Science.

10.2 AUTHORITIES AND DECISION-MAKING

10.2.1 COLLEGIUMS / COMMISSIONS FOR DOCTORAL STUDIES / FACULTY SENATES

All procedures for monitoring themes and titles of doctoral dissertations, appointing commissions in doctoral procedures, applications for resolving individual requests from candidates (e.g., change of subjects etc.) and conducting all other matters in connection with doctoral procedures shall be commenced by the responsible authorities commissioned by the faculties providing each of the fields of study. The coordinators of the scientific fields (see chapter 11) are members of these bodies (e.g. collegium of the field of study, commission for doctoral studies or faculty senate).

10.2.2 PROGRAMME COUNCIL

The Programme Council consists of the coordinators of the scientific fields, representatives of faculties and other institutions which have at least five lecturers in the programme and representative of doctoral students. The Programme Council is chaired by the President of the Programme Council, who has a deputy. The term of office of the president is four years and is renewable.

Competences of the Programme Council:

- It examines applications from candidates and decides which candidates will be admitted to the programme;
- It adopts supplementary programmes;
- It adopts the working plan of education in doctoral studies in Biosciences;
- It analyses the effectiveness of implementation and suggests measures for its improvement;
- It adopts rules on the organisation and financial business of doctoral studies in Biosciences for each year separately;
- Decides on individual student applications and requests (e.g. subject change, enrolment in another field of study);
- Ensures the connection and cooperation of research groups.

11 COORDINATORS OF SCIENTIFIC FIELDS

Competences and tasks of field coordinators:

- The coordinator cooperates with relevant services in the preparation of applications for co-financing of studies and, later, in fulfilling obligations from the contract on co-financing studies;
- S/he ensures coordination of the work of mentors and lecturers;
- S/he ensures timely replacement of absent teachers in the study process;
- S/he supervises the supplementing and up-dating of the study programme by making harmonised proposals to the senate of the parent faculty and then to the Programme Council;
- S/he takes part at sessions at which doctoral procedures are decided;
- S/he helps candidates in making contact with potential mentors;
- S/he cooperates in the preparation of individual subjects of candidates enrolled in the selected scientific field. S/he co-signs the syllabus;
- Takes part at the meetings of Programme Council.

The coordinators of the scientific fields covered by Biosciences are also the coordinators for the 3rd cycle exchange students who come to Slovenia and select subjects from the Interdisciplinary Study Programme in Biosciences.

List of coordinators and deputy coordinators

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12 ACQUISITION OF THE ACADEMIC TITLE DOCTOR OF SCIENCE

The procedure for registering the theme of a doctoral thesis is conducted by the faculty coordinating the field. The rules for obtaining the title of Doctor of Science are published on the website of faculties providing the programme (by alphabetical order):

http://www.bf.uni-lj.si

http://www.fe.uni-lj.si

http://www.fri.uni-lj.si

http://www.fs.uni-lj.si

13 ADDITIONAL INFORMATION ON THE STUDY PROGRAMME

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KEY FOR SUBJECTS NUMBERING

Subjects are coded with three numbers, the first of which represents the scientific field, the second the type of subject and the third the successive number of the subject.

Fields:

01	Agronomy
02	Agrifood Microbiology
03	Bioinformatics
04	Bioingeneering in Health Sciences
05	Biology
06	Biotechnology
07	Economics of Natural Resources
08	Horticulture
09	Landscape Architecture
10	Wood and Biocomposites
11	Nanosciences
12	Nutrition
13	Technical Systems in Biotechniques
14	Managing Forest Ecosystems
15	Protection of the Natural Heritage
16	Animal Science
17	Cell Sciences
18	Food Science

Type of elective subject:
1 – theoretical subjects
2 – individual research subjects

So, for example, a subject with code **01-1-05** is in the field of agronomy (01), is a theoretical subject (1), and its successive number within the field of agronomy is 5.

INTERDISCIPLINARY DOCTORAL PROGRAMME OF BIOSCIENCES

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