

Development Plan 2025

4.15 Faculty of Life Sciences

4.15.1 Objectives

The Faculty of Life Sciences encompasses the disciplines of biology, pharmacy and nutritional sciences.

The Faculty aims at acquiring a deep understanding of the principles of life and evolution. On the basis of this knowledge, it addresses the multifaceted challenges of the future, such as aspects of environmental change, nutrition and health of an ageing human population.

Living organisms are embedded in complex networks with other organisms in a continuously changing environment. The thorough understanding of the evolution, the diversity and maintenance of biological systems increasingly requires systems biological approaches which enable the generation of big data sets, as well as their computational and functional analysis. Hence curiosity-driven fundamental research provides the basis for society-driven applied science to advance basic knowledge of biological systems and consequently find solutions to societal challenges and problems.

The goals of the Faculty of Life Sciences are to further stimulate interdisciplinary research among the individual departments of the Faculty and to further enhance the interdepartmental use of the research equipment and instrumentation that is available now and will be acquired in the future. The Faculty encourages interdisciplinary research within the Faculty and between faculties to address major contemporary research challenges in life sciences. The Faculty aims at intensifying its collaboration with other national and international research institutions to further strengthen its position in life sciences at the national level and in the international research arena. The planned relocation of a large part of the Faculty to the vicinity of the Vienna Biocenter (VBC) will further enhance the synergy and collaborative interactions with groups from the MFPL as well as the non-university research institutes at the VBC (IMP, IMBA, GMI).

Scientific research in many departments is oriented towards the research agenda of the European Research Area and participation in international programmes such as Future Earth, massive sequencing programmes and systems biology projects to attract additional third-party funding from national and international research agencies.

4.15.2 Thematic Areas and Key Research Areas

The research activities of the Faculty of Life Sciences are represented by five thematic areas: botany and biodiversity research, organismal systems biology, functional ecology, nutritional sciences, and pharmacy.

The focus of the thematic area of botany and biodiversity research is the study of the evolution of biodiversity, the causes and consequences of its distribution in space and time, and its potential change due to anthropogenic processes (global change). Its research is tightly linked with the key research areas of patterns and processes in plant evolution and ecology, and environmental change biology. The topics addressed and methods employed range from molecular genetic, genomic, structural-morphological and modelling approaches to analyses of selected organismal groups, complex species communities and landscape structures. They include laboratory- and computer-based reconstructions for modelling evolutionary processes and obtaining assessments



of species' genetic and eco-evolutionary responses to environmental change. This enables forecasts of future changes in biodiversity patterns. The Botanical Garden core facility as well as the La Gamba tropical field station, with their living plant collections and additional resources, provide key foundations for biodiversity-related research and teaching at the University of Vienna. This involves close cooperation with other departments at the Faculty of Life Sciences. In addition, the Botanical Garden is a competence centre for national and global strategies to preserve biodiversity. It develops, and actively participates in species protection and nature conservation programmes and thus contributes to our knowledge and the preservation of plant diversity. With its postgraduate and advanced training activities, the Botanical Garden also plays a relevant role in society, art and policy matters beyond the university framework.

The aim of the thematic area of organismal systems biology is the pursuit of a better understanding of metazoans as complex systems. In this framework, a broad range of invertebrate and vertebrate species, including human beings, are investigated comparatively at the molecular and cellular, as well as the ecological and social levels. The main effort is to analyse the development and evolution of these organismal systems, using experimental methods, including 3D and 4D imaging and computational analyses to obtain large genomic and tomographic data sets. The thematic area of organismal systems biology is represented by the key research areas of cognition, neuroscience and behaviour, and the evolution of organismal complexity.

The objective of the thematic area of functional ecology is to gain insight into the structures and functions of limnic, marine and terrestrial ecosystems. The focus is on microbial ecological, biogeochemical ecosystems and systems biological research, as well as on microbial symbioses and model organisms. These research approaches are eminently relevant in environmental science and for society in general, especially regarding the grand challenges of global change and Future Earth. In order to achieve the above goals, state-of-the-art technologies from the fields of systems biology, bioanalytics, biogeochemistry and imaging are being combined. Another focus is on analysing the function of microorganisms in their natural and technical habitats, as well as on the relationships between microbial control and global material flux in aquatic and terrestrial systems. In the future the quantitative aspects of ecology will be advanced to consolidate the predictive character of ecology and its theoretical foundations. The key research areas of environmental change biology, symbioses, and microbial ecology and ecosystems represent the key focuses within this thematic area.

The thematic area of nutritional sciences is aimed at examining biological processes that result from the interrelationships between organisms and their diet. The focus is on molecular nutrition research in a systems biological approach using genomic, transcriptional, proteomic and metabolic strategies. This will contribute to our understanding of the cellular and molecular modes of action of nutrients and non-nutritive food components. This will also support biomarker development to predict long-term diet-related diseases and to identify genetic variants that are involved in the development of diet-related phenotypic expressions. The instrument of systematic analysis helps detecting possible correlations between diet-associated factors and numerous diseases. It is a powerful tool for formulating new research questions. Various aspects of this thematic area are reflected in the key research area of nutrition and ageing.

The thematic area of pharmacy is oriented towards the discovery, development and safe use of new medications, for the benefit of society. The main focus is on the identification and characterisation of new biologically active natural and synthetic substances and their interactions within the human organism at the molecular level. In silico, in vitro, and in vivo models are developed and tested to yield new substances and treatment approaches and to develop delivery

systems for drugs. Several aspects of this thematic area are represented in the key research areas of drug discovery from nature, computational life sciences, and nutrition and ageing. They are also reflected in the intensive cooperation with the Medical University of Vienna, e.g. in the context of joint projects funded by the Austrian Science Fund, collaboration in the area of biomedical imaging, and joint teaching activities in the new master's programme in Drug Discovery and Development.

Evolution of organismal complexity

The goal of this key research area is to understand the mechanisms of evolution and of developmental biology, whose complex interactions bring about the diversity of differentiated cell types, organs and body plans. This area combines high-end molecular, genomic, morphological and biomathematical methods, along with 3D and 4D imaging techniques. The integration of theoretical and experimental approaches to systems biology enables a comprehensive understanding of the evolution of organismal complexity. A great variety of experimental systems are used to comparatively examine gene regulatory networks, the influence of epigenetic regulation and dynamic cellular interactions. For instance, fundamental principles of the development, structure and function of nervous systems and their interaction with the environment are studied.

Cognition, neuroscience and behaviour

The cognitive, neuronal and hormonal basis of behaviour represents the main topics of this key research area. Its strength lies in its broad comparative approach, which integrates a variety of model systems and research topics at different organisational levels, ranging from the cell to social groups. Fundamental issues in this field include the evolution of cognitive processes, the influence of environmental factors on behavioural phenotypes, as well as interactions between behavioural, genetic and physiological factors. Social aspects such as the complexity of social relationships, cooperation, communication and stress management are particularly relevant. One important goal is to strengthen the neurosciences, along with animal behaviour and cognition research within the Faculty. Continuing efforts are being made to foster intensive collaboration between the groups working in this field at the University of Vienna and in Vienna's surroundings. The new NeuroCog initiative will foster the cooperation between different faculties of the University of Vienna and pool the existing expertise coming from other universities and non-university research institutions such as the IMP, IMBA and IST Austria.

Patterns and processes in plant evolution and ecology

This key research area deals with the evolutionary, developmental and ecological processes that have given rise to today's diversity of plant life. Its research focuses on how plant diversity has developed and changed under natural conditions. Nowadays, the human impact plays a considerable role in this process, which raises the question of how plant diversity can be preserved in the long term. Identifying the underlying processes requires a thorough understanding of the evolutionary ecology of biodiversity, which includes the study of the morphology, phylogenetics and population biology of plants. These multidisciplinary approaches are supported by the infrastructure and collection of living and preserved plants of the Botanical Garden and the La Gamba tropical field station.

Symbioses

Symbiosis, i.e. different organisms living together, is a universal principle of life. This key research area deals with relationships between microbes and protists, animals and plants. A variety of

associations are studied, ranging from two-partner symbioses to complex relationships between animals or plants and their manifold microbiomes. The focus of research is on host and symbiont diversity, including the variability and function of the phenotype in ecological and pathological contexts, as well as the molecular and physiological mechanisms of microbe-host interaction, its establishment and maintenance. Finally, reconstructing the evolution of symbiotic relationships is an important part of the current research activities. This includes empirical studies to test theoretical conceptions in evolution. As many symbioses are associated with bacteria, a close cooperation with researchers of the key research area of microbial ecology and ecosystems is maintained.

Microbial ecology and ecosystems

Microorganisms play a key role in food webs and in all global biogeochemical cycles. Here, the focus of interest is on the structure and function of microbial communities and the resulting matter flux in aquatic, terrestrial and technical ecosystems. In an interdisciplinary approach, priority will be given to those questions that help improve our understanding of functionally important microorganisms. Research on the ecology and evolution of microorganisms is a prerequisite for understanding the functions of microbes in a changing environment and for optimising the use of microbial communities in technical systems. This approach requires state-of-the-art methods from the fields of metabolomics, proteomics, functional genomics, single-cell microbiology and isotope analysis.

Environmental change biology

The current environmental changes have multiple, and frequently interacting, components. This key research area focuses on climate change and land use change, as well as on changes in the carbon and nitrogen cycles. It studies biological invasions and environmental pollution and their effects on, and interactions with, biological systems at all levels of organisation from genomes to biomes. This includes interdisciplinary collaboration with biology, the earth sciences, chemistry and physics.

Nutrition and ageing

In an ageing society, gaining more detailed insight into the molecular mechanisms involved in ageing is an issue of major importance. Nutrition is regarded as one of the driving factors for healthy ageing but the detailed mechanisms and the interactions of nutrients with the ageing processes of cells and whole organisms are not yet fully understood. This key research area thus focuses on selected aspects of the interaction of nutritional and other lifestyle factors with the process of ageing, using human and animal studies as well as in vitro models to explore the mechanisms behind epidemiological observations. The development and refinement of age-specific biomarkers helps improving our understanding of ageing and keep people healthy as long as possible (healthy and active ageing).

Drug discovery from nature

This key research area is centred around natural substances that, based on their evolutionary optimisation, appear to be particularly suited for interaction with potential targets as key structures for developing medications (privileged structures). The goal of research in this area is to identify new active substances from nature (e.g. plants or microorganisms) and to understand their functional mechanisms, especially at the molecular level. Studies on the interaction between natural substances and anti-targets also help to improve the safety of medicines. The current development is directed towards metabolomics and target fishing in order to characterise the

polypharmacological profiles of natural substances. Modern imaging techniques are used to help evaluating the efficacy and safety in relevant disease models.

Computational life sciences

This key research area pools the numerous activities with regard to applying and developing information technologies in the life sciences. In addition to forming topic-specific clusters, another aim is the interdisciplinary establishment of new methods in the fields of pharmacoinformatics, in-silico metabolomics and bioinformatics, as well as in structural and systems biology. Particular emphasis is given on processing high-throughput biological data, the development of mathematical methods for modelling biological and biomolecular systems, as well as on the topics of data integration and data mining. This key research area cooperates closely with other faculties, the Centre for Molecular Biology and the Austrian Academy of Sciences. The existing collaboration with the Centre for Integrative Bioinformatics Vienna will be intensified once the new biology building is operational.

4.15.3 Professorships as of 1 October 2017

For a better overview, all professorships (including any professorships initially financed by the ministry responsible for science and research) existing as of 1 October 2017 (section 98 and section 99, para. 3 of the 2002 Universities Act) are listed here. For information purposes, the research areas that are currently covered are provided in square brackets. The names outside the square brackets give the official designations. The list below shows the situation at a certain point in time and does not predetermine any future subject dedication of professorships, nor the ones dealt with in the following section.

Developmental Biology of Animals
Dietetics and Food Quality
Nutritional Physiology/Molecular Nutrition
Nutritional Sciences (Special Human Nutrition)
Evolutionary Cognition Biology
In-Silico Genomics [Computational Systems Biology]
Cognitive Ethology
Marine Biology
Microbial Communities
Microbial Ecology
Microbial Symbioses
Molecular Plant Physiology
Molecular and Cellular Neurobiology
Morphology of Animals
Ecogenetics
Ecophysiology of Microorganisms
Plant Systematics and Evolutionary Research
Pharmaceutical Biotechnology
Pharmaceutical Sciences
Pharmacognosy
Pharmacognosy (Pharmaceutical Biology)
Pharmacoinformatics
Pharmacology and Toxicology
Pharmaceutical Chemistry



Pharmaceutical Technology

Physiology and Ecology of Plants

Population Ecology

Structural Botany

Animal Physiology with Focus on Ornithology (cooperation of the University of Vienna with the University of Veterinary Medicine, Vienna)

Vegetation Science

Zoology [Theoretical Biology]

Zoology with Special Consideration of Morphology, Ecology and Neurobiology

Zoology and Marine Biology

4.15.4 Subject Dedication of Future Professorships and Status of Implementation

Professorships dedicated as of 1 October 2017

Didactics of Biology (cooperation with the Centre for Teacher Education)

Limnology

Neurobiology

Dedication of professorships in line with research profiles and with the need to teach fundamental subjects

Subject dedication of professorship: **Theoretical Evolutionary Biology**

Time of appointment: following vacancy of the Professorship of Zoology (presumably as of 1 October 2018)

Subject dedication of professorship: **Pharmaceutical Technology and Biopharmacy**

Time of appointment: following vacancy of the Professorship of Pharmaceutical Technology (presumably as of 1 October 2018)

Subject dedication of professorship: **Pharmacology and Toxicology**

Time of appointment: following vacancy of the Professorship of Pharmacology and Toxicology (presumably as of 1 October 2019)

Subject dedication of professorship: **Marine Biology**

Time of appointment: following vacancy of the Professorship of Marine Biology (presumably as of 1 October 2023)



Future professorships subject to availability of funds

Subject dedication of professorship: **Public Health Nutrition** (joint appointment with the Medical University of Vienna)

Subject dedication of professorship: **Geobiology** (joint appointment with the Faculty of Earth Sciences, Geography and Astronomy)

Subject dedication of professorship: **Ecological Modelling**

Subject dedication of professorship: **Molecular Drug Targeting** (cooperation with the Centre for Molecular Biology with regard to advertising and recruitment)

Subject dedication of professorship: **Sports Nutrition** (joint appointment with the Centre for Sport Science and University Sports)

Subject dedication of professorship: **Microbial Viruses**

Subject dedication of professorship: **Genetics of Bacterial Non-Model Organisms**

Subject dedication of professorship: **Neuroscientific Foundations of Human-Animal Interaction** (joint appointment with the University of Veterinary Medicine, Vienna; cooperation with the Faculty of Psychology with regard to advertising and recruitment)