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The Department of Biology (BIO) is the result of a merger of 17 individual departments starting in 1992 and culminating in a final merger leading to the current Department of Biology January 1st, 2008. The rationale behind the final merger was to create a department embracing all disciplines of biology – from the classical fields of biodiversity sciences, cell biology, ecology, evolutionary biology, microbiology and physiology to biochemistry, molecular biology and bioinformatics – with a goal of facilitating novel integrative research spanning different disciplines. This goal has to a large extent been reached in the period 2008-2013 in spite of a drastic reduction in tenured staff and technical support.

Today the Department of Biology is organized as an administrative unit with 11 scientific sections and a central cost-effective administration. The Department has finished the implementation of a budgeting model providing transparent principles for allocation of funds to each of the 11 sections. A significantly improved success in attracting external funding in all sections of the Department, a steady increase in the income from teaching by increasing the number of students passing their exams, and strict financial control have not only stabilized the economy of the Department, but has led to a situation where the Department generates an annual surplus that will allow funding of new strategic initiatives. In conclusion, as of 2013 the Department of Biology stands as a strong biological department providing the most comprehensive study programs across biology disciplines in Denmark. The Department houses a large number of very strong and internationally recognized individual researchers and research groups. The Department has during recent years been able to attract a considerable number of novel staff members of very strong international standing, and attracts an increasing number of international PhD students and postdocs.

In the following pages, we present an overview of the Department’s strategic visions and goals and the immediate objectives. In the web-based version of the strategy plan, this is followed by a more detailed description of the departmental research sections emphasizing their research strategy, short-term goals, education and outreach strategy, and external collaborations. This is by no means a static description, but a plan that we intend to update once a year, in a situation where basic university funding is decreasing, student enrolment may vary and the need for attracting external funding is constantly increasing due to the overall steady decline in basic funding.

Numerous persons have been involved in the production of this booklet. The executive board of the Department of Biology has together with the staff involved in fund raising written the basic part of the text. The draft has been extensively discussed in the individual section, in the BIO-Strategic Board, and during general meetings of the department staff. Section leaders have provided the text describing each individual section. Leif Bolding has been responsible for the layout.

Copenhagen, June 2013

On behalf of the Executive Board
of the Department of Biology

Karsten Kristiansen
Professor and Head of Department
The Department of Biology conducts excellent research and teaching embracing all disciplines of biology – from the classical fields of biodiversity sciences, cell biology, ecology, evolutionary biology, microbiology and physiology to biochemistry, molecular biology and bioinformatics – with a goal of facilitating novel integrative research and teaching spanning the different disciplines.

The department strives to become an internationally recognized department for excellent research and education.

We will aim at securing facilities and opportunities for front-line research and education providing access to state of the art instrumentation and know-how.

We aim at attracting staff of international caliber including recruitment of international researchers.

We want to establish clear career tracks.

We want to attract the best national and international students.

We intend to develop a cost-effective, service minded administration, providing effective support for research and education.

We want to establish an attractive working environment based on mutual trust and help, where all employees are respected and valued.
## Department organization

### Buildings and locations
The Department has almost finalized a lengthy re-organization locating most sections on Nørre Campus (Biocenter, August Krogh Building, Universitetsparken building 1 and 3, and Universitetsparken 4). The Department keeps most of the Section for Marine Biology together with the public aquarium “Øresundsakvariet” in Elsinore. Remodeling of the premises in Elsinore is planned, so we expect the entire physical re-organization of the Department to be concluded during 2014.

### Sections and centers
The Department is currently organized into 11 Sections. Each Section is led by an appointed Section Head. Three Centers of Excellence at the Department are supported by the Danish National Research Foundation, and three research groups are part of similar Centers of Excellence at the Faculty of Science and the Faculty of Health. Several research groups are further affiliated with, or are major partners in, other large research initiatives funded by e.g., the Villum Kann Rasmussen Foundation, the Novo Nordisk Foundation, and the Lundbeck Foundation.

### Education
The Department hosts major study programs in Biology and Biochemistry, an elite study program in Molecular Biomedicine, and a master’s curriculum in Bioinformatics, all associated with the departmental teaching committee. Furthermore, a master’s study in Aquatic Science and Technology is offered in collaboration with the Technical University of Denmark (DTU) and a curriculum in Environment and Nature Protection has been established. More than 2000 students are currently enrolled in these study programs. During recent years, Biology, Biochemistry and Molecular Biomedicine have had a full enrolment of new students.

### Departmental boards and administration
The Department is directed by an executive board chaired by the head of the Department and comprising two vice heads for education, two vice heads for research, and a head of administration. The human resources administrator, the financial administrator and three students take part in executive board meetings. The Department has established a forum for monthly meetings between the section heads, which further function as the Departmental Research Committee, and the executive board. In addition the Department has instigated an annual two day retreat for all tenured academics, which from 2014 also will be offered to all permanent administrative staff members.

The administrative staff was reduced in 2009 and 2010, and a reorganization of the administration into functional units was implemented in 2010 to secure an efficient and robust administration. This goal was largely achieved before the Department from November 1, 2010 became part of an administrative center sharing a joint head of administration with the Department of Exercise and Sport Sciences. This structure has now been abandoned, and the Department of Biology is now striving to re-establish a well-functioning and cost-effective administrative organization.

With the decrease in basic funding, external funding has become essential for carrying out research at an internationally competitive level. The Department has established an administrative infrastructure to identify new calls of potential interest and to provide assistance to researchers in the preparation of large national and international proposals. To further assist researchers and reduce the cost of consumables and equipment, the Department has established a unit for coordinating purchase of consumables and large equipment to obtain the best possible discounts.

The Department has established a Strategic Research Board consisting of 8 young prominent researchers at
the Department to aid the Executive Board with input on strategic matters. Furthermore, the Strategic Research Board organizes departmental meetings dealing with research programs, research funding and strategy as well as other issues of importance for the development of the Department. From 2013, a Department Council has been established. Other committees established at the department are:
- Local Collaboration Committee (Lokal Samarbejdsudvalg)
- Departmental Committee on Security and Health (Institut Arbejdsmiljøudvalg)
- Communication and Outreach Committee (Kommunikationsudvalg)
- Departmental Teaching Committee (Undervisningsudvalg)

**Economy**
The Department has carried out a major reorganization of the staff to stabilize the economy and to adjust the cost of tenured personnel to the actual funding of the Department. This involved a significant reduction in the tenured scientific and administrative staff during the period 2009-2012, and a reduction in basic departmental funding of researchers. Despite these dramatic changes, focus has been on maintaining high educational standards and attracting new research funding. Basic university funding for the Department of Biology has been decreasing and this trend will almost certainly continue. Consequently, the Department has become increasingly dependent on external funding, which now makes up more than 55% of the total budget and is expected to increase even further. Attracting external funding is therefore a focus area.

A transparent system for distributing basic funding, teaching income (STÅ) and overhead has been fully implemented by the Department and the Department now has a very robust economy. The Faculty of Science has recently implemented a similar budgeting system.

**Research**
Strong research is the cornerstone of the Department of Biology, which houses a considerable number of strong researchers of international caliber. In many biological disciplines, strong research requires groups with a size above a certain critical mass. The establishment of strong sections and the formation of larger research groups within the sections are ways to fulfill this requirement. International networks and collaboration are of paramount importance and the Department encourages sections to establish international collaborations, accommodate guest researchers and guest professors, and to actively apply for funding of such initiatives. Postdocs and PhD students are essential participants in research groups. The Department is focused on increasing the number of national and international PhD students and postdocs in order to strengthen research and innovation. Besides a large number of co-financed PhD positions, the Department funds 4 fully financed PhD
stipends each year to ensure recruitment of exceptional talent, particularly in research areas where external funding possibilities are limited. In many departmental research areas, cutting-edge technology is crucial and is often beyond the capacity of a single research group. Thus, the establishment of dedicated core facilities with technical support will be essential in the future. The Department contributes to core-like facilities in NMR, Bioimaging and metabolic characterization of rodents. An initiative in relation to bioinformatics and supercomputing is currently being pursued. The Department has established an International Scientific Advisory Board consisting of 5 strong internationally recognized scientists. The first evaluation took place in 2011 and the next visit of the Scientific Advisory Board is planned to take place during spring 2014.

International relations and collaboration
Competitive scientific research is highly dependent on strong international relations and collaboration. Researchers at the department have established numerous strong relationships and collaborative projects with researchers on all continents. Several researchers at the department hold adjunct and visiting professorships at foreign universities, and the Department encourages the establishment of further international and exchange programs. Recently, the Department has extended its ties with major Chinese universities and research institutions, including the establishment of a joint PhD program with BGI-Shenzhen, the world’s largest genomics research institute. In addition, the Department has established an agreement on a joint PhD program with the National Institute of Nutrition and Seafood Research, Bergen, Norway.

Career opportunities
Clear career opportunities and instruments for acknowledging excellence are important tools in modern organizations, but are missing in the current Danish university system. The Department of Biology wishes to establish a clear tenure-track system with very strong selection at entry, and a transparent academic promotion process for its tenured researchers. We have established criteria defining the different levels of academic employment for the scientific staff. We intend to implement a model, in which promotion can occur once a year, similar to established systems in other parts of the world. We thus envision a model with a clear career track from Assistant Professor over Associated Professor to Full Professor.

Internal communication, working conditions and environment
All organizations strive to establish optimal physical and mental working conditions. The Department has three committees – the Local Collaboration Committee (Lo-kalt samarbejdsudvalg), the Departmental Committee on Security and Health (Institut-arbejdsmiljøudvalg) and the local Communication Committee (VIP members from each section) – where working conditions, internal communication and possible improvements are discussed. These topics are also routinely addressed by the executive board and the assembly of section heads. A central focus is timely and clear information explaining why and how decisions are made, including unpleasant ones. To facilitate the flow of information, the Department publishes a bi-weekly newsletter (Bioupdate) by direct mail and on the local intranet. Similarly, paying attention to opinions in the different sections and working units is crucial. The Department has made progress along these lines, but there is certainly still room for further improvement and a need to improve, motivation and a positive well-being. This will be an important task in the years to come and will require clear and efficient communication channels promoting constructive dialogue and a broad ownership of the Department. We expect that the newly established Department Council will enhance this development.
Education strategy

Research based educations
The Department of Biology aims to attract the most talented students within environmental and life sciences and provides educations covering organismal biology, ecology, molecular biology, biochemistry and bioinformatics. The four study programs (biology, biochemistry, molecular biomedicine and bioinformatics) are strongly linked to research. They are supported by internationally leading research groups, in which there is close contact between students and researchers. Lectures at all levels are regularly given by research staff to ensure that students get acquainted with state-of-the-arts research.

• We will maintain close ties between the study programs and leading research environments at the Department.

Field and laboratory courses
Hands-on practical teaching is the backbone in our study programs, both at the bachelor and masters levels. Field courses in arctic, terrestrial and marine biology with obligatory summer schools in field biology at the bachelor level will be maintained and further developed. Likewise, laboratory courses in the molecularly oriented study programs will continue to be of high priority. In spite of the costs associated with these efforts, we will maintain a focus on hands-on-biology in the laboratory and in the field.

• We will continue to offer and develop hands-on laboratory and field courses.

Up to date curricula at all levels
Rapid developments in computational biology, genome sequencing and molecular biology have been major drivers for several biological disciplines, and it is our responsibility to provide an up-to-date curriculum – not only in advanced courses, but also in more general bachelor courses. We encourage frequent revision of curricula and course design to encompass the newest research developments, and to include new learning and teaching strategies. The latter specifically emphasizes the use of various assessment methods, feedback to students and alternative teaching techniques.

• We will continue to offer and develop hands-on laboratory courses in computational biology, genome sequencing, molecular biology, and biochemistry, including an extended collaboration with and courses at BGI-Shenzhen.

• The teaching committee at the Department of Biology will establish close collaboration with the study boards and head of studies to ensure necessary revisions of curricula.

Support of teachers
The Department of Biology will assist and support the academic staff in their continuous development of teaching skills.

• A yearly teaching day will be introduced to facilitate discussion and become up-to-date with topics such as new teaching and educational initiatives, strategies and teaching styles.

• The teaching committee will continue to support teachers in developing specific courses and educational programs.

• The performance of individual teachers will be followed by the teaching committee and the contribution to teaching will be considered in the tenure-track system and performance measures of the faculty.

• Collegial supervision will be supported by the Department.

A stimulating study environment
The Department of Biology has a specific focus on ensuring completion of studies within the proscribed time frames without reducing the scientific content and academic quality of the education. Mentoring students from the beginning of their study program has a high priority. The mentoring program reduces delays in study time, and
guides students towards the fields and job opportunities that fit their interests.
• We will continue to develop our mentoring programs for undergraduate students, and will extend the programs to encompass master’s level students.
• We will continue to support student initiatives in relation to study groups organized and driven by more senior students.
• We will continue to support and establish facilities for social and scientific interaction between students.

Job opportunities
We educate students for a wide-range of job opportunities, and we seek to provide them with a flexible, personalized educational experience to enable them to optimize their studies. Through involvement of both private companies and governmental agencies in our courses, the students become acquainted with applied aspects of biology and the priorities of key employers in the job market for biologists, biochemists and bioinformaticists. These activities increase opportunities for students to gain work experience, including volunteering and enterprise activities, and allow them to establish personal contacts and networks with private companies and governmental organizations.
• We will continue to develop courses in innovation and teaching collaborations with private and public agencies.
• We will establish a close collaboration between the new recipient boards and the Departments management board to ensure our students job opportunities.

International recruitment
We will attract the most talented students, irrespective of background and nationality, and will continue to increase the number of high-quality international students in our educational programs. Such activities will not only increase our credibility in the international educational market, but will also prepare our students as global citizens.
• We will extend collaboration with top universities within the framework of the IARU collaboration, the IARU Global Summer Program, and the established programs with BGI-Shenzhen and the National University of Singapore.

National recruitment
The departmental student recruitment strategy aims broadly from elementary to high school students, and it involves numerous activities. We arrange visits for students to the Department, meetings with educational counselors, information visits to high schools, and a yearly open-house event introducing potential students to our study programs and student’ environments. We also have a strong link to high school teachers and support training in novel areas of high school teaching such as biotechnology and marine biology – the latter via extensive recruitment activities at the public “Øresundsakvariet”.
• We will continue to develop our student recruitment strategy.
The Department of Biology (BIO) houses numerous strong researchers and research groups of international caliber, and has a strong international network in many areas of the biosciences. In many biological disciplines, strong research requires groups with a size above a certain critical mass.

To ensure this, research at BIO is organized in 11 sections consisting of one or several research groups. An important focus of BIO is to further strengthen its research groups and to stimulate new research initiatives, both via international recruitment of excellent researchers, and via new initiatives building on the broad scientific expertise of the sections. Another focus is to further develop research infrastructure and research education. An important challenge for BIO is to find the right balance between promoting large-scale funding activities and attracting top researchers, while maintaining and developing in-house talents and supporting excellent young scientists to develop their careers.

BIO’s overall research strategy builds on input and discussions between its leadership, its research committee (BIO-FU including section heads), and its strategic research board (BIO-SFU) which is an independent committee consisting of young, tenured scientists. Specific strategies of the sections are given in an appendix (available online).

Key overall focus areas for BIOs research strategy are:

**Staff recruitment & career development**

BIO aims to be an internationally attractive research institution that can recruit the best researchers at all academic levels. This is essential to facilitate new research, and to consolidate and expand in-house research excellence. An important instrument is an ambitious and transparent career development plan at BIO in combination with attractive start-up packages for new recruits.

- BIO aims to establish a clear tenure-track system with stringent selection at entry, and a transparent promotion process for its tenured researchers based on specific criteria required for promotions.
- BIO strives to implement a model, similar to models used in other parts of the world, in which employees may apply for promotion once per year. We envision a model with a clear career track from Assistant to Associate to Full Professor. For temporary professors with special duties (MSO), a contract specifying expected goals and achievements will be signed upon appointment, and promotion to Full Professor will follow when these goals and achievements are attained.
- BIO will establish a mentoring program for its tenure-track positions, in which 1-2 experienced tenured staff from the same or related research areas advise tenure-track staff on aspects of career development including international networking and sabbaticals, fundraising and research publication.
- BIO will implement start-up packages for new recruits at all academic levels to make BIO attractive to the best researchers on the international market.

**Research infrastructure & core facilities**

In many departmental areas, cutting-edge technology is crucial to research productivity. The establishment of dedicated core facilities with technical support is therefore essential. However, such facilities may well be beyond the funding capacity of single research groups. Thus, given competitive scientific plans for core facilities, their development and improvement will depend heavily on external funding and on solid business plans. Some infrastructure has a volume and interdisciplinary potential that enables co-funding across departments and faculties at U. Copenhagen such as the Center for Advanced Bioimaging (CAB).

- BIO will initiate a procedure whereby proposals for core facilities are invited once a year and initially discussed and evaluated by BIO’s leadership, BIO-FU and BIO-SFU.
• BIO will continue its support of CAB and will explore ways to consolidate and further develop advanced bio-imaging platforms at BIO.
• Based on a previous expression of interest, BIO will seek to establish a core facility for Biocomputing to strengthen access to bioinformatics and computational biology resources.
• BIO will take the lead in establishing a cross-faculty core facility for NMR, with key instruments and center leadership based at BIO.

Research funding
The Department has increased its external funding activities substantially over the past 5 years, including prestigious grants to young and established researchers, new centers of excellence, large strategic research projects, and collaborative projects with industry and governmental organizations. Part of this success has involved the recruitment of strong researchers bringing in substantial funding, most recently via a Novo Nordisk Foundation Laureate fellowship. BIO will continue to have a strong focus on attracting external funding and will further develop in-house fundraising activities. Thus, during the next 5 years:
• BIO will continue to develop its fundraising support by dedicated BIO staff that can facilitate sparring, exchange of experience, and contacts to funding agencies. In-house peer-review and mentoring of young researchers by more experienced fund-raisers in the sections will be another important instrument.
• BIO will strive to obtain at least 1 ERC Young Investigator grant and 1 ERC Advanced Investigator grant in each future call from the European Research Council (ERC), either by promoting and supporting the strongest in-house researchers in the application process, or by recruiting strong candidates or grant holders externally.
• BIO will strive to obtain at least 1 Centre of Excellence grant in each future call from the Danish National Research Foundation.
• BIO will strive to obtain at least 1 project or research platform grant per year in future calls from the Danish National Advanced Technology Foundation.
• BIO will seek to strengthen the success rate for its grant applications to the Danish Research Council for Independent Research and the Danish Strategic Research Council.
• BIO will seek to strengthen its contacts to industry and large private foundations with a goal to obtain 1-2 large excellence or collaborative grants per year.
• BIO will develop white papers describing its research excellence and expertise in particular areas. Such material can be used when establishing contacts to industry and foundations, as well as in situations in which new research opportunities appear on the political agenda or lobbying activities are important.

Researcher education
BIO has been successful in recruiting substantial numbers of PhD students in recent years. Most PhD students receive one third of their funding from BIO and two-thirds from external sources. BIO also offers 4 fully financed stipends each year, to ensure the recruitment of exceptional talent, particularly in research areas in which external funding possibilities are limited. This recruitment strategy will continue together with initiatives to ensure a high quality in PhD education.
• BIO will realize an annual uptake of no less than 56 new PhD students, i.e., the current uptake quota defined by the Faculty of Science.
• There will be special focus on recruiting the best candidates nationally and internationally, including candidates from the new growth economies (China, Brazil, South Korea, etc.). The Brazilian Science-without-borders program is a very good opportunity for BIO to undertake such recruitment and to establish new research links.
• BIO will also seek to provide full PhD scholarships for the most talented internal candidates.
• To ensure quality in researcher education, BIO will implement a mentoring model in which each PhD student is followed by a thesis committee (including the super-
visor) that serves to advise on practical planning and scientific progress of the thesis work.

- BIO encourages staff to develop existing and new PhD courses, by offering the organizing section an equivalent of 50% of the ECTS-income from the course.
- BIO wants to increase the financing of PhD educational activities and researcher training from Nordic (Nord-Forsk programs) and from European (RTN and IDP programs) sources.
- BIO wants to host PhD students enrolled on 5+3, 4+4, and 3+5 educational programs. The 5+3 model is currently the most common, while the other models remain difficult to implement at University of Copenhagen. In line with the faculty strategy, BIO wants to facilitate easier enrolments to all three PhD study programs.
- BIO will continue to host an annual PhD day organized by the PhD students in the form of a scientific symposium including invited external speakers. BIO will establish an annual prize for the best PhD thesis, which will be announced and awarded at the PhD day. To support the PhD day and other networking activities among PhD students, BIO will contribute DKK 100,000 per year to the PhD student organization.
Collaboration and innovation

Competitive research is highly dependent on strong international networking and collaboration. Researchers at BIO have established numerous strong relationships and collaborative projects with researchers on all continents. Several researchers at BIO hold adjunct or visiting professor positions elsewhere, and BIO encourages the establishment of further international collaboration and exchange programs. BIO has strong ties with major Chinese universities and research institutions, including the formation of the Sino-Danish Genomics Centre and the establishment of a joint PhD program with BGI-Shenzhen, the world’s largest genomics research institute. In addition, the Department has established an agreement on a joint PhD program with the National Institute of Nutrition and Seafood Research, Bergen, Norway. BIO will consolidate the strong collaborations with China, and will strive to establish stronger links to leading research institutions in other countries, including countries with rapid economic growth such as Brazil, Singapore, South Korea and India.

The Department of Biology has a strong tradition in frontline basic research and producing know-how and innovations with strong potential for applications outside the university. The Department aims to create a framework supporting increased transfer and exploitation of this knowledge to increase:

• the inflow of public funds supporting academic-private collaborative research
• the export of knowledge for the benefit of the general society, public and private sectors

In particular, the Department aims to strengthen contacts to the private sector, i.e., large industrial partners and small and medium Enterprises (SMEs), by launching a 3-year strategy plan for innovation early in 2014. The implementation of the plan will be coordinated with relevant bodies at the faculty and university levels and will involve specific matchmaking schemes such as the Advanced Technology Grouping (GTS) of independent Danish research and technology organizations, national innovation networks, and relevant clusters of knowledge-based SMEs, such as innovation parks. Initiatives will also occur at the European and international levels.
Dialog and communication

The Department of Biology is in continuous dialogue with society, governmental and non-governmental organizations, as well as end users in Denmark and abroad. This ensures internal and external communication about topics in bioscience in response to immediate and strategic internal needs and the external demands from the public and private sectors.

Internal communication channels include:
- A well-functioning intranet for employees and research students (www.bio.ku.dk/intranet)
- The newsletter BIOupdate (released every 14 days)
- Homepages for students
- Info-monitors
- A joint meeting for all employees twice a year
- A strong cooperation with the Faculty of Science and the University’s Central Communication Department

The website www.bio.ku.dk continuously keeps external target groups up-to-date on our research, education and outreach activities. External communication channels include outreach activities such as:
- “Skoletjenesten” for primary schools (app. 2000 students every year)
- Practical training and visiting arrangements for secondary schools (app. 1000 students every year)
- Series of lectures for secondary schools and other interested parties
- Participation in the Night of Culture in Copenhagen, the Danish Science Festival, ‘Open House’ arrangements and the annual national ‘Research Day’
- Frequent press coverage (15-20 press releases per year) and media appearances of department scientists
- Externally funded projects focusing on new activities, primarily for secondary schools
- The public aquarium Øresundsakvariet in Helsingør (www.oresundsakvariet.ku.dk) with app. 50,000 visitors and educational activities for 10,000-12,000 children (ranging from preschool over primary school to high school students) each year

In the coming years, the Department of Biology will maintain and optimize its communication strategy by:
- Enhancing internal communication channels at the Department
- Continuous optimization of departmental websites and integration of new media formats
- Increasing visibility in national and international media
- Enhancing outreach activities and communication of research to the public and private sectors
- Enhancing recruitment activities to attract and motivate future students (from Denmark and abroad) to study biological science at the Department
Section strategies
General introduction
The genetic code of life is essential to understanding biological processes in all organisms from the single cell to the entire human body. The genome information that is now available for thousands of organisms is greatly facilitating our ability to investigate genetic mechanisms that control the biological processes of life with important implications for human health and our environment. In the Section for Functional Genomics, our research takes a primarily genetic and genomic approach using suitable model organisms representing the three domains of life: archaea, bacteria, and eukaryota.

The main areas of research interest within the Section are:
• Genome stability, cell cycle regulation & differentiation
• Gene expression, transcriptional silencing & chromatin structure
• DNA repair, replication & homologous recombination
• Molecular mechanisms of cancer
• Genome hypervariability in hyperthermophilic crenarchaea
• Virus-host interactions and immunity in crenarchaea
• Antibiotic inhibition of DNA replication and protein biosynthesis
• Plant innate immunity, programmed cell death & signal transduction.

The Section currently has 3 professors, 7 associate professors, 10 postdocs, 32 PhD students, 10 master students, and 6 technicians.

Research strategy
The strategy of the Section is to apply molecular genetics and genomics to fundamental biological questions using relevant model systems. The Section has a focus on three research areas, each represented by a group of 2-5 principal investigators: 1) genome dynamics; 2) archaeal genomics and virus-host interactions; and 3) plant innate immunity, programmed cell death & signal transduction. The Section seeks to maintain strong national and international collaborations in these research areas.

Measurable short-term goals
• Genome dynamics: molecular genetic dissection of DNA damage response pathways in unicellular (S. pombe, S. cerevisiae, U. maydis) and multicellular (G. gallus, M. musculus, H. sapiens) eukaryotes; development of DNA replication as a therapeutic target; analysing the interface between chromatin structure, gene expression and genome stability.
• Archaeal genomics and virus-host interactions: understanding the mechanisms that maintain archaeal genome integrity in Sulfolobus islandicus; molecular genomics of the archaeal adaptive immune-system CRISPR in S. islandicus; a detailed analyses of virus-host interactions for two selected crenarchaeal viruses – a rudivirus SIRV2 and a bicaudavirus ATV. We are also focussing on
the detailed molecular mechanisms involved in the host immune responses to two monocaudaviruses SMV1 and STSV2.

- Plant innate immunity, programmed cell death & signal transduction: develop new ways to identify conserved regulatory nodes in innate immunity using Arabidopsis as a model; based on discoveries in Arabidopsis, identify resistance gene specificities towards particular pathogens in crops and used them to create GMO’s with natural resistance; solidify proof-of-concept that discoveries in Arabidopsis can be successfully translated to human disease research in collaboration with groups in the Faculty of Health Sciences.

The Section will continue to seek external funding with the aim to maintain an average staff of 1 technician, 2 postdocs, and 2 PhD students per principal investigator. Refilling of 1-2 technician positions for the Genome Dynamics group is necessary to continue the current teaching and research activities. The Section aims to attract more and larger collaborative grants through The Danish National Research Foundation (Danmarks Grundforskningsfond), the EU 7th Framework, and Marie Curie, HFSP and ERC programmes.

Important tasks include maintaining and developing major core facilities, together with other Sections, for high-throughput DNA sequencing, bioinformatics, microarray analyses, electron microscopy, and bioimaging.

**Education strategy**

Our Section contributes to the basic teaching of molecular, genetic, and cellular biology and will continue to run specialized courses in yeast genetics and cell biology, archael genetics, cell biology and virology, and plant molecular biology. The Section organizes PhD courses in “Advanced methods in genome integrity” and “Advanced Live Cell Imaging”. In the future, we will offer a master course in “Experimental higher model organisms” as part of the new competence profile in Molecular Biology and Genetics for biology students.

**Outreach strategy**

The Section will continue to maintain our Web sites and contribute general scientific articles to newspapers and educational magazines. Moreover, we will hold public lectures when invited and contribute to television and radio programmes. In addition, we will contribute to the annual Night of Culture in Copenhagen.

**Collaboration with the private sector**

The Section will engage in collaboration with the pharmaceutical, biotechnology, and nanotechnological industries in areas of applied research.

**Further information**

Section home page [www.bio.ku.dk/english/research/fg/](http://www.bio.ku.dk/english/research/fg/)

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**Selected recent publications**


Biomolecular Sciences
BIOMOLEKYLÆRE VIDENSKaber

General introduction
The section has 11 permanent scientific staff members addressing protein chemistry and metabolism. The areas of interest reach from protein synthesis and degradation over protein dynamics and design to enzymology and metabolic networks. The work is based on strong traditions in the Danish research community which date back to the groundbreaking work of distinguished scientists like Kaj Linderstrøm-Lang and Ole Maaløe.

Research strategy
Main areas of interest include protein synthesis and turnover, the relationship between protein dynamics and function, and methods for and applications of protein design and enzymology. The section is firmly based in biochemistry, molecular biology, cell biology and biophysics, including a strong emphasis on applications of NMR methodologies. During the winter of 2013-14 the section will be expanded with the group of Kenn Gerdes, who recently received an NNF Laureate Research Grant. This arrival will greatly strengthen our research capacity in molecular microbiology, and is likely to result in the establishment of an independent section within this focus area. Specific focus areas include:

- Elucidation of protein dynamics by computer simulations and NMR
- Engineering and design of proteins
- Cellular protein folding and degradation
- Dynamics and regulation of protein synthesis
- Intrinsic disorder in proteins

We will continue to generate excellent science within the focus areas and will aim to maintain our external funding at the current high level over the next 3-year period (approximately 15 mill DKK a year).

One of the prime strategic targets will be a new center for NMR spectroscopy with a section focus on the link between protein dynamics, computational biology and protein structure/function in a biological context. We are committed to establishing a strong and focused interdepartmental Center for High-Field NMR. This technology is utilized, primarily or through collaborations, by a majority of section members.

We will further strengthen collaborations within the section, the department and other faculty departments. To achieve this, we conduct regular workshops to identify common interests and to define new common well-defined research projects. The aim of this effort is to lay the ground for an application for a Danish National Research Foundation Center of Excellence.

Education strategy
The section has its main teaching competencies and obligations within biochemistry and protein chemistry to students of biology, biochemistry and molecular biomedicine at all levels. In addition, we supply teaching capacity to molecular biology, microbiology and gene technology as well as molecular cell biology.

Over the next three years we will implement a new curriculum for the Biochemistry bachelor level teaching. This
entails many modifications to courses and an increased attention to a coherent learning progression and will also require increased resources in a transition period. To support a high-level of research based teaching in biochemistry and enzymology we wish to hire an associate professor in these areas.

The section presently hosts around 20 PhD students. We will seek to increase its uptake of new PhD students over the next 3-year period. To achieve this goal we will need to attract excellent applicants that are able to secure external funding. The best applicants will be recruited by establishing more external exposure of projects and by stronger recruitment already at the master’s level. Furthermore, we will strengthen our affiliations with external partners to increase co-financing.

Outreach strategy
The section provides a teaching platform in biotechnology for high-school teachers. We provide yearly courses with for high school teachers to bring novel methods and technology to young students so that they can get hands-on experience with modern biochemistry/biotechnology.

We play an active part in public display during the Night of Culture in Copenhagen (Kulturnat) where the workings of enzymes come to the attention of a broad audience.

We wish to display a stronger profile of protein science in the media by further promoting the very interesting scientific research and its high economic and innovation potential.

Collaboration with the private sector
Many of the research areas within the section have a strong applied potential. This is in particular the case with parts of protein chemistry, protein design, and structural biology. There are strong ties with major biotech companies in Denmark, including NovoNordisk, Novozymes and Chr. Hansen

Further information
Section home page www.bio.ku.dk/english/research/bv/

Selected recent publications


Computational and RNA biology
BIOINFORMATIK OG RNA BIOLOGI

General introduction
The research in the Section for Computational and RNA Biology spans the DNA, RNA and protein worlds. We cover a novel and innovative methodological spectrum from wet-lab molecular biology to advanced computational model building and statistical inference. These methods and areas of research enable cutting-edge research at the interface between experimental molecular biology and bioinformatics. The general focus of the Section for Bioinformatics is to investigate important biological questions by developing and using: 1) sophisticated computational tools based on modeling and statistical inference and 2) advanced experimental methods based on sequencing and genetic screens and 3) study the regulation and function of RNAs. There is strong collaboration within the Section, including collaboration between computational and experimental groups. The Section currently has 20 PhD students, 15 postdocs, 6 associate professors, 2 professors and an adjunct professor. External funding to the Section is 10-15 million DKK per year from diverse sources, including EU, DANIDA, the Novo Nordisk Foundation, The Lundbeck Foundation, and the Danish Research Councils.

Research strategy
Computational biology and bioinformatics, specific focus areas
- Understand the complex mechanisms of post-transcriptional gene regulation with emphasis on the interplay between microRNA, RNA binding proteins and RNA structure.
- Develop basic computational methods for analyzing high-throughput DNA sequencing for ancient DNA, genomics and RNA sequencing.
- Predict, design and determine the 3D structure of RNA and proteins, by developing sophisticated probabilistic models that describe aspects of protein structure. These models are mainly based on machine learning methods (including dynamic Bayesian networks), and directional statistics i.e. the statistics of angles, directions and orientations.
- Understand gene regulation, the transcriptome, the epigenome and technological and informatics aspects through computer-assisted probing of large biological datasets that are generated using novel genomics techniques.
- Using Machine Learning and statistical methods to solve complex inference problems.
- Probabilistic modeling of genomic data such as gene expression micro-array type and sequence tags, chip-on-chip and Cap Analysis of Gene Expression (CAGE) data.

Population genetics and statistical genetics, specific focus areas
- Understand the inference of demographic changes of populations and inference of evolutionary processes involved in the speciation process, among large African mammals.
- Sequence 100 genomes from the six great ape species: chimpanzee, bonobo, western gorilla, eastern gorilla, Sumatran orangutan and Bornean orangutan (as part of the Great Ape Genome Consortium).
- Understand evolutionary genetics of foot-and-mouth-disease (FMD) virus in East Africa.
- Perform large scale association studies for complex diseases in both outbred and small isolated populations.
- Develop statistical and computational methods for dealing with the uncertainty of highthroughput genomic data including methods for detecting and correcting for population stratification, detecting natural selection, loci dependent methods for identity by descent and genotype calling.

Experimental RNA biology, specific focus areas
- Study the mechanisms by which small RNAs regulate
gene expression. We use the flowering plant Arabidopsis thaliana as a model system, and make particular use of molecular genetic and biochemical approaches in our work.

- Understand the role of post-transcriptional events such as RNA localization, RNA stability, and translational control during fetal life and oncogenesis with an emphasis on the role of cytoplasmic RNA-binding proteins.
- Develop improved, high-throughput methods for detection of RNA structure and RNA-protein interactions and apply these to understand cellular processes and to increase the efficiency and specificity of RNA based drugs.
- Use RNA degradation profiles to find functional genomic regions, using a combination of gene knockdowns, sequencing and computational analyses.
- Explore disease-specific RNA isoform recruitment and gene regulation in patients with inflammatory bowels disease, skin cancer, sclerosis, with the goal of making novel diagnostics or even find new drug targets.

Measurable short-term strategic goals
- Become an international leader in the analysis of high-throughput sequencing data.
- Become an internationally respected centre for research on non-coding RNAs in animals and plants.
- Apply the techniques developed in the section to medically relevant material, such as patient cohorts or viruses.
- Increase the number of papers published in high-impact journals.
- Expand the number of employees, especially postdocs and permanent positions in the next years.
- Expand our IPR protection activities and generally explore our opportunities to commercialize our best research through fruitful partnerships.
- Secure more funding from EU framework program and domestic programs by exploring collaboration possibilities.

Education strategy
In addition to running our own Master's program in bioinformatics, the section participates in biochemistry, molecular biomedicine, computer science and biology Bachelor's and Master's programs. We want to promote the Bioinformatics Master program to a Danish Elite Program to promote student recruitment and also further consolidate the international status of the program as one of the best in Europe. Furthermore, as bioinformatics skills are in increasing demand, we plan in the future to offer bioinformatics courses to employees in public or private research organizations, which need to upgrade or develop such skills.

Outreach strategy
Enhance international outreach through organizing scientific conferences, workshops or seminars and by increasing active participation in international lecture series organized by other groups at BIO. Furthermore, we want to promote more collaboration internally, locally and internationally as bioinformatics is becoming a necessity is most cutting-edge molecular biology research.

Collaboration with the private sector
The section has a track record in collaborating with private companies that also contribute to the funding of the research. These include Novo Nordisk, Novozymes, Santaris Pharma, Exiqon, and Copenhagen ZOO.

Further information
Section home page [www.bio.ku.dk/binfl](http://www.bio.ku.dk/binfl)

Selected recent publications

General introduction
The Section for Cell and Developmental Biology focuses on fundamental biological processes that occur during development or maintain homeostasis in adult organisms, such as cell proliferation, cell volume regulation, cell signalling, cytoskeletal organisation, cell motility, cell differentiation, cell-cell interaction, matrix modulation and programmed cell death. These processes are orchestrated by a complex network of signal transduction pathways, which when aberrantly regulated may lead to diseases and developmental disorders. Thus, we focus also on cellular and physiological changes that underlie human pathologies such as obesity, type 2 diabetes, channelopathies, ciliopathies and cancer. The section covers the molecular, cellular, organ, and organism levels by employing mouse and human tissues, established cell lines and isolated cells including embryonic and adult stem cells, as well as intact model organisms such as Chlamydomonas and mouse, and further involves deep genomic and metagenomic sequencing to uncover genome-metagenome interaction controlling tissue development and energy homeostasis. Major external funding to support these activities is provided by the Lundbeck Foundation, the Danish Cancer Society, the Danish National Research Foundation, the Danish Council for Independent Research, the Danish Council for Strategic Research, the Novo Nordisk Foundation, and the EU.

Research strategy
Our strategy is to maintain and improve our international standing within our main research fields. We are particularly strong in basic science in cell signalling and ion transport, tissue development and differentiation, molecular mechanisms of energy homeostasis, genomics, metagenomics and cancer biology. We are actively engaged in network activities within these areas through IonTraC Marie Curie Initial Training Network, Basic Stem Cell Biology within the Danish Stem Cell Center, Cooperation in Science and Technology (COST Action CM1105), EU FP7 project DIABAT, the Sino-Danish Breast Cancer Center, the Danish Platform for large-scale sequencing and bioinformatics, the Norwegian projects Fish Intervention Studies (FINS), Safe feed, safe and healthy seafood, Seafood protein in the prevention of the metabolic syndrome and Insulin resistance and obesity. In addition, members of the Section have recently secured substantial funding from the University of Copenhagen 2016 funds for a large interdisciplinary project on biobanking and ciliopathies. Through these initiatives the Section seeks to strengthen existing collaborations with other sections of the Department, in particular on studies of pH regulation and ion transport mechanisms and the effect of physical activity on metabolism undertaken by Section for Molecular Integrative Physiology, and to develop new collaborations with partners outside the Department, such as the Faculties of Health and Law at University of Copenhagen and BGI-Shenzhen. These collaborative efforts are expected to provide a solid foundation for further developing and strengthening our research platform for attraction of additional external funding and for improving the establishment of collaborations with the private sector in the years to come.

Measurable short-term strategic goals
- Maintain a high scientific output including publication of original research in high-ranking journals
- Strengthen our national and international recognition through participation in and leadership of scientific networks and through organization of international meetings and conferences
- Increase external funding and interactions with the private sector
- Spur attraction of high-quality students to our research area through dedicated teaching

Education strategy
The section has a successful track record in recruiting and
enrolling students to our research field. The courses organized and/or significantly contributed to by the section are very popular among students of biology, biochemistry and molecular biomedicine and in addition attract students from a variety of other educations. We, moreover, consider mentoring and advising of students to be an integral and important part of their education and several of the members of the Section are formal student mentors.

We believe that the Section’s proven track record of successful research and teaching provides a solid foundation of future development. The current and predicted future funding situation of the Section’s research will permit training of several PhD and MSc students as well as the establishment of novel PhD courses within key subjects of our research area. We recently launched a novel Master’s level course, Ion Transport in Cancer, running for the first time this year, and we wish to develop additional novel Master’s level courses attractive to students of molecular biomedicine to spur further recruitment of high quality students. Finally, the section is actively involved in reorganizing the curriculum for biochemistry students, including planning of new BSc level courses in cell- and molecular biology to promote future recruitment of excellent students into our research areas.

**Outreach strategy**

We have a long-standing history of outreach activities, which will be further intensified to inform the community of our research and to draw attention to our research activities as attractive funding objects. We are currently engaged in presentations and activities for the public such as Night of Culture (“kulturnat”), industry-related activities such as membership of scientific advisory boards of private companies, activities for high schools such as hosting senior high school students, and contribution to popular science articles and public media.

**Collaboration with the private sector**

A main strategic focus is to strengthen our interaction with the private sector. Currently, we have established collaborations with several national and international companies including Chr. Hansen, Novo Nordisk and Origio A/S in Denmark, and Nanion Technologies GmbH (Munich) and Bayer Pharma AG (Berlin) in Germany. The collaboration includes specific research projects and education of PhDs through the industrial PhD programme.

**Further information**

Section home page [www.bio.ku.dk/english/research/cu/](http://www.bio.ku.dk/english/research/cu/)

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**Selected recent publications**


Molecular Integrative Physiology
MOLEKYLÆR INTEGRATIV FYSIOLOGI

General introduction
The section focuses on research in membrane transport, various organs, metabolism and adaptations to physical activity, integrating information from the molecular level to the complex organism level.
We use preparations from rats, genetically modified mice, selected invertebrates, amphibians, and human subjects, as well as expression systems in yeast, oocytes, and cell lines, and utilize a battery of techniques including molecular and protein biology, electrophysiology, and state-of-the-art bioimaging.

Research areas:
• Biomembranes
We focus on protein structure, folding, function and regulation of P-type ATPases, ion channels, receptors and amino acid transporters at the molecular level. Projects involve expression, purification and structural studies of membrane transporters, and studies of their role in signal transduction and cell cycle regulation of the corresponding genes. The studied proteins originate from a number of model systems ranging from yeast to man.
• Physical activity and cellular adaptations
We examine the beneficial effects of physical activity on cellular adaptations in skeletal muscle and adipose tissue with the purpose to understand how physical activity prevents lifestyle related diseases. The research focuses on membrane transport, inflammation, and metabolism. Regulation of adaptive cellular responses is studied at the gene, protein and activity level using human, animal, and cell culture models.
• Epithelia
We study epithelia of exocrine glands, digestive system, kidney and skin in order to elucidate molecular and cellular mechanisms of ion and water transport and their roles in the integrative physiology of the organism. Projects include studies of various membrane transport molecules, acid base transport, Ca²⁺ homeostasis, solute coupled water transport, and their regulation by various intra- and extra-cellular signaling pathways mediated by for example purinergic signaling in health and disease.

Visions: Within BIO – The Section is integrating knowledge from molecules to living organisms and is thereby the node point for other sections within the department. Within DK – Maintain and expand strong basic research in physiology that will interface with medical physiology, exercise physiology, and veterinary/zoophysiology.

Research strategy
Common strategic efforts within the section: Develop high resolution and live Bioimaging methods that elucidate processes from molecules to body. In addition, we are part of the August Krogh Centre (a Metabolic Science Center) placed primarily in the August Krogh Building; this would include setting up of a metabolic facility for mice in the animal facility in the building. Other new technologies: Extend the use and generation of genetically modified organisms, especially rodents. Other classical physiological methods including electrophysiology and organ physiology could be of value for the rest of the department. Provide new platforms for technologies dedicated to study structure-function of ion channels and ion/solute transporters in simple and complex models.
Reinforce our existing collaborations with other parts of KU, as well as Novo Nordisk, Lundbeck, Sophion, Symphogen, and EU partners.
Ensure TAP support for advanced techniques within physiology.

Measurable short-term strategic goals
• Recruit new VIPs to maintain and strengthen our research goals and physiology teaching.
• Improve collaboration within the section; focus on common research projects and write section-based applications.
• Extend collaboration within BIO, and with DTU, SCIENCE, SUND.
• Establish new PhD courses within integrative physiology and associated technologies.
• Attract students from other faculties.
• Increase number of PhD and post docs, including international candidates.

Education strategy
The section is responsible for a number of bachelor and master courses in the Biology and Molecular Biomedicine curriculum and participates in a number of other courses. We are responsible for the courses Human Physiology, Cellular and Integrative Physiology, Zoophysiology, Comparative Anatomy, and Gene technology. We furthermore participate in General Molecular Biology, Biology A1, Molecular Genetics, and Ion Transport in Cancer. It is our intention to continue providing a strong basic education in physiology for bachelor students, as well as to provide strong advanced education for master and Ph.D. students, which they can use in further employment. In that context we have established a new master course “Molecular Biotechnology” involving a number of researchers from the Danish Biotech Industry. The course is offered for the first time in spring 2014. In addition, we aim to host Ph.D. students from Marie Curie INT networks, such as the present “IonTraC”.

Outreach strategy
The outreach activities of the section has included textbooks for brush-up courses for laboratory technicians, articles for the public and recently participation in “research theater” presented in a number of Danish cities. Similar activities will continue.

Collaboration with the private sector
We are presently partner in a 90 mill kroner projects financed by the Danish National Advanced Technology Foundation. This involves the private companies Aquaporin, Dupont, DSS, Arla. Collaboration with the private sector also includes LeoPharma, Grundfoss and DHL. We have been engaged in collaboration with the Biotech Industry for many years. Collaboration has included Centre for Eukaryotic Protein Production, joint effort including Novozymes, Danisco, Unizyme and Bioneer. We have furthermore been collaborating through co-financed PhD grants with Novo Nordisk, Neurosearch, Sophion and Symphogen.

Further information
Section home page www.bio.ku.dk/english/research/fys/

Selected recent publications


Walas H and Juel C. Purinergic activation of rat skeletal muscle membranes increases V\textsubscript{max} and Na\textsuperscript{+} affinity of the Na,K-ATPase and phosphorylates phospholemman and α1 subunits. Pflugers Arch – Eur J Physiol 463: 319-326, 2012.


Cell and Neurobiology

Background

Our section is studying the neurobiology and molecular endocrinology of insects and other arthropods. Within insects, we are mainly focusing on well-established models, such as the fruitfly Drosophila melanogaster. Furthermore, our section is intensely involved in insect and arthropod genomics and this research area will also be our focus for the next five years. This topic is very timely, because the genomes from about 50 arthropod species have just recently been sequenced and there are plans to sequence the genomes from 5,000 arthropod species (the i5k project) within the next 5-10 years. These enormous amounts of genomic data are extremely useful to better understand the biology of insects and other arthropods. In addition, this work has also societal relevance, as many of the sequenced arthropods are medically important as vectors for serious diseases such as malaria, Dengue and yellow fever, elephantiasis, sleeping sickness, Lyme disease, and many others. Furthermore, insects are agriculturally important, because most food plants depend on insects for their pollination and insects can be agricultural pests, destroying 30% of our potential annual harvest. In the light of an expected increase in human population of currently 7 billion people to 9 billion by the year 2050 and an expected concomitant food shortage, a reduction of these food losses caused by insects would also be extremely important.

Research strategy

Biogenic amines, neuropeptides, and protein hormones and their G protein-coupled receptors (GPCRs) steer central biological processes in insects, such as reproduction, development, feeding, and behavior. They do this in concert with steroid hormones, which in insects are mainly ecdysone and its derivatives. 20-OH-ecdysone, for example, stimulates the expression of several neuropeptide GPCRs, while some neuropeptides and protein hormones stimulate or inhibit the production of ecdysone. One Research Group in our Section is mainly studying GPCRs and their ligands, while another Research Group, which only recently joined our Section, is investigating the actions of ecdysone and its derivatives in insects. It is our goal that the research activities from these two groups get fully integrated during the next five years, including co-supervised undergraduate and PhD students and common research grant proposals.

We are active members of many large international research consortia (the Honey Bee, 5 Bees, Bumble Bee, Nasonia, Manduca, Hessian Fly, Pea Aphid, Rhodnius, Termite, Tick, and Centipede Genome Sequencing Consortia). It is our strategy to continue these collaborations, because they give us valuable first-hand information on the signal molecules, we are interested in. Our comparative approach using all these arthropod genomes has already been proven to be a powerful tool for discovering new neuropeptide signaling pathways. This neuropeptide discovery program will be an important part of our future work. Another strategic approach is the application of RNAi and large-scale genome-wide screening of transgenic Drosophila. All these different efforts will contribute to a better understanding of the neuroendocrinology and, thus, the biology of insects. Because Drosophila is an excellent model for human endocrine diseases, such as obesity and diabetes, we also expect that our work will contribute to human health.

Measureable short-term strategic goals

- Publish in high-impact factor journals and obtain high ISI citation quotes (>600 per year per staff scientist)
- Increase the number of staff
- Increase the number of enrolled PhD students
- Increase the amount of external funding from current 4 million DKK per year to >6 million DKK per year.

Education strategy

Our Section is the only group within the Faculty of Science that has a broad overview of mammalian neurobiology and we are responsible for all teaching in Neurobiol-
ogy at the Department. We have currently one high-level course in Molecular Neurobiology (7½ ECTS, for about 90 students yearly). We want to extend this teaching with a new course at the introductory level (Basic Neurobiology, 7½ ECTS). Our Section is also responsible for undergraduate teaching in Cell Biology (about 230 students yearly). Here, we would like to extend our teaching with laboratory practicals, depending on the presence of additional staff.

Outreach strategy
We have frequent interviews with Danish newspapers, radio or television. These contacts with the media should be continued in the coming years.

Collaboration with the private sector
We supervise numerous bachelor and master students who do their research projects in the private sector (NeuroSearch, Lundbeck, Novo Nordisk).

Further information
Section home page www.bio.ku.dk/english/research/cz/

Selected recent publications
Rewitz KF, Yamanaka N, Gilbert Ll, O’Connor MB (2009). The insect neuropeptide PTTH activates the receptor tyrosine kinase Torso to initiate metamorphosis. Science 326: 1403-1405
General introduction
A striking characteristic of microorganisms is their tremendous capacity to adapt to changing environmental conditions. Extensive gene shuffling provided by horizontal transfer of mobile genetic elements, in combination with the short generation time and high potential for dispersal and growth, represent central traits in microbial evolution. These are important distinctions between microorganisms and multicellular organisms. The Section for Microbiology is working to understand and exploit the immense adaptive potential of natural microbial communities using cutting-edge molecular techniques. Research on microbial interactions and adaptation in complex microbial communities is conducted within three main topics:
• Genetic adaptation
  Themes: horizontal gene transfer, plasmid biology, antibiotic resistance, co-evolution between bacteria and host, synthetic biology
• Adaptative changes in community composition
  Themes: succession, multispecies biofilms, biodiversity and climate change, host/bacteria adaptations
• Physiological adaptation
  Themes: stress responses, signalling, synergetic interactions, adaptation to the environment gauged by enzyme expression and production of metabolites.

Research strategy
Extend microbial community and activity with diverse environmental samples – including samples from the Arctic and Tropics – from pristine and polluted soil and waters. Our research is based on a variety of technologies, ranging from classical microbiological growth-dependent methods to analysis of community DNA/RNA by high throughput sequencing and reporter gene technology combined with single cell detection by flow cytometry. Specifically, we are currently conducting meta-genomic/transcriptomic surveys in diverse and complex environments such as the human microbiome, rat-gut microbiota, various types of soil environments, Mariana trench sediments, and food products e.g. cheese. We are currently polishing and publishing a new technique to sequence plasmid metagenomes (metamobilomics). We are also currently working on optimizing our single cell analysis for both environmental and biotechnological applications. The combination of single cell technology and high throughput sequencing will give us an excellent platform for future research development. A substantial part of the research is related to microbial biofilm formation. Here we are focusing on multispecies biofilms and the social interaction within these. It is our goal to establish a European Centre of Excellence in the emergent area of socio-microbiology within the next 5 years.
We expect to receive financing for these studies from National and European thematic grants within: Climate change, Food microbiology, Biotechnology, Synthetic biology and Health. Especially the health sector gives opportunities for strategic co-operation.
Through co-operation and participation in international projects the number of foreign students, post-docs and visitors has increased and we aim to maintain and expand this change to create a stimulating and productive environment.

Measurable short-term strategic goals
The section will benefit from local Bioinformatics research support for metagenomic sequence data. This position
will be an important short-term goal. Furthermore, we intend to consolidate the research activities within complex microbial communities (e.g. biofilm and human microbiome). This will include senior staff both with expertise in molecular microbiology and modelling.

• Ensure external funding exceeds 4 mill DKK per year to support and involve all VIP staff member grant applications.

• Ensure centre (VKR, DSF, DG, or ERC) construction for support of core areas.

• Obtain and maintain access to cutting-edge instruments
  o Main partner in Copenhagen High throughput sequencing centre.
  o Maintaining instrument centre for flow cytometry and cell sorting.
  o Establishment and implementation of the BIOFLUX platform as a Danish Centre for Biofilmstudies.

• Further participation in European partnerships – EU-funded

• Increase high impact paper publication

Education strategy
Bachelor’s level: The Section offers a General Microbiology course and many (>10) experimental bachelor’s projects annually.

Master’s level: Coordination of Microbiology Study-line and three courses: Advanced Bacteriology, Microbial Biotechnology, and Emerging Molecular Techniques in Microbiology. The Section is also involved in the Evolutionary Medicine course and the Microbial Ecology course. We supervise 10-15 experimental master projects annually including projects done at industrial and research partners.

Continued education: We coordinate the biotech part of the course Biotechnology and Bioinformatics aimed at high school teachers in biology and chemistry teaching biotechnology at Danish high schools.

Measurable short-term goals
• Develop a PhD course in next generation sequencing and bioinformatic analysis, contribute to at least two other PhD courses and finish at least three doctoral theses annually.

• Supervise and train more than 10 master students in their experimental projects annually

• Develop a new course on “The Human Microbiome” targeting Students at the Molecular Biomedicine study in collaboration with Thomas Bjarnsholts group at SUND.

Outreach strategy
Invitations to give lectures and to comment on microbial phenomena on the radio or TV are always welcomed. Our closest contact with the education sector is through a mail-order service providing microbial cultures to schools.

Collaboration with the private sector
We currently co-operate with private companies on four projects ranging from advisory functions, to joint experiments, to patent considerations.

We expect that projects including technological applications will at least potentially be attractive for further collaboration and are convinced that ultrafast sequencing facilities will be an important part of this development.

Further information
Section home page www.bio.ku.dk/english/research/ed/

Selected recent publications
Haugwitz MS, Bergmark L, Michelsen A, Sørensen SJ, Beier C, Priemé A. 2013. Soil fungal and bacterial communities respond differently to climate change manipulations and seasonal fluctuations. Soil fungal community responses to global changes, 31


General introduction

Plant and soil organisms are responsible for storage, conversion, and mineralization of naturally occurring as well as anthropogenic compounds. Anthropogenic impacts, including climate change and xenobiotics influence these organisms, with potential severe effects on ecosystem structure, functioning, and services. An immense number of species interact in these processes and a true understanding of the functioning of the system can be ascertained only through the study of key processes with due consideration of biodiversity of populations, species and functional groups. Possible interactions can be above ground-below ground, plant-symbiont and selected predator-prey, all of which are current topics in the Section. This understanding is of utmost importance when evaluating the effects of human activities such as warming and permafrost thaw, of habitat fragmentation and pollution as well as the measures taken by society to mitigate these effects. These research efforts in the Section have recently been substantially boosted with the strong involvement in the Center for Permafrost (CENPERM), funded by Danmarks Grundforskningsfond, and in the DSF funded ASHBACK.

Research strategy

• NOW: Research in newly established and long-term field experiments in the Arctic (CENPERM) and in Denmark (CLIMAIETE) simulating predicted future climatic conditions will continue.
• NEXT: Focus will be on the role of plants and microbes in the emission of CO$_2$ and VOCs and on nitrogen control of carbon sequestration, using a range of novel stable isotope and mass spectrometry techniques.
• NOW: We study biological decomposition processes and the dynamics between bacteria, fungi, protozoa and nematodes.
• NEXT: We will focus on the impact of species diversity on the functioning of the decomposer food web using state of the art molecular tools in combination with well-proven traditional methods.

The Terrestrial Ecology Section has long-term expertise in studying the effects of climate change and other anthropogenic impacts on organisms and ecosystems.Individually, we are experts in fungal ecology, soil biology, plant ecology, biogeochemistry, plant ecophysiology and evolutionary biology. Together, we can reveal the role of diversity and key organisms controlling the cycling of natural and anthropogenic compounds in ecosystems. We have strong expertise with large research infrastructures such as long-term field manipulations of microclimates in the Arctic within the DG funded CENPERM, and the similar Danish facility CLIMAIETE funded by VILLUM, as well as in experimentally based work such as that in the current DSF, VILLUM, and Environmental Agency funded projects ASHBACK, ARCTIVOC and MIRESOWA, respectively.

Measurable short-term strategic goals

• To maintain or increase current funding level in order to keep the number of post docs and PhDs well above the number of permanent staff
• To promote our eligible associate professors to full professorships

Education strategy

We will continue to deliver high-quality teaching including bachelor’s and master’s courses, supervision of proj-
ec tackle the awareness of the effects of climate change and other anthropogenic impacts on nature. This will be through mass media, and events like the Night of Culture, among other methods.

Collaboration with the private and public sector
Through new DSF funding ASHBACK we have strengthened our relations with the energy sector as well as the environmental protection agency. We already collaborate with clean drinking water suppliers through the projects MIRESOWA and serve as member of the board in Giant-code Corporation, Singapore.

Further information
Section home page www.bio.ku.dk/english/research/to/

Selected recent publications


General introduction
Section research addresses fundamental questions about the organisational principles and functional history of life and covers the disciplines of population and community ecology, evolutionary biology and animal behaviour, including the interfaces between them. Teaching obligations reflect the same breadth. Most projects are theory-driven and conceptually or experimentally orientated and use DNA technologies, GIS, biodiversity information tools, gas chromatography and mass spectrometry, statistics and modelling, and state-of-the-art acoustic equipment. Major research foci are:
• The ecological, population-genetic and co-evolutionary dynamics of interacting populations
• Spatial and temporal patterns of biological diversity, particularly for conservation biology
• The evolution of animal societies and the regulation of social conflict
• The evolution and mechanisms of acoustic, visual and chemical communication
• The application of ‘omics’ methods to address questions of biological adaptation
• Applications of ecological, evolutionary and behavioural principles in public health, biological control, software development, and animal welfare

Research strategy
The Section has 2 Full Professors, 5 Associate Professors and 1 Assistant Professor. Interdisciplinary approaches are common, both within the Section and with other research groups at the University of Copenhagen and beyond. These include biodiversity, conservation and climate change, genomics, microbiology, organic chemistry, parasitology, and population genetics. The Section implements research via long-term field programmes in tropical biology (Central and South America), Arctic biology (Greenland) and temperate zone ecology (Denmark, Europe, North America), and through experimental and modelling work directly related to field research. The Section enjoys major external support via a Centre of Excellence funded by the Danish National Research Foundation:
• The Centre for Social Evolution directed by Prof. Jacobus J. (Koos) Boomsma with further support from the The Danish Natural Research Council and an Advanced ERC Grant
And further includes:
• The Animal Behaviour group, directed by Prof. Torben Dabelsteen, funded by a large grant from The Danish Natural Research Council
• The Biodiversity group, which focuses on community ecology and nature conservation, has a number of grant proposals in review
The Section pursues an active policy of national and international talent recruitment via PhD and postdoctoral fellowships, and hosts a substantial number of EU-Marie Curie postdoctoral fellowships and senior sabbatical visitors from abroad.
Measurable short-term strategic goals
- A number of academic positions identified by the Section to be filled in the coming years, either as junior tenure-track positions or at a more senior level, to compensate for retirements and to secure the subfields of Animal Behaviour, Molecular Evolutionary Biology and Conservation Biology
- A further increase in external funding including a junior ERC grants
- The development of a permanent programme of PhD courses

Education strategy
The Section continues to develop its integrated programme of courses throughout the bachelor’s and master’s curriculum in Biology (the “Ecology and Evolution line”) with occasional contributions to other curricula, and aims to increase its teaching collaborations with other Sections, Institutions and Faculties in the Greater Copenhagen area. The Section is particularly keen on coordinating a more integrated teaching programme in Evolutionary Biology, to increase the visibility of this crucial field across the academic disciplines.

Outreach strategy
The section publishes a regular stream of press releases and achieves ample coverage in the national and international media. We also contribute to exhibitions, regularly give popular lectures and, through mass media, promote the use of scientific evidence in nature conservation issues.

Collaboration with the private sector
The Section collaborates with national and international consultant companies, NGOs, non-profit organizations, and (inter)governmental organizations, focusing on issues of biodiversity management, ecosystem services related to land-use and climate change, and restoration planning.

Further information
Section home page www.bio.ku.dk/english/research/oe/

Selected recent publications


Freshwater Biology
FERSKVANDSBIOLOGI

General introduction
Freshwater Biology Section (FBS) conducts research on streams, lakes and coastal areas encompassing experimental and comparative studies on species, communities and ecosystems differing in human or climatic impact. The overall purpose is to understand and explain patterns in biological diversity, adaptations of organisms in relation to their environment and to the structure and function of whole aquatic ecosystems. We seek to stay among the world’s leading institutions in four research fields:
- Influence of altered local and global climate, land use and eutrophication on aquatic ecosystem quality and processes applying automatic monitoring systems and ecosystem modelling.
- Microbial transformation of organic matter and biogeochemical processes related to aquatic organisms and ecosystems.
- Ecology and physiology of aquatic plants using contemporary methods and innovative micro-sensor techniques.
- Predicting the distribution of species, communities and biodiversity from mechanistic eco-physiological experiments and environmental data.

FBS’s research in these fields has a high publication rate and will be further expanded in the coming years. Activities will continue to be carried out at the local, regional and global scale, especially in the temperate climatic zone but also in the arctic and the tropics. Significant scientific discoveries are often obtained through collaboration among different disciplines and we therefore aim at promoting freshwater ecology in multidisciplinary initiatives which is enforced when the section moves to Copenhagen.

Research strategy
FBS is a strong and attractive partner in national and international aquatic research. We are successful in obtaining external funding, and we will increase our share of large volume international projects in order to attract more postdocs and PhD students. We find it important to maintain our strong portfolio of research activities covering a wide range of topics, as long as they have an internationally competitive quality.
It is vital for our success as a research and teaching unit to assure a critical mass of permanent staff. The section has experienced staff reduction (two associate professors and three technicians) a consequence of the departmental budget reductions. This combined with upcoming retirements request a significantly economical boost in order to realize the the focused research areas stated above. We are in the need of staff with competences within the fields of:
- ecosystem metabolism, mass balances and modeling of disturbances including climate change, land use and invasive species
- microbial transformation of organic matter and the functional response of organisms to varying nutrient regimes and climatic conditions.
Measurable short-term strategic goals
- To increase the amount of external funding through internal collaboration
- To attract a new tenure track position in ecosystem processes
- To increase the number of postdocs and PhD students
- To establish new research groups based on interdisciplinary collaboration commitments
- To increase the production of candidates and the yield (STÅ) from teaching activities
- To contribute to specialized courses for PhD students

Education strategy
Our teaching portfolio includes bachelor and master courses, supervision of projects, excursions and field work, as well as the mentoring and guidance of students through all phases of their study. We are responsible and/or involved in a number of courses: General Ecology, Statistics, Biodiversity, Experimental Biology, Arctic Biology, Modelling of aquatic ecosystem, Ecophysiology of aquatic plants, Freshwater Ecology, Environmental management as well as field courses in General limnology, Macroinvertebrate ecology and Water chemistry & pollution. We will maintain our share of teaching at the Department of Biology, and we will continue to improve the quality and seek the best possible practice for teaching and supervision.

All of the master students that we produce find jobs in national environmental authorities, R&D companies and the industry or continue as PhD-students in external funded projects lead by us or our research alliances.

Outreach strategy
FBS has a long tradition in outreach activities. Our contributions include books, web pages, articles to popular magazines, specialized journals and newspapers, radio and TV broad casting, public debates, lectures for the public, teaching in open source environments and contributions to major public events such as The Night of Culture in Copenhagen. Despite difficulties finding time and funding for such activities we intend to maintain a high level of activity.

Collaboration with the private sector
Several of our research areas have the potential for extensive collaboration with commercial and inventor partners. Presently, we have fruitful collaborations with two R&D micro-sensor company as well as two small-sized companies that develop equipment for automatic monitoring systems. We anticipate that these relationships will continue and develop over the next few years and that it will be of mutual benefit.

Further information
Section home page www.bio.ku.dk/english/research/fbl/

Selected recent publications
Cazzanelli, M., Forsström, L., Rautio, M., Michelsen, A., & Christoffersen, K. S. 2012. Benthic resources are the key to Daphnia middendorffiana survival in a high arctic pond. Freshwater Biology, 57: 541-551.


General introduction
The Section is based at two locations; one at the North Harbour in Helsingør, the other at the newly established laboratory at the University Park 4 in Copenhagen. About 2/3 of the staff is located in Helsingør, while the rest is located in Copenhagen. The Helsingør facility represents the only permanently staffed marine station in Denmark. The Copenhagen facility houses Scandinavian Culture Collection of Algae & Protozoa (SCCAP) containing more than 1000 algal strains. It is the only of its kind in Denmark and is the largest public service collection in Scandinavia. A public aquarium and outreach facility (Øresundsakvariet) is an integral part of the Marine Biology Section (MBS) in Helsingør, receiving >50,000 visitors and teaching marine biology to >10,000 children and students per year, representing a unique coordination of research, teaching and outreach activities in marine science.
The permanent staff includes 2 professors, 9 associate professors, 7 emeriti, 3 lab technicians, 2 ship crew, and 1 technical staff member in a mechanics workshop in Helsingør. On different projects we host at the moment 1 associate Professor, 6 post docs, 2 scientific assistants, 1 lab technician, 16 PhD students and 21 Master students.
The staff at the aquarium includes 2 permanent scientific members, 1 permanent technical staff member, plus a number of non-permanent technical staff; all are funded through the aquarium activities.

Research strategy
Our research covers basic and applied aspects of marine biology within the following research areas:
1) Aquatic microbiology (e.g. microbial ecology, physiology, systematics, phylogeny, diversity and interactions).
2) Functional biology of marine organisms (e.g. functional morphology, adaptation and evolution of benthic invertebrates and fish, comparative respiratory circulatory physiology of fish, evolution and function of vision in primitive invertebrates and protists).
3) Climate change (e.g. effects of ocean acidification, hypoxia and elevated temperatures on organism and community levels, conservation physiology of fish).
4) Aquaculture and bioproducts (e.g. bacteriophage therapy, bioproducts from photosynthetic microbes, production and nutritional physiology of fish and mussels, the effects of harmful algal blooms on fish and invertebrates).

The research involves numerous national and international collaborations, including exchange of students and staff, and takes place in a wide range of systems from polar to tropical habitats and from shallow estuaries to the deep sea. A number of interdisciplinary projects link the two main research topics (Aquatic microbiology and Functional biology) and the two geographic locations and thus contribute to the coherence and collaboration in the section (see Figure 1 on this page). We publish annually 70+ international papers with peer review.

Measurable short-term strategic goals
- Continue to attract larger strategic grants and EU grants within the next 5 years. The amount of external funds should support ~15 PhD students, ~4-6 post docs and 1-2 lab technicians.
- Increase the number of publications in high-ranking journals.
- Establish 1-2 permanent international PhD courses within main research areas.
- Modernize/renovate laboratory facilities in Helsingør and establish a new “wet” teaching facility to accommodate 24 students
- Make needed improvements to salt water facilities, including establishing a pumping system providing bottom water directly from Øresund.
- Strengthen our collaborative effort with DTU Aqua supporting future scientific and educational collaboration between KU and DTU Aqua. This includes sharing of ship facilities.
- Increase our teaching income to reach 90 “STÅ” per year (STÅ = student year equivalents), primarily through re-
Recruitment of students for bachelor and master projects.

- To expand the ownership of the Scandinavian Culture Collection of Algae & Protozoa by including both other departments at the University of Copenhagen and other national universities in the funding and use of the collection.

**Education strategy**

The MBS contributes to basic and advanced courses at KU. Our teaching efforts have been revised and focused recently and a number of new courses have been developed during the past two years. At the basic level we currently teach courses in General Ecology, Bacteriology, Organism Diversity, Applied Marine Biology, Field Biology and Invertebrate Zoology. At the advanced level we have created a new Marine Biology competence profile, allowing students to specialize in Marine Biology. Master courses include Marine Biology, Marine Microbiology and Virology, Animal Morphology, Experimental Marine Biology, Fish Physiology, Protists, Applied Phycology and Invertebrate Physiology. The section is a key provider of courses and infrastructure to the international masters education, “Aquatic Science and Technology”, in collaboration with DTU Aqua. This collaboration is an important building stone for maintaining and expanding the MBS as a strong centre for marine research and education in Denmark. The current yearly student intake at MBS is high (~20 MSc and 10 PhD students), and we will maintain and expand this momentum by various recruitment initiatives (e.g., open house arrangements and excursions). Currently we produce ~80 STÅ/year.

**Outreach strategy**

Staff at the MBS has a strong tradition for outreach activities communicating marine science to the public via books, articles in magazines, websites and newspapers, and frequent appearances in the media (radio, TV and newspapers). The proximity of the MBS to the sea, and its wet labs and close association with aquarium provide optimal conditions for teaching and communicating marine issues to the public. We will expand outreach efforts in the future by exploiting a large potential for outreach and teaching targeted towards high schools and training of teachers.

**Collaboration with the private sector**

The MBS has strong collaboration and links to several SMEs developing and selling advanced research equipment such as advanced electrochemical and fiber-optic microsensors (Unisense A/S, Presense GmbH, and Pyro-Science GmbH). Furthermore, there are strong links to industry (e.g. Orbicon, Chr. Hansen A/S, COWI, BioMar A/S, Dyrup, Sunchemical (Hempel), Hjarnø Havbrug, Musholm Lax A/S, and AquaPri A/S) through several ongoing strategic and applied research projects, e.g., on optical properties of diatoms, harmful algae and fish kills and on aquaculture and phage therapeutic approaches. We see a large potential to further expand such collaboration in the future, e.g., by targeting business partnerships in the field of bioproduction, biodiscovery and bioactive compounds.

**Further information**

Section home page [www.bio.ku.dk/english/research/marinebiology/](http://www.bio.ku.dk/english/research/marinebiology/)

**Selected recent publications**
