

*Biology towards 2020:
Higher goals, deeper insight*

STRATEGY

SHORT VERSION

FOR THE DEPARTMENT OF BIOLOGY
2011–2015



UNIVERSITY OF BERGEN
Department of Biology

Vision and objectives

Vision

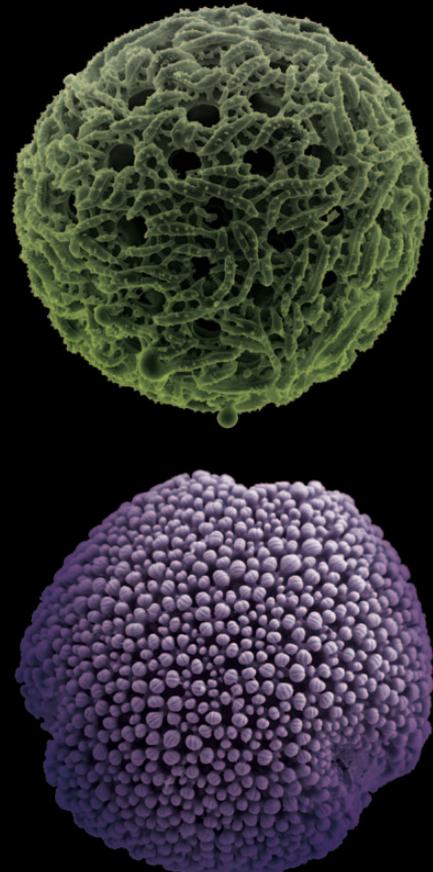
BIO shall generate pioneering, fundamental knowledge about the origins of life, evolution, processes and systems, and help to resolve major global challenges.

Objectives

BIO shall:

- generate and communicate fundamental knowledge about life forms and life processes, from genomes to biomes¹, and how they are affected, modified and used
- train qualified biologists with broad scientific insight and a critical attitude
- communicate relevant biological knowledge to schools and the public
- build a foundation for the application of biological and biotechnological knowledge in wealth creation and resource management
- actively participate in public debate by showing how biology and biological knowledge are relevant to address global challenges

¹ Biomes are large regional units of organisms that live in similar environmental conditions. Biomes correspond to the main ecosystems on earth, and together they constitute the biosphere (<http://en.wikipedia.org/wiki/Biome>).



Grand challenges and overarching goals

Biology is the science of life, living organisms and their relationship to the environment they live in. Important unresolved questions in biology concern issues such as the origins of life and the possibilities of life elsewhere in the universe, the processes of life and how genes and molecules are linked to produce functioning biological organisms, and evolutionary processes and how organisms interact in ecosystems.

Recent decades have seen major advances in science allowing us to achieve a more comprehensive understanding of biology and its applications. New methods of observation and analysis have increased our insight at the molecular level, while increasingly sophisticated computers and methods provide a basis for better integration of observations and models. In this way, we are constantly improving our understanding of molecular and cellular processes, the physiology and behaviour of organisms, and individuals' adaptation to each other in populations and communities in relation to their habitat and food availability. More recently, biology has become the centrepiece of the greater Life sciences² term. This development has led to a fundamental shift in approach away from traditional organism and biome-based disciplines (such as botany, zoology, microbiology; marine or terrestrial) and towards more process and system-oriented studies such as developmental biology, evolutionary biology and ecology. This new, integrative biology³ also encourages greater interdisciplinary collaboration with other fields such as physics, chemistry, geology and medicine, and has entailed a stronger emphasis on mathematics through computational biology and bioinformatics.

This development requires communication and interaction across traditional academic borders with a firm basis in the disciplines. In this development, subjects like molecular biology and bioinformatics are no longer regarded as "tools" for biologists, but are integrated components of biology. Modern biology thus requires expertise in highly specialised areas as well as breadth, access to advanced equipment and infrastructure, and the skills and opportunity to use and analyse the information generated.

Biological knowledge and research are also needed to understand and resolve many of the grand challenges facing society⁴. Loss of biological diversity, the effects of climate and environmental change, and mankind's need for food, water, health and energy are all areas where biological knowledge can contribute to sustainable solutions. At the same time industry, government authorities and the healthcare sector need biological and scientific expertise to be able to absorb and make use of this kind of knowledge.

The *Ostend Declaration* identifies the world's seas and oceans as one of the grand challenges of the 21st century⁵. The sea was the cradle of life and is an important arena for research into life's mysteries. Marine organisms make up a significant percentage of the life forms and biological diversity on earth, and the organisms and ecosystems in the oceans play a central role in productivity, biogeochemical cycles, and climate systems. Oceans and coastal areas are vital to human life, providing access to resources, health and wellbeing. At the same time, oceans are extremely vulnerable to human impacts. Research into marine ecosystems has a high priority on the international research agenda.

Research and teaching at Norway's largest biological academic and research institute need to reflect developments in the profession and the challenges facing society. We must keep abreast of the main international trends both in order to be at the forefront of the research we provide, and also to train students at Bachelor's, Master's and doctoral levels so they are well qualified in all the latest developments in the field.

2 http://en.wikipedia.org/wiki/Life_science

3 Integrative biology is defined here as an overarching, interdisciplinary study of living organisms and life processes, from genome to biome, where classical biological disciplines are integrated with other disciplines such as physics, chemistry, biology and medicine. Systems biology is a key element of integrative biology.

4 The Lund Declaration (2009); Millennium Ecosystem Assessment.

5 The Ostend Declaration (2010), <http://www.euroocean2010.eu/declaration>

BIO strives to be a research and teaching environment with high ethical standards and awareness in all our activities: from choice of topics, via collaboration with researchers, industry and society, to publication, education, dissemination, and management of the resources society has entrusted us with.

BIO wants to:

- be a high-profile participant in international research into unresolved issues in biology and be an international leader in some areas
- contribute to finding solutions to the grand global challenges
- be a key international player in marine research, global research and research in Arctic areas
- train students at the Bachelor's, Master's and doctoral levels to be highly qualified scientists and well equipped to fulfil leading roles in research, education, industry and society
- generate basic and pioneering knowledge and provide schools, the public and decision makers with relevant information

This strategic plan stakes out a course to achieve these goals and points to various measures that we want to implement. The strategic plan builds on the Department's previous strategic plan and the Faculty's and the University's strategic plans for the period 2011–2015. The national Review of Research in Biology and Relevant Areas of Biochemistry at Norwegian Universities, Institutes and State Colleges ("Biofagevalueringen") in 2010–2011 will provide guidelines for the implementation of some aspects of the strategic plan.

Focus areas

Based on the Department's strengths and areas of expertise, BIO has identified four main focus areas.

BIO will:

1. be involved in the search for answers to biology's major unresolved issues, with a focus on evolutionary, developmental-biological and ecological processes
2. be a major player in marine biological research, nationally and internationally, throughout the entire research chain from molecular processes to aquaculture and oceanography, from genome to biome
3. help increase understanding of the effects of global changes on species and ecosystems (climate change, habitat change, pollution, resource consumption), on the basis of research in polar areas and global comparative studies
4. through research-based education within these areas train highly qualified scientists at the Bachelor's, Master's and doctoral levels to be able to assume leading roles in research, education, industry and society

Focus area 1: The big questions in biology

BIO and its predecessors have always worked on the "big questions" in biology: How did life originate, and how do life forms, life processes and patterns develop? What are the underlying biotic and abiotic driving forces behind this development? These basic evolutionary questions can be approached from different levels, using a range of methods and from different angles.

BIO is involved in cutting-edge interdisciplinary research in geobiology⁶, where we try to understand the origins of life and its early development, among other things. Studies on the organism level focus on issues such as the development and evolution of important life functions and morphological traits. A major challenge in this work is understanding how genetic information is expressed and developed in living organisms. At BIO, these kinds of questions are central in research across types of organism, habitat and research methodology – from thermophilic microbes to terrestrial vertebrates, from pelagic to alpine environments, and from morphological and genetic analysis using bioinformatics to behavioural studies. Studies on the population and ecosystem levels touch on questions concerning the development and evolution of the diversity of species, populations and ecosystems. BIO combines modelling and empirical studies in systematics, biogeography, palaeoecology, population genetics and ecology to shed light on questions such as: How do ecosystems – from micro-habitats to continents – develop, how are they

6 Centre for Geobiology, www.uib.no/geobio

affected, and why is there variation? How does biodiversity occur and how is it maintained? What are the underlying factors that drive regime shifts in ecosystems? Which ecological processes stabilise ecosystems?

A common feature of these major issues is that they require an integrative biological approach. Strengthening integrative biology is an important priority for BIO in this strategy period. This means we must build up expertise and support structures and projects that encourage collaboration on hypotheses, processes and patterns detached from traditional classifications based on type of habitat or organism.

In order for BIO to be able to participate in the international research arena in these fields, we must build on the common strengths in the community in Bergen by making good use of the research institutes and infrastructure both within and outside the University of Bergen. At the same time, this requires that we actively seek out the best teams internationally and develop collaboration that complements and further develops our own expertise.

Focus area 2: Marine ecosystems – from genome to biome

The marine ecosystem is the main system studied at BIO, and we have made a name for ourselves in this area with several internationally leading research groups. Within the field of marine biology, BIO covers the entire research chain from genome to biome, and the entire chain of organisms from viruses to vertebrates. We explore the fundamental questions in biology, and in collaboration with other researchers and industry, we have developed a good and mutually beneficial integration of basic and applied marine research. BIO has excellent marine research facilities, providing scientists with access to excellent laboratory and field-based installations, as well as unique coastal, fjord and marine environments.

In the wake of the previous national review of research in biology subjects, BIO has strengthened its basic marine research through emphasis on scientific relevance and prioritisation of posts linked to basic subjects in strong academic environments (marine microbiology, modelling, systematics and biodiversity, geobiology, developmental biology, evo-devo, molecular biology and bioinformatics), through investments in infrastructure, and by stimulating integrative approaches.

Our marine infrastructure ranges from molecular biology laboratories and platforms for research on aquatic model organisms⁷, via organism laboratories and high-capacity freshwater and saltwater aquarium facilities, to mesocosms and research vessels.

BIO's basic research on marine organisms' reproduction, development, growth, nutrient uptake and immune system, combined with studies of the oceans' primary production, viruses, bacteria and parasite-host interactions, contribute to research-based, sustainable aquaculture. Similarly, our research into marine microbial food webs, marine species' population dynamics, food selection and reproduction, combined with studies of ecosystem dynamics, evolution and the effects of global and anthropogenic changes, provide a knowledge base for sustainable fisheries and coastal zone management, nationally and internationally.

⁷ Zebrafish, guppy, Appendicularia, Cnidaria, Ascidia, sea lice, Porifera, plankton, bacteria and virus cultures.



BIO will continue to be a key player in the international marine research arena and produce research of high scientific relevance and will facilitate this through the priorities made in the strategy period. We will bolster efforts to tap into the potential for mutual support and encouragement inherent in close, binding collaboration with more applied research institutions, industry, businesses and the authorities. Relevant topics for translational⁸ research approaches of this nature include fisheries, aquaculture and fish health, biofuels, natural resource management, biotechnology, bioprospecting and the effects of pollution, climate change and environmental change.

Focus area 3: Effects of global change

In our research we seek to understand the processes, mechanisms and patterns in nature, how they originated and how they develop through interaction between the organisms and their external environment. Anthropogenic global changes affect this interaction, and understanding the effects of these changes in the short and the longer term are interesting research questions. BIO researchers examine how the climate, environment and use of resources affect the biotic responses on many different levels, from gene regulation, via physiology and immunology, reproduction and behaviour, to population dynamics, biodiversity and ecosystem functions.

Evolutionary vs. plastic responses, change rates, tolerance limits and resilience are some of the key issues that are relevant regardless of level, organism group or habitat.

Through this research, BIO generates knowledge that enables society to understand and find solutions to many of the grand challenges it faces. Loss of biological diversity, the effects of climate and environmental change, and mankind's need for food, water, health and energy are all areas where biological knowledge can contribute to sustainable solutions and the sound scientific knowledge on which decisions should be based. At the same time industry, government agencies and the healthcare sector need biological and scientific expertise to be able to absorb and make use of this kind of knowledge, and BIO makes an important contribution in this area by educating biologists with the necessary skills and expertise. In this area too, the translational research strategy will serve to provide useful ties between research, administration and industry.

Comparative studies are important in research on global changes, and BIO has research activities in the fjord landscapes of western Norwegian, in the high north and in countries farther south. Arctic research is vital to the work to obtain a fundamental and comprehensive understanding of the marine ecosystem, and to the Department's climate research. Many of the questions that the Department addresses in its research are of great relevance in the south too, both because the effects of the global challenges are greater in these regions and because southern study systems may be able to provide answers to important scientific questions. Based on our expertise and in line with our academic objectives, BIO intends to promote research and educational collaboration in order to build up capacity with partners in the south as part of our corporate social responsibility.

Research on the effects of global changes will remain an important priority at BIO in this strategy period, and we will continue to build on our positive experience from creating win-win situations through research that is highly relevant academically and to society.

⁸ Translational research is increasingly being used in areas where basic research, transferability, and application to practical situations are viewed together, and where practical situations may provide impetus for new, basic research questions.

Focus area 4: Education

Through our student programmes, BIO will educate qualified biologists with a broad academic foundation who are well equipped to assume leading roles in research, education, industry, government and society in general. Based on research of high international quality, BIO will provide students with models, methods and concepts that enable them to apply biological theories and principles in an analytical manner as well as general skills in resolving complex problems. In-depth studies will give students the opportunity to acquire academic knowledge, hone their specialised and general academic skills and develop proper research and professional ethics.

In light of these ambitions, we have revised and modernised our Bachelor's degree with effect from autumn 2011. Our Master's programmes will undergo a similar revision in the strategy period in order to ensure we provide modern and forward-looking training for tomorrow's biologists.

Researcher training is one of the core activities at BIO, the main components of which are the PhD students' own research work and advanced academic training. The PhD programme consists primarily of work in the research groups, supplemented by specialised courses, research schools, and collaboration with external scientific environments, and also includes participation at international conferences, seminars, workshops and research-related exchange visits.

BIO's primary objective is that high quality should be the main characteristic of all aspects of the education at the Department from Bachelor to PhD, with a clear focus on high learning outcomes and a good learning environment.



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