

Global Challenges – Research strategy for Department of Biology, 2019 - 2025

1. Introduction

The Department of Biology's (IBI) overall strategy for the period 2019 – 2025 states a general path forward for all main activities at the department, research, education, dissemination, innovation, organization and management. In addition, the Department has two more specific research strategies:

- IBI's contribution to understand and predict the effect of four selected global challenges
- IBI's goals and strategy for the marine area.

The strategic vision of the Department of Biology is to ***Understand Life – Preserve the Environment***. This dual vision is the strategic foundation for all research, research training and education at IBI. The two elements are of equal importance at IBI. The research aimed to ***preserve the environment*** is resting on fundamental science aimed to ***understand organismal life and processes***, at all levels from molecular through physiological to ecological and evolutionary processes. IBI thus aims to promote international excellence in science addressing both fundamental questions and environmental issues in close interdisciplinary collaboration, nationally and internationally.

The Department's vision and strategies will contribute to realizing NTNU's vision Knowledge for a better world and NV's vision ***Natural Science and Technology for a sustainable future***.

In line with NTNU's aim of ***Knowledge for a better World***, the NV Faculty and the Department of Biology target global challenges, in particular with respect to our environment. The Department of Biology has identified four major global challenges as focus areas for our research and education:

- Climate change
- Biodiversity loss
- Environmental Pollution
- Sustainable exploitation and use of natural resources

The present strategy document, *Global challenges*, complements the overall strategy for all responsibilities for the Department of Biology (IBI 2025, *Understand life – Protect the environment*) and describes our contribution to understanding and predicting the effects of selected global challenges. In addition, we are applying the strategy to marine challenges, and highlighting areas of expected future growth and importance in the marine sector.

IBI Climate change research

The October 8, 2018 announcement by the Intergovernmental Panel on Climate Change, emphasized that global warming is the single biggest challenge faced by humanity in the 21st century. It will far have reaching effects on biological systems at all levels, many of which are poorly understood or may be presently unknown and unexpected. IBI is well-positioned, with its existing staff and research programs, to make major contributions towards the basic science foundation essential for understanding, predicting, and managing the biological effects of climate change in the northern European region and other regions. The research contributions will be complemented and expanded through a research-based educational component ensuring that Master's students and PhD fellows coming from our own study programs are well-prepared for the challenges they face in our ongoing research projects and when serving society outside IBI and NTNU.

Goals

- Build on and expand existing knowledge and skills to generate baseline data and predictive models on the effects of global warming, increased atmospheric CO₂, and associated environmental changes at cell, organism, population, and ecosystem levels.
- Investigate and understand effects of climate change on the gene, cell and single individuum and ecosystem level.

Action plans

- Establish an interdisciplinary climate change interest group at IBI to create opportunities for novel synergistic interactions and link it with external partners.
- Refocus existing / initiate new research programs to take advantage of funding opportunities (large, interdisciplinary NFR and EU grants) and to address the need for data on biological responses to climate change
- Develop research initiatives within and between researchers and research groups to connect different scales of biology (from single cells to ecosystems).
- Use Master's projects as connecting elements in climate change research programs to start new collaborations and incorporate new PhD / postdoc positions in the climate change-focus to generate critical research activity.
- Build knowledge and skills relevant to climate change research into the curriculum at all levels and establish a 6th semester, compulsory interdisciplinary capstone course on Global Change Biology for the BBI degree.

IBI Pollution Research

IBI performs extensive research on the occurrence and effects of a broad range of pollutants within biological systems from the molecular to the population level, using field sampling, controlled experiments as well as mathematical modeling. There is focus on holistic approaches, which assess the impacts of multiple stressors, including pollutants, climate change, habitat degradation and disease on biological systems. This work ranges from the molecular and cellular to the organismal and population level. It involves both basic and applied research, which contributes to a better understanding of the biological implications of pollution of natural, rural and urban environments through applied research is particularly relevant for national and international legislation regarding production and use of chemicals as well as risk management measures for pollutants with possibly adverse effects on organisms and populations in their natural environment. Another important output of the research is information related to management of species, biodiversity and ecosystems in light of anthropogenic pressures.

Goals

- Advance integrative research to understand how effects of pollution are propagated across different levels of biological organization, from molecules to ecosystems.
- Stimulate predictive approaches in environmental toxicology focusing on relevant exposures and impacts, including those on human health.
- Increase impact of its research activities on society.

Action plans

- Expand the use of quantitative approaches and models in environmental toxicology, including toxicokinetic and toxicodynamic models and population models, to better address the impact of pollution in a changing environment.
- increase its public visibility by intensifying and professionalizing outreach activities, expand communication with public institutions to promote and ensure science-based policy-making and intensify communication with all relevant stakeholder through workshops to identify current and future challenges.
- Intensify collaborations locally with disciplines like chemistry, molecular biology, ecology and biomedical research as well as nationally and internationally with leading research institutions through joint research projects
- Enhance integration of research and teaching activities within IBI through joint MSc and PhD projects that focus on linking laboratory and field work, covering relevant animal models and experimental approaches (e.g., mesocosms) and involve colleagues from molecular/systems biology and ecology.

IBI sustainability

Environmental sustainability can be defined as utilisation of natural resources that meets the needs of the present without compromising the ability of future generations to meet their own needs. IBI has significant research activities in the area of environmental sustainability, which can be grouped into the three topical areas: Sustainable harvesting; Sustainable cultivation and genetic modifications of food and energy crop organisms; limitation of negative anthropogenic impacts on ecosystems. Knowledge in all three areas is a prerequisite for the sustainable use of natural resources both in developed countries like Norway, as well as developing countries worldwide. Therefore extensive international collaboration is a pre-requisite for understanding similarities and differences in the areas due to natural or societal differences. Common for the three areas is that they are expected to be most efficiently studied and knowledge transferred with respect to sustainability when carried out in close collaboration with other fields of science as well as the stakeholders, industries and governmental agencies involved. Involving these other parties ensures the necessary interdisciplinary scientific approaches and that scientific concepts and solutions developed are validated and applied in the real world. Existing relevant research infrastructure, active research-based teaching in the area (exemplified by the Master programmes in Natural Resource Management and Ocean Resources), and alignment with the NTNU strategic research activities on Sustainability will form the foundation for future activities in this area.

Goals:

- Continue developing and improving general ecosystem models to study and predict consequences of harvesting in natural systems.
- Facilitate sustainable food and energy production through knowledge-based improvement using molecular means and breeding programs.
- Increase understanding of the anthropogenic influences like pollution, urbanisation, infrastructure development and other habitat modifications on natural ecosystems.

Action plans:

- IBI will actively contribute to NTNU's research activities in the strategic area of Sustainability and if resources are available dedicate co-funding to projects where IBI is involved.
- Align and connect research with societal needs by:
 - o performing interdisciplinary work involving collaborators both from IBI, social sciences and technology-focused disciplines sciences relevant to environmental sustainability.
 - o collaborate more actively with institutions outside academia.
- Increase the funding obtained from national and international (e.g. EU funding) grant calls on Sustainability.

IBI Biological Diversity

We are currently living during the sixth period in the Earth's history of mass-extinction of species. This massive loss of biological diversity occurs all over the globe including Norway. In contrast to the earlier periods with rapid extinctions of species, this time it is mainly caused by different forms of human activities such as loss and fragmentation of critical habitat types, changes in climate, pollution, over-harvesting and invasive species. Although the biological diversity is currently lost at an unprecedented rate, we still know little about the long-term consequences for the biosphere. Research groups at IBI have produced important insights in how single-populations will respond to different kinds changes in the environment and how their long-term persistence will be affected. This research has mostly been based on approaches combining development of mathematical models and statistical methods with analyses of data from several unique model systems that researchers at IBI have been running, often over several decades.

Goals

- Expand the research approaches focusing on the ecology of single species to include an evolutionary perspective as well as interspecific relationships.
- Maintain existing strong links between theoretical and empirical / applied research activities in areas like evolution, ecology, behavior and population and community dynamics and develop new ones with areas outside IBI.

Action plans:

- Continue and expand usage of quantitative approaches in both research and education in this field at the IBI.
- Maintain and if possible expand projects taking advantage of existing long-term time series data repositories.