The Department of Biosciences (IBV) was established 1st January 2013, following the merge of the Department of Biology and the Department of Molecular Biosciences. The Department’s research focuses on understanding the fundamental biological processes from molecular and cellular level to population and ecosystem level.

The Department has one Centre of Excellence (Centre for Ecological and Evolutionary Synthesis) and seven research programs (Cell Biology, Genetics, Integrative Biology, Marine Biology, Microbial Evolution Research Group, Physiology and Neurobiology, and Protein).

By 31st December 2013, the Department of Biosciences housed 50 permanent staff, 9 II-positions (professors and adjunct professors in 20% positions), 14 permanent and 3 temporary administrative positions and 44 permanent and 13 temporary technical positions. 107 post docs/researchers and 72 PhD research fellows were employed by December 2013. Additionally the Department this year housed >100 visiting researchers, extending the number of nationalities of employees and guest researchers to 29 for 2013.

In the fall semester, there were approximately 400 bachelor students, 250 master students and 152 PhD students actively enrolled at the Department. 64 master degrees and 30 PhD degrees were awarded by the Department. We taught a total of 118 courses; 23 bachelor-, and 95 master- and PhD-courses.

In 2013, our researchers published 277 articles in peer reviewed journals and contributed more than 300 conference papers, reports, media contributions and other professional presentations.

Best teachers in 2013, nominated by the students, were Anne K. Brysting and Kristian Prydz. The innovation/dissemination award were presented to Kristian Gundersen, and Anne Maria Eikeset et al., Yang Jin et al. and Robert P. Kumpf et al. were awarded best paper prizes.

The total budget for the Department of Biosciences in 2013 was 312 million NOK, of which 121.1 million NOK came from external funding sources. External funding of projects is distributed between the Norwegian Research Council (83.5 million NOK), and other national and internation funding (EU, public and private sectors; 37.6 million NOK).

Cover picture: The Italian sparrow Passer italiae is one of few well-supported homoploid hybrid species where evidence suggests reproductive barriers have developed against both parental species, the house sparrow P. domesticus and the Spanish sparrow P. hispaniolensis. Since hybrid speciation is often depicted schematically as the origination of a third lineage from two diverged branches (parental lineages) on a dichotomous phylogenetic tree, its essence is nicely captured by the position of the hybrid sparrow in this years’s cover photo. © Ivan Ivanov
2013 has been the first year of operations for the Department of Biosciences (Institutt for biovitenskap, henceforth called IBV). The main motivation for the merger was to create a stronger department able to make the best priorities for research and education within the entire domain of biology at the University of Oslo.

A university department is not equal to its management, but rather a reflection of all the people that work in that department. However, in a department with approximately 300 employees (tenured and temporary) some form of structure is needed, and a major effort in 2013 has been the reorganization of the department. Thus, the IBV was reorganized (applicable from 1.1.2014) into five research sections (including the CEES), one infrastructure section and a section for administrative services. The seven section leaders have the difficult task of representing their section’s interests in the IBV management meetings while at the same time thinking about what is best for the department as a whole. Personally, I am very happy with the outcome of this reorganization and I am confident that all the section leaders will grow with their new responsibilities. The organizational chart of IBV as of 2014 can be found on our web pages http://www.mn.uio.no/ibv/for-ansatte/aktuelt/nytt-organisasjonskart-for-ibv.html

Education is without doubt the area where the IBV, and the Faculty of Mathematics and Natural Sciences as a whole, has the largest impact on Norwegian society. More research within biology and biomedicine is required to solve many of the issues the world faces today, such as pollution, climate change, safe and sustainable food production and the need for better treatment for both “old” and emerging diseases. However, to translate research results into national policy and put this into practice requires that the population in general, and our elected political leaders in particular understand the scientific foundations and validity of these results. Thus, it is of utmost importance that we make education a top priority, both to train a new generation of scientists and to educate the people that will ensure scientific rationale in policies and in practice. In accordance with this, the Faculty of Mathematics and Natural Sciences has launched in 2013 a main ambition to revamp and improve its education programs. This is an effort where the IBV will have a central role.

In accordance with the department’s ambition to be a stronger voice in society the IBV board decided to strengthen the Laboratory School in Biology by establishing a permanent position as University Lecturer in addition to the 3-year non-tenured position as Lecturer. After only a few months of full operations, there is already a buzz about the laboratory school as they are involved in a number of outreach efforts to schools, kids in general as well as taking an active role in the development of the new high school teacher education curriculum.

Maintaining and improving research infrastructure needed for top notch research is another priority of the IBV and I am proud and happy that the Research Council of Norway decided to finance phase 2 development of the Norwegian Sequencing Center with 41 MNOK. On a smaller scale, but of great importance for many research groups within the department, the IBV board decided to strike a deal with the Biotechnology Centre to co-localize the two UiO-supported proteomics facilities. Thus, the proteomics core facility currently located at the Biotechnology Center will move to our department during 2014.

Perhaps the most significant judgment of the research quality in the department is the results of the annual FRIPRO (primarily FRIMEDBIO, but also FRINATEK) call, which are announced near the end of the year. It is fair to say that 2013 was an exceptional year for the department with a large number of successful applications, particularly in the Young Research Talent category. Even if we know that there will be fluctuations from one year to the next, I was particularly proud of our success in 2013, and happy that so many of the talented young people in our department were funded.

In the following pages you can read a more about the IBV and in what has occurred in the department during 2013. Enjoy!

Finn-Eirik Johansen | Department Chair
## Board and committees

### Board

- **Department chair**
  - Finn-Eirik Johansen

- **Scientific staff representatives**
  - Asbjørn Vøllestad
  - Marianne Fyhn

- **External scientific representative**
  - Dag L. Aksnes (UiB)

- **Technical and administrative staff representative**
  - Hans Borg

- **Temporary scientific staff representatives**
  - Øystein Langangen
  - Monica Hongre Solbakken

- **Student representatives**
  - Ina Hodnebrug
  - Jonfinn Blix Knudsen

- **Deputy representatives, scientific staff**
  - Kristian Prydz
  - Josefin Titelman

- **Deputy representatives, technical and administrative staff**
  - Kathrine Schou
  - Agnethe B. Salvesen

- **Deputy representatives, temporary scientific staff**
  - Paul E. Grini
  - Bente Børud

- **Deputy student representatives**
  - Line Lieblein Resåeg
  - Håkon Hegset

### Committees and workgroups

#### Employment Committee, PhD students and post docs

- Norbert Roos (chair), Helene M. Lampe, Monica Solbakken
- Deputies: Tom A. Kristensen, Winnie Eskild, Øystein Langangen

#### Education Committee

- Olav Sand (chair), Uwe Klein, Glenn-Peter Sætre, Anneleen Kool (NHM), Håkon Høgset (student representative), Brit Vike (student representative), Agnethe B. Salvesen

#### PhD Program Committee

- Fahri Saatcioglu (chair), Pål Falnes, Tom Andersen, Håvard Kau erud, Sumera Majid

#### Master and Bachelor Program Committees

- **Biology**: Glenn-Peter Sætre (chair), Stein Fredriksen, Ketil Hylland, Anneleen Kool (NHM), Mathilde Haug Skarsjø (student representative), Andreas Otterbeck (student representative), Lise Bøkenes, Agnethe B. Salvesen

- **Molecular biology, biochemistry and physiology**: Uwe Klein (chair), Jon Nissen-Meyer, Kristian Gundersen, Heidrun Lode (student representative), Bettina Fuglerud (student representative), Torill Røtvedt, Kyrre Grøtan

#### Dissemination Workgroup

- Klaus Hailand, Guro Sandvik, Einar Strømnes (NHM), Tone Gregers, Kristin Glerstad Tsigaridas, Tore Oldeide Elgvin, Gry Anita S. Eriksen (student representative), Malin Røe (student representative), Ingrid Mo (student representative), Tore Wallem, Agnethe Salvesen

#### Local Working Environment Committee

- Cecilie Mathiesen (chair), Finn-Eirik Johansen, Maren Onsrud, Marit Led saak, Jonfinn Blix Knudsen (student representative), Daniela Moreiro Engh (student representative), Jan Erik Olsen (TA, observer), Kathrine Schou (secretary)

#### SOP Project Group


#### Safety Representatives

- Ibrahim Hujaleh, Marit Led saak, Trude Haug, Helene Lampe, Nanna W. Steen, Cecilie Mathiesen, Mads Granberg, Marit Langrekken
## 2. Finances


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**Figure 1a** Salary, running expenses, equipment costs and overhead as parts of basis expenses

**Figure 1b** Salary, running expenses, equipment costs and overhead as parts of external project expenses
# Research programs and CoE-Centre for Ecological and Evolutionary Synthesis

## CoE-Centre for Ecological and Evolutionary Synthesis

<table>
<thead>
<tr>
<th>Name</th>
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<tbody>
<tr>
<td>N.C. Stenseth</td>
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<tr>
<td>A. Brysting</td>
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<td>N.W. Steen</td>
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<td>A. Tooming-Klunderud</td>
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## Cell Biology

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## Gene Program

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<td>H. Letnes</td>
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## Integrative Biology

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## Microbial Evolution Research Group

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## Physiology and Neurobiology

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*Figure 2 Department Research Programs and CoE (per 15.12)*
In 2013, CEES consisted of 171 members (including Core staff, Postdocs and researchers, PhDs, research assistants, technical and administrative staff, and master students). In addition, 29 guests stayed for more than one month, and 36 guests for less than one month. The members and guests represented 29 nationalities. The Centre has a core group of 17 employees (two are employed by the Department of Mathematics, one by the Department of Economy and one by the Institute of Marine Research). One employee is a visiting scientist at the University of Alberta, Canada. CEES is chaired by Professor Nils Chr. Stenseth.

CEES supervised 35 master and 27 PhD students in 2013, and was also involved in the teaching of 9 PhD/master courses and 3 bachelor courses. 4 new PhD students were employed, and 7 PhD students and 8 master students completed their degrees. The CEEs graduate school held its annual conference at Holmen Fjordhotell with 110 delegates.

Approximately 74 MNOK of the total budget of 141 MNOK came from the 50 externally funded research projects conducted by CEES in 2013. Most of these were funded through the Research Council of Norway. CEES is also involved in various EU-funded projects. 18 new projects were started.

CEES members published 146 articles in peer reviewed journals and 6 books/book chapters/reports in 2013. The majority of these results lie within the core scope of CEES. More than 190 talks/participations in poster sessions were conducted. The centre hosted 80 guest speakers, primarily from abroad.

The work of CEES is structured into Colloquia and Themes, the former being focused projects each lasting for three years and the latter consisting of on-going, long-term work that is accommodated within the centre. The Themes are Theme 1: The role of population structuring in adaptive evolution. Theme 2: The potential for adaptation. Theme 3: The evolution of reproductive isolation. The topics of the Colloquia are as follows: Colloquium 1: Selection and evolvability: Concepts, measurements and statistics. Colloquium 2: Bridging the gap between genomics and evolutionary biology. Colloquium 3: The ecology and evolution of infectious diseases with an environmental reservoir (refocused relative to the original proposal to create a greater scientific impact using the expertise at CEES). Colloquium 4: Integration of ecology and evolution: A synthesis.
SCIENTIFIC HIGHLIGHTS

Response of trophic relationships to climate change in sub-Arctic seas

Understanding the drivers that determine the productivity of marine ecosystems is an important issue. Climate and exploitation interact in their effects, such that climate alterations may cause failure in a fishery management scheme while fisheries may disrupt the ability of a population to withstand, or adjust to, climate changes. For example, removal of large (and thus implicitly old and experienced) individuals, resulting in a juvenile, age-truncated spawning population, has been described by numerous authors as resulting from modern day fisheries patterns. Similarly, non-uniform fishing pressure on population sub-units may also lead to a reduction in the capacity of populations to withstand climate variability and change.

It follows that ecosystem-based management of the world’s oceans requires a better understanding of how these changes affect food-web relationships. To explore this topic, a series of international workshops funded by the Research Council of Norway on fish population structure in marine ecosystems was held by CEES. These workshops brought together academic and applied scientists from five countries (Norway, Canada, USA, France and Russia) with special expertise in theoretical ecology, animal behaviour, fish and seabird ecology, fisheries oceanography, and ecosystem modelling. This resulted in the publication of a Theme Section of five papers, all coauthored by members of CEES and edited by Joël Durant and Nils Chr. Stenseth, in Marine Ecology Progress Series.

During these workshops, we have investigated the effect of fishing and climate on population structure across sub-Arctic ecosystems, using a comparative approach. We particularly focussed on how temperature- and fishing-induced changes in spatial and demographic population structure affect recruitment and population growth rate.

For instance, we studied the effects of variation in spawning stock and sea temperature on long-term temporal patterns related to the recruitment dynamics of 38 commercially harvested stocks in the northern North Atlantic, and found that abrupt changes (and maybe even regime shifts) may be common. In another study, we examined for 5 fish stocks (4 species in 3 ecosystems) the usefulness of indices of juvenile abundance relative to larval abundance for predicting recruitment. Prediction of year-class strength is a critical challenge for fisheries managers and is classically based on larval abundance. We found that juvenile abundance could give a better estimate of stock abundance, but that the result was too dependent on data quality to be practical. Our results also showed that forecasts of future recruitment were either improved or qualitatively unchanged by including environmental correlates. In a third study, we compared for 7 gadoid fish stocks (3 species in 7 ecosystems) the effects of fisheries on population growth rate, and the sensitivity of population growth to climate, as well as the role of changed population structure in mediating these effects. We found that there was a general tendency for an increase of the population growth with the increase of the contribution of recruitment.

The results reported in the collection of papers suggest common patterns, but also highlight differences in the relative importance of fishing and climate among the populations and ecosystems. The key message of this Theme Section is the importance of the interplay between environment and stock (size and structure) in shaping recruitment of sub-Arctic marine fish stocks. The 5 papers highlight different aspects of this theme and draw attention to the value of monitoring temporal and spatial patterns, as well as environmental forcing. Amongst other findings, we have demonstrated that recruitment estimates may be improved by taking into account environmental information and nonstationarity. We have shown that age-structure may be important for understanding the dynamics of harvested populations. Finally, we have shown that spatial ecology is important to understand the underlying mechanisms that drive fish population dynamics.

Fisheries-induced evolution adds a bonus to good management

In a new study, published by the Proceedings of the National Academy of Sciences of the United States of America (PNAS), we have been the first to determine whether genetic changes resulting from fishing pressure have any significant economic effects for Atlantic cod (Gadus morhua) (Eikeset et al.
The study shows that evolutionary changes allow individual fish to grow faster and mature earlier, which increases stock productivity and revenue for fishermen. However, if harvesting pressure is particularly high, genetic changes have negative consequences and cause economic costs.

The overexploitation of our oceans is worrisome for several reasons. One of the latest concerns is that fishing pressure can be so high that it causes a fish stock to alter its genetic composition. In the academic community, it is widely debated whether historical harvesting pressure has been high enough to cause these genetic changes to occur. And if so, have these genetic changes had a positive or a negative effect on the fate of the fisheries and fishermen’s revenues? We carried out this study at CEES, in collaboration with several international partners, in order to look at these questions in detail. It was already known that harvesting could cause genetic changes, but what was not known was whether fishermen and managers should be concerned about this. The major challenge in answering this question is the fact that growth and reproduction schedules of individual fish do not only depend on their genetic code, but also on the state of the environment. Since marine systems are constantly in flux, it is notoriously difficult to disentangle genetic and environmental effects. To overcome this obstacle, our team developed a detailed model that closely resembles the population of Northeast Arctic cod, currently the largest cod stock in the world. The trick was to create two versions of the model – one in which genetic changes could occur and the other where the fish only responded to environmental changes.

What we found was that genetic changes occur even if fishing pressure is very small. Surprisingly, genetic changes can have positive or negative consequences, depending on how high the harvest pressure is. In general, evolution allows fish to adapt by growing faster and maturing earlier, which is a good thing, because it allows the stock to produce more offspring. But if harvesting pressure is high, genetic changes have negative consequences and cause economic costs. This happens because evolution facilitates higher growth, which implies that fish can be caught at younger ages, often before they have reproduced. Furthermore, the study found that the key to successful management is a low harvesting rate – irrespective of whether genetic changes occur or not. However, this does not mean that managers can safely ignore evolutionary changes: the economic costs may appear very small, but they are highest for the mesh size that is currently being utilised.

Colloquium 3: The ecology and evolution of infectious diseases with an environmental reservoir
Among bacterial pathogens, Yersinia pestis (causing plague) is an interdisciplinary treasure trove. Plague comes with a rich body of historic documentation, and its aetiological agents have been studied and monitored in their natural reservoirs in Asia for more than 50 years. Distinct bacterial strains have been genetically typed and sequenced from both current and ancient samples, resulting in an incredibly detailed description of genetic relatedness across time and across the globe (i.e. a phylogeography), that can be interpreted in its natural ecological context.

However, despite over 300 years of study, the disease is still poorly understood (which might reflect poorly on us scientists). Basic yet highly relevant questions are still unanswered: where did the three major plague pandemics originate from? What triggered the three pandemic phases of this infective disease? Why did plague disappear from Europe twice? How does plague persist, when it reappears again in a region after long periods of absence? At CEES, we are trying to answer these still open questions for Yersinia pestis, as well as similar questions for Bacillus anthracis (anthrax). Studying both organisms in their full biological range - from molecular interactions with host species and the abiotic environment, their evolution, routes of transmission, and sensitivity to climate fluctuations - is generating fundamentally new insights into disease ecology and evolution that are broadly applicable.

The ERC Advanced Grant MedPlag
The medieval plagues: ecology, transmission modalities and routes of the infections aims to answer many of the open questions on medieval plague by joining the fields of anthropology, ancient genomics and epidemiology within a biological framework. A new ancient DNA laboratory at CEES, under the supervision of Barbara Bramanti, will soon be ready. After disclosing the genetics of ancient Y.
pestis strains from the first (in 2013) and second (in 2010) pandemics, she and Stephanie Hänisch will continue the delicate process of extracting and analysing DNA fragments from old tooth samples of plague victims from the 6th to the 18th century throughout Europe, as well as from Georgia, Kyrgyzstan and South Korea. Some of the same questions on medieval plague are approached from a theoretical epidemiological point of view, by Boris Schmid and Katie Dean. We now have evidence that plague was continuously being imported into Europe during the second pandemic (rather than only at the start of it), following climatic fluctuations in plague reservoirs in Western Central Asia. These results were presented by Boris in an award-winning poster at the Yersinia 11 conference in China last year. Katie Dean is modelling the spread of plague within medieval European cities, trying to elucidate which of the modes of transmission (pneumonic, classical rat-mediated bubonic, or human-to-human through an arthropod vector) fits historic records of the epidemiology best. The reservoirs of plague form a central theme in our work, and PhD student Pernille Nilsson is in an exciting collaboration with Chinese colleagues, de novo sequencing and analysing the immunological response of the great gerbil (Rhombomys opimus), one of the main hosts of plague in Asia. Besides plague, work on anthrax continues in its natural ecosystem in Namibia, where various observations on the behaviour of the hosts at anthrax carcass sites, and the life of anthrax in the soil are undertaken by Wendy Turner, Ryan Easterday, and Kyrre Kausrud, as well as PhD students Anders Aas and Karoline Vaseth.

The work on plague and related Yersinia species is rapidly expanding. Besides an additional PhD in the MedPlag program, two new PhD students, funded by the departmental focus grant “COMPI”, and under the supervision of Dirk Linke, Gareth Griffiths, and several CEES members, will look at the infection mechanisms of various Yersinia species and strains. Last, but not least, Thomas Owens Svennungsen & Thomas Haverkamp are supporting the plague group with their expertise. Svennungsen focuses on the constraints that are placed on the evolution of plague virulence by the lifestyle of its hosts, while Haverkamp brings valuable expertise to the group on the behaviour of soil bacteria.

**Genomics and ecology of gut adapted bacteria**

Awareness is growing of the importance of gut microbial colonisation for human health, as numerous links with a multitude of diseases are discovered. The total microbial content of the gut is often referred to as the gastrointestinal (GI) microbiota. Recent advances in sequencing technology have generated massive amounts of data, but much remains to be understood about the processes important for maintaining a healthy bacterial community structure in the gut. Escherichia coli, as well as being a much studied model organism, is an important and ubiquitous member of the human GI microbiota. Although E. coli constitutes only a small fraction of the total GI microbiota, it has a wide spectrum of potential interactions with the human host, ranging from probiotic to commensal and on to pathogenic. In addition to being a globally dominant cause of acute infections, certain E. coli strains have been consistently linked to chronic conditions such as inflammatory bowel disease (IBD). This highlights the importance of understanding colonisation on the strain level and linking this to the dynamics of other species of bacteria that normally colonise the gut.

We compared the genome sequences of 16 commensal and pathogenic E. coli strains isolated from infants in the Trondheim area of Western Norway, during a limited time frame, in order to look for gene content signatures distinguishing various phenotypes. In general we found that differences in gene content reflected differences in the core genome phylogeny. We further found gene content signatures distinguishing pathogens from commensals, early and late colonising strains, and strains with high or low maximal growth rates. We also observed ongoing adaptation in vivo, toward a maturing gut environment, in a strain that was isolated from a 10 days old infant and then re-isolated 4 months later. Comparison of our 16 strains with the genome sequences of 25 global isolates representing the broad species diversity demonstrated that, with a single exception, the Trondheim strains separated into two clades that were clearly distinct from the global isolates. This result emphasises the importance of geography in shaping gene content profiles on the strain level.
In a related study we investigated the colonisation dynamics of three *E. coli* strains isolated in succession from a single infant by conducting a series of in vitro serial transfer competition experiments, including a model background microbiota with representatives of the predominant GI phyla. We found that the latest isolate consistently out-competed the early and mid isolates in two- and three-way competitions. However, addition of the background microbiota reversed the competitive outcome of two-way competitions between the late and early strains, and this effect was attributed to the rapid growth of *Clostridium perfringens*. Growth rate assays of the *E. coli* strains, under various conditions of nutrient availability, demonstrated that the strains conformed to two distinct ecological profiles known as ‘exploiters’ (high growth rate at high nutrient concentrations) and ‘gleaners’ (high substrate affinity at low nutrient concentrations). Further experiments showed that *C. perfringens* rapidly depleted the main energy source in the growth medium, amino acids, thus providing an environment favoring the gleaner. Genome sequences of the isolates provided some clues to the adaptations underlying the two ecological strategies. Modulation of a two-way competition by a distantly related third species is termed context-dependent interaction, and has not previously been described among species on a single trophic level.

Continuation of this research was awarded with funding through the FRIPRO program of the Research Council of Norway. The new project, starting summer 2014, will be a high resolution time series study of microbial GI colonisation in a cohort of healthy infants born in Oslo, Norway. The study will allow us to observe colonisation dynamics in unprecedented detail, with a focus on development of predictive dynamic models for establishment of the infant GI microbiota.

**Grazing, climate warming and vegetation in alpine ecosystems**

Shifts in ecological systems following recent rapid climatic change are of particular concern in arctic and alpine regions. Climatic warming has increased the altitudinal and latitudinal distribution of many species from a wide range of taxa. Warming effects of high altitude plant communities are well documented in terms of increasing tree-lines and upward shifts of overall vegetation communities, leading to a homogenisation and loss of alpine biodiversity. However, we know very little about how climate change may interact with other aspects of global change such as land use. Despite the importance of livestock grazing in mountain regions of Europe, knowledge regarding how warming and grazing interact to determine changes in vegetation is generally lacking.

We have empirically investigated plant community responses to differing densities of domestic sheep (*Ovis aries*) (0, 25, and 80 sheep per km²) along an elevational gradient, using a landscape-scale and fully replicated long-term (10 year) field experiment in the mountains of Norway. During the experiment, summer temperatures were never below the average of the previous 30 years, thus a push from climate on the plant communities was present.

In the controls without grazing, the recruitment of birch rose by ca. 200 m in elevation (the maximum possible given the scale of the enclosures). In contrast, no such elevational increase in birch recruitment was seen where grazing was continued or increased relative to pre-experimental levels. We thus provide direct experimental evidence that herbivores can limit the treeline below its potential at the landscape scale in this climatic zone. The effect of sheep grazing on recruitment of *Salix* spp., being important for many game species, was negative at high elevation, but tended towards being positive at low elevation due to reduced competition from other plants. The whole community of vascular plants moved 3 m upslope in 8 years, within the range reported many places in the world under climate warming. However, the vegetation community was stable at low sheep density and tended to move downslope at high sheep density. This impacted species richness and temporal stability between treatments differently along the elevational gradient. Where grazing was ceased, species richness declined by up to 3.7 species at low elevations and increased by up to 3.5 species at high elevations, whilst changes were less extreme where grazing was maintained or increased. Our series of studies highlight how land use may be used to potentially buffer the impact of global warming on the plant communities and tree-lines in alpine ecosystems.

**Epistasis and evolutionary dynamics**

Most biologists share the intuition that interactions between genes, or epistases, are fundamen-
tual to the evolution of complex organisms. This intuition contrasts with the single-gene focus that emerged in the modern synthesis. The vast majority of evolutionary theory is based on models that either study genes in isolation or postulate additive interactions, where the effects of individual genes can just be summed up. This is not just grounded in convenience, but is also supported by a class of models that show that epistasis does not have any permanent effects on the response to selection. In a new study, Hansen (2013) has taken a new look at these models and shown that they have been misinterpreted. They do not show that gene interactions do not have permanent effects. Rather, they assume this. In reality, epistasis can have a dramatic influence on evolutionary dynamics, but this influence depends on the patterns of interaction among genes. It has largely gone undetected because the field has worked with a “patternless” and evolutionary inert statistical conceptualisation of gene interactions.

In Figure 3 we can see the response that different genetic architectures have to the same strength of selection. In the additive architecture, allele substitutions have constant effects that are added together to make the phenotype under selection. In the positive directional epistatic architecture, allele substitutions with positive effects also tend to increase the effects of other allele substitutions with positive effects. In the negative directional epistatic architecture, allele substitutions with positive effects tend to decrease the effects of other allele substitutions with positive effects. Finally, in the non-directional epistatic architecture, allele substitutions will change the effects of other allele substitutions, but in a nonsystematic manner. In this case, the response is virtually identical to the additive architecture. Most studies of epistasis have implicitly assumed a non-directional architecture, and therefore missed the potentially strong effects of epistasis on evolutionary dynamics.

We can think of (systematic) epistasis as curvature in the genotype-phenotype map. Positive directional epistasis is positive curvature (convexity) and negative directional epistasis is negative curvature (concavity). Figure 4 shows how the same amount of underlying genetic variation is amplified by moving along positive curvature to steeper regions of the map, and canalised by moving along negative curvature to flatter regions of the map.

In a related new study, Le Rouzic et al. (2013) study how patterns of epistasis and additivity are expected to evolve under stabilising and fluctuating selection. In that study it is shown that a degree of canalisation (reduction of effects) is expected for both additive and epistatic effects, and under both stabilising and fluctuating selection. However, complete canalisation is hard to evolve, and systems under fluctuating selection are not canalised as far as those under stabilising selection. This is related to the maintenance of genetic variation and evolutionary potential. Figure 5 shows how standing genetic variance and the sizes of mutational effects depend on the period and amplitude of fluctuations in a fitness optimum.

**Figure 3** How different patterns of epistasis influence a response to directional selection. The bars give one standard deviation over replicate simulations. (Modified from Carter et al. 2005).

**Figure 4** The genotype-phenotype map, and expressed variation (Hansen 2014).
The evolution of age-dependent phenotypic plasticity

Phenotypic plasticity, the ability of a genotype to develop different phenotypes in different environments, is a universal property of organismal life. All living organisms are plastic in at least some of their traits. For example, water flea (Daphnia spp.) grow a ‘helmet’ when exposed to predators in the water, and the spider Parawixia bistriata can adapt the type of cobweb it produces to the type of prey it expects to catch. Another illustrative example is the plasticity of marine iguanas (Amblyrhynchus cristatus) in body size. These iguanas shrink in El Nino years, when food is scarce, which increases their overall survival chances.

The plasticity of a trait is not generally a quality that is maintained through life, but rather one that is limited to certain periods of an organism’s life. The central question, which we asked in this study, was why plasticity evolves to be age-dependent, or why windows of plasticity (where organisms are plastic only during a particular time window of their life) exist in the first place. The hypothesis which we evaluated was if and how limited information about environmental conditions could potentially limit the evolution of plasticity and cause age-dependent plasticity patterns. Previous studies have analysed conditions under which plasticity would evolve in general, but, to our knowledge, this is the first study to investigate the evolution of plasticity from a life-history perspective.

We developed a mathematical model where we described a stochastic environment that is partially predictable for the organism. We also took into account adjustment costs for the plastic traits and different example life-histories for the model organisms. Then we modeled the developmental trajectory of an organism in this environment and derived plasticity patterns that were optimal in terms of fitness for the organism. Our results show that plasticity will often be expected to vary with age: Plasticity will usually vary in a non-monotonic fashion. Early in life it is generally optimal to delay phenotypic adjustments until enough information has been collected about the state of the environment. Towards the end of life, phenotypic adjustments are disfavored as well because the organism cannot sufficiently benefit anymore before its death from a highly adjusted phenotype. A combination of these effects can produce a diversity of non-monotonic plasticity patterns.

Figure 5 Effects of fluctuations in a fitness optimum on the amount of additive genetic variance and size of mutational effects under non-directional and directional epistasis (Le Rouzic et al. 2013). The effect of pure stabilising selection is shown by the line at the bottom. Note how the highest levels of variance and the largest mutational effects evolve for fluctuations of intermediate lengths ($T = \text{tens to hundreds of generations}$). Note also how complete canalisation (mutational effects = 0) never evolves.
NorMER is a Nordic Centre of Excellence that brings together the expertise of leading research groups from all Nordic countries and several North American institutions, to implement a collective and interdisciplinary research strategy to explore the biological, economic, and management consequences of global climate change on fisheries resources. It will achieve this through a unique program of primary research, implemented by PhDs and post docs in a system of collaborative projects, with a focus on the Atlantic cod (*Gadus morhua*). Though our Nordic focus is on cod, this research is intended to be a platform to extend this knowledge to other marine systems.

The aims and corresponding actions of NorMER are:

1. **Perform effect studies to:** a) evaluate climate effects on Nordic marine ecosystems, b) Build new tools for predicting biological consequences of climate change, and c) quantify impacts on profit, employment, and harvesting.

   **Actions:** PhDs are co-supervised internationally. Post docs collaborate internationally. Leading senior scientists and climate researchers provide expert input.

2. **Create an effective training environment for young researchers**

   **Actions:** Annual meetings, graduate courses, and special workshops focus on transferable and interdisciplinary skills. Regular interaction between students and international experts in climate- and marine ecosystem-related fields further strengthen the training program in NorMER.

3. **Develop a team of outstanding global quality**

   **Actions:** Research institutions from every Nordic country are partners. International researchers and industry representatives are invited to annual meetings. A 7-member Centre Advisory Panel (CAP), consisting of an interdisciplinary mix of globally leading researchers participate at all annual meetings. Annually, one internationally distinguished researcher is selected as the honored Johan Hjort Chair to participate at the annual meeting to share expertise with NorMER partners and students.

4. **Link to industry and policy managers**

   **Actions:** Industry and Policy representatives from each of the Nordic countries are encouraged to attend annual meetings for discussing societal/ economic effects of climate change, and to learn more about NorMER work. PhD students will be encouraged to visit marine industries or participate in commercial fishing. A strong bio-economic focus within NorMER will facilitate transference of results to fisheries managers.

5. **Update marine ecosystem management policies to sustain healthy fisheries**

   **Actions:** NorMER is a research-based program to evaluate the effects of climate variability on marine ecosystems and how fisheries management can be adapted to maintain sustainable harvest levels. We hope to produce strong results, built on solid fundamental science, that will be applied to real systems in the Nordic region. NorMER is primarily supported with funding from Nordforsk, on behalf of the Top-level Research Initiative (TRI), and from each of the main partners.

**Comments from the Chair of NorMER, Nils Chr. Stenseth (excerpt)**

We have been through yet another full year as a ‘Nordic Centre for Research on Marine Ecosystems and Resources under Climate Change’ (NorMER): a Nordic Centre of Excellence focusing on training Young Researchers (PhDs and post docs) within the topic of how climate change is affecting marine systems – from ecology and evolution, to economics and management, and including how society ought to adapt to the environmental changes resulting from climate change. Although our perspective is general, we have focused on cod (*Gadus morhua*) as our model organism because we believe this will make it easier to
integrate the different disciplines involved within NorMER: all NorMER members will have one common marine system over which they can combine and apply their diverse expertise. It is clear that we are on the right track with regards to our ambition to be a true Nordic Centre of Excellence, not the least thanks to our excellent team of Young Researchers (YR) — both PhDs and post docs. Communicating our perspectives and results to a broad spectrum of people, particularly politicians, is an important part of NorMER. In order to facilitate dialogue with politicians and managers about the science we are doing, we organised — just as we did the year before — a public session at the University of Iceland in connection with our third NorMER annual meeting. This session featured presentations from the President of Iceland, the CEO of the largest seafood company in Iceland, the Dean of the School of Social Sciences, and the Director of the Icelandic Marine Research Institute, and several internationally recognised scientists. Our 2013 NorMER Annual Meeting, and this public session, were both highly successful. We will extend the work of NorMER to also address the question of how we humans should adapt to the Anthropocene in order to sustainably coevolve with the biosphere, as well as addressing which social transformations are needed to facilitate a sustainable coevolution. The Stockholm node will play a key role in this endeavor — together with the rest of the NorMER team. Specifically, we will combine these with the rest of our work into a new NorMER theme, which specifically focuses on adaptation and transformation in Nordic marine socialecological systems, from an interdisciplinary perspective. This will be facilitated by linking up with collaborating Nordforsk-funded project, GreenMAR (greenmar.org).

NorMER report 2013 facsimile. The 90 page report can be found at normer.org, or you can order it from normer-post@lbv.uio.no.
Integrative Biology Program

The main research areas within IB are human toxicology and ecotoxicology, life history traits, limnology, marine and freshwater ecology, population biology, environmental modelling, ecological stoichiometry, ecophysiology and lichen taxonomy. The program, established in its present form in 2007, comprised six professors, three adjunct professors, four postdoctoral fellows, three technical staff, five PhDs with IB main supervisor and five PhDs with IB co-supervisor in 2013. One PhDs with IB supervisor defended his work in 2013.

Toxicology is one of three MSc study programs in biology, and IB staff supervises from 1/3 to 1/4 of all master students at the Department, which amounts to more than 30 annually. IB scientific staff was responsible for all courses in toxicology and ecotoxicology, and heavily involved in other courses both at bachelor and master levels. The publication record for the program has been consistently high the last years. The research in toxicology and ecotoxicology spans in vitro mechanistic studies with primary cell cultures, through exposure studies with fish and marine invertebrates to mesocosm studies of pelagic and sediment processes. Recent projects have included a characterization of effects caused by oil spills (the project Pristine Arctic, funded by the Nordic Council of Ministers), measurement of genotoxicity in marine organisms from mussels to polar bears. In addition to using small-scale, high-throughput experimental models such as primary cell cultures, the group is at the forefront in developing and using sediment micro- and mesocosms, short and long-term fish experimental systems with different exposure pathways, caging experiments and pelagic mesocosms. In 2013 there was an increasing activity in arctic ecotoxicology, mainly focusing on the above-mentioned mechanisms of genotoxicity and DNA repair. A collaboration with CEA in Grenoble led to the use of chip technology to investigate the ability of fish, invertebrate and seal cells to repair specific DNA lesions. There are ongoing projects on ringed seal, polar bear and beluga.

Ecological stoichiometry builds on the concept that all living organisms are constructed over the same general template. Originating within limnology, ecological stoichiometry is now recognized as an important integrative principle across a range of biological disciplines, from cell physiology to global biogeochemical cycles, with applications in cancer research and astrobiology. Recognizing that vital rates and stoichiometry are linked through the causal chain of growth rate, protein synthesis, ribosome density, and cellular P content has recently led to a partial merge between the metabolic theory of ecology and ecological stoichiometry. The main contribution to ecological stoichiometry is the focus on interactions between temperature and food stoichiometry comparing several phylogenetically distant organism groups. In the stoichiometric approach to ecology there is often a focus on how imbalances between carbon fixation and mineral nutrient acquisition in autotrophs can lead to reduced growth efficiency in herbivores. In a recent project, we explore how the same stoichiometric principles can be applied for optimizing the lipid yield in experimental biofuel reactors.

Research on linking life history to effects of environmental variation combines studies of tolerance to climate stress (ecophysiology), phenotypic plasticity in life history traits (acclimation, thermal reaction norms), phenology and spatial heterogeneity with population dynamics and species interactions. Studies are done in experimental model systems as well as in the field, with terrestrial arthropods and in freshwater systems. Climate change impact on the Arctic and subarctic soil systems have been studied in a long-term project with main focus to understand basic mechanisms underlying differential responses of species/species assemblages on environmental change, including effects on species invasion. Marine copepods (Calanus spp.) are used as model organisms to study the relation between genome and body size in micro- and macro-evolutionary patterns among animals from contrasting thermal environments. Another project has focused on dispersal of ticks and tick borne pathogens by
birds, which represent an increasing challenge in Norway due to environmental changes. Morphological (cuticular) adaptation to different climatic conditions in *Collembola* is used in collaboration with nano-technologists to understand (evolution of) structures determining their superhydrophobic characteristics.

Lakes are ideal systems for testing predictions and responses related to **biodiversity and ecosystem functioning**, since they are units with well-defined boundaries, as inverted islands isolated by land. A strong east-west gradient in both phytoplankton and zooplankton species richness makes a longitudinal transect across Norway and Sweden and is a natural laboratory for investigating effects of biodiversity on natural lake ecosystem functioning. The relationships between species pool saturation, ecosystem functioning, and vulnerability to bioinvasions is studied by field sampling of natural biodiversity gradients, classical and molecular measures of phyto- and zooplankton biodiversity, and up-scaling by predictive modelling tools. Statistical modelling is used to disentangle effects of multiple stressors like eutrophication, climate change, and invading species on the ecosystem services of lakes.

**Iterative research**

There is clearly a potential to develop cross-disciplinary projects by integrating and combining the research areas represented within the program and this activity was continued in 2013. An integrating activity within the program involves measurement of DNA-damage in terrestrial or aquatic model organisms (*collembolans, Daphnia* sp., *Rotifera*) in relation to natural stressors such as desiccation (terrestrial), temperature stress, food availability or food composition. Methods have been developed to measure DNA damage with the very small volumes available and further experiments are underway. The studies aim at clarifying underlying mechanisms for the vulnerability of species towards environmental changes and how individual fitness may have consequences for population development. The scope of the research includes environmental factors such as (micro-)climate, habitat, nutrient stoichiometry and the influence of stressors such as oil and xenobiotics. In order to understand effects at population and community levels, experimental approaches also incorporate habitat heterogeneity, habitat fragmentation and demographic changes. The competence within the program makes it possible to investigate links between individual health and performance, population growth and the dynamics of species assemblages. Life history traits, such as growth rate, age and size at maturity are relevant response variables in a focus on phenotypic responses, but also important determinants of population responses. Species-specific differences in these responses may have great effects on species interactions, and thus on community structure and ecosystem functioning. An important challenge is to improve our understanding of direct compared to indirect effects of environmental variables and why related species may react very differently on environmental changes. The experimental nature of the research activity in the program requires terrestrial and aquatic model systems that are amenable to manipulation. The scientific staff has extensive experience with relevant species and systems, e.g. *collembolans*, rotifers, cladocerans, selected plant species, fish and sediment-dwelling organisms. There is work in progress to establish compact and flexible exposure systems, which may be designed for experimental studies at high degree of complexity, including multiple species interaction and interaction between environmental variables. The chosen model organisms are currently used in experiments in simplified cultures and in micro- and mesocosms, as well as in field studies and field experiments. The existing expertise in molecular and cellular methods within the program will be used to understand mechanisms underlying individual responses to environmental perturbation such as climate change, desiccation and changes in food quantity and quality. There is an ongoing research activity on DNA and membrane damage in *collembolans* and a research project on the heritability of DNA repair efficiency and oxidative stress defense mechanisms in *Daphnia* was established in 2013. As will be apparent, much of the research activity within the program concerns the effects of environmental changes on natural biodiversity and human health, issues clearly relevant to society. As a consequence, there has been an increasing need for toxicologists in Norwegian society over the past decade, and following graduation (MSc), most candidates in toxicology or ecotoxicology have rapidly found employment with national or regional environmental management organizations, research institutes, consultants or industry.
Scientific collaboration, representation and outreach

The toxicology group has close collaboration with human toxicological research groups and ecotoxicological research groups. The main national collaborators for IB were the National Institute for Public Health (genotoxicity), Norwegian College for Veterinary Sciences (microarray, autoradiography, reproductive toxicology), Norwegian Institute for Water Research (toxicity testing, food-web modelling, sediment processes, analytical chemistry, passive samplers), NTNU (courses, teaching), Polar Institute (arctic ecotoxicology) and the University of Bergen (pelagic ecology). In addition to a well-established ICES network, including marine research institutes from most European countries with an Atlantic coastline (Cefas, IFREMER, Marine Scotland, von Thünen Institut, DFO, Deltares, IEO, AZTI), the group collaborates on a regular basis with colleagues at universities in Ancona, Bilbao, Göteborg, Odense, Porto, Stockholm, Reykjavik and Zagreb. A close collaboration with Icelandic colleagues was continued in 2013, involving research studies at the field station in Sandgerdi.

The leader of IB chaired an ICES working group (WGBEC) and an international project (ICON) based on the ICES network, the results of which will be published in 2014. The national and international collaboration has ensured high quality projects and has been used a mechanism for exchange of methods and training of MSc- and PhD-candidates. Members of the group have chaired and contributed to a range of national and international organizations and have contributed substantially towards international processes, particularly in marine environmental issues, occupational toxicology and risk assessment.

In addition to ad hoc advice to national authorities and membership in national expert groups on offshore monitoring and sample banking, this has included contributions to OECD, ICES, OSPAR, IRC and EU working groups and committees over the past years. Particularly in toxicology and ecotoxicology, the group was in 2013 involved in public meetings on topics such as mixture toxicity and regulatory toxicology.

National collaboration in aquatic ecology involves first and foremost other programs at our department (CEES, MERG, MARIN), but also UMB, HiT, NINA, and NIVA on the freshwater side, and UiB and NTNU on the marine. Nordic cooperation involves SLU, and the Universities of Uppsala and Umeå, Sweden, for limnological research, and SYKE, Finland for Baltic sea research.

International cooperation on ecological stoichiometry involves several US universities including Arizona State and Minnesota, as well as European colleagues in Brest (France), Lunz (Austria), Oldenburg, and Munich (both Germany). National collaboration on terrestrial arthropods involves UMB and Norwegian School of Veterinary Science (SAK-project). Through a Norway-South Africa collaborative framework there has been close integration of projects between Norway, South Africa, Sweden and France with a focus on climate adaptation, life history, population biology and biodiversity of springtails. The main partners are Centre for Invasion Biology, Stellenbosch University, Department of Ecology, Swedish University of Agricultural Sciences and Museum National d’Histoire Naturelle, Paris. The project on collembolean cuticle is a collaboration with Department of Engineering Design and Materials, Norwegian University of Science and Technology.

Gambling of the pelagic food web in Lake Mjøsa for contaminant analysis © Katrine Borgå
Marine Biology Program

www.mn.uio.no/ibv/forskning/grupper/marinbiologi

The Marine Biology Program research activities focus on marine pelagic and benthos ecology, biodiversity, algal systematics and physiology, and animal behaviour. MB consists of 3 professors (Edvardsen, Fredriksen, Ugland), 2 associate professors (Karlsen, Titelman) and 3 adjunct professors (Eikrem, Kaartvedt, Norderhaug). Two post docs are associated to the program (Gerecht, Wilson), 7 internal PhD students (Andersen, Bjærke, Egge, Gran, Thormar, van Son, Hansen), and 3 external (Engesmo, Fagerli, Supraha), 2 technicians (Amundsen, Brubak), 4 emeriti and 21 master students. Van Son and Andersen completed their PhD degree and 7 master students their MSc degree. Although marine research is carried out to some extent within all four programs at the department, MB staff are responsible for the marine biology curriculum at both bachelor and masters levels. MB staff are also heavily involved in bachelor courses in biodiversity, ecology and biological methods.

The program has contributed to the understanding of systematics and evolution of marine species, their interactions, and response to their environment, patterns of marine diversity, and how the structure of marine assemblages relates to the functioning of such ecosystems. The research spans all along the Norwegian coastline (> 100,000 km), and extends to polar and tropical seas. The research is conducted in the field and in the laboratory, using observational and experimental approaches. Our expertise ranges from molecular techniques and genomics, advanced microscopy and video tracking to acoustics and community studies, in addition to statistical analyses and modelling. The basic research carried out in the program has implications for ecosystem understanding and thereby ultimately management of marine resources.

Pelagic Ecology and Behaviour

The research focuses on different aspects of plankton interactions, dynamics and diversity in pelagic habitats. Studies address responses of individual plankton organisms, and how plankton community composition and abundances varies in time and space as a function of environmental forcing. Advantage of easily accessible, sheltered and deep fjord locations have been important. Another research focus has been on small-scale behavioural interactions in crustaceans, mainly copepods. Experiments have been conducted at Drøbak Biological Station and at Blindern by Bjærke in collaboration with Titelman to study how predation risk affects copepod male reproductive strategies and other life history investments in marine zooplankton.

The biology of mesopelagic fish in the oligotrophic and warm Red Sea has been compared with mesopelagic fish in the murkier and seasonally productive Norwegian waters. This work is driven by Kaartvedt, from KAUST and on visits to Norway.

At the Biological Station in Drøbak projects led by Karlsen studying the hearing abilities and behavioural responses in fish, cephalopods and crustaceans continued. Setups where behavioural responses can be observed (video) in response to acoustic stimuli have been employed and extended. The aim is to understand how predation has influenced the evolution of acoustic-lateral sense organs in fish and groups of marine invertebrates.
The group also investigates the impacts of seismic noise on fish and marine mammals, aiming to understand how behaviour is affected by high intensity sound pulses such as from seismic exploration activities, monopiling etc. These activities are of high relevance to ongoing oil activities and the search for new oil fields.

Benthic Ecology and Interactions
Benthic ecology and interactions focus on two main topics. One is the ecological study of macroalgal systems to elucidate why large areas of kelp forests (Laminaria hyperborea) have disappeared and have been replaced by enormous amounts of green sea urchins (Strongylocentrotus droebachiensis). A focus this year was to investigate how climate change affects kelp-sea urchin dynamics. This was also the topic of a workshop on Vega, organised by Norderhaug. This part is led by Fredriksen and Norderhaug in cooperation with other institutions in Norway and abroad.

The second focus is on seagrass and is run by Fredriksen and Thormar. Seagrasses are a group of higher plants with a worldwide distribution. A follow up experiment of the global ZEN project was conducted in 2013. Our part of the experiment was conducted in close cooperation with Swedish colleagues from Kristineberg (Sven Lovén Centre for Marine Sciences). Nordic Seagrass Network arranged a workshop at Finnøy, NW Norway, for PhD students and seagrass researchers from Nordic countries where Fredriksen and Thormar participated.

Edvardsen, Eikrem and Fredriksen continued the collaboration with Kaartvedt at KAUST to explore the biodiversity and community structure of a seagrass bed in the Red Sea, Saudi Arabia. The micro- and macroflora and fauna, and fish, in addition to food webs have been investigated. In a master’s project 16 microalgal strains have been isolated, genetically characterised and systematically placed and includes new species for science.

Fredriksen and Eikrem and a joint master student participated in a cruise around Spitsbergen to investigate microalgae in sandy shores and macroalgae from rocky coasts at 10 sites.

Biodiversity
Ugland has worked with patterns in biodiversity and the model for estimation of species abundance distributions (SADs). The model has shown to be useful for a range of different ecosystems and has been applied to fungal, plant, macroalgal and plankton communities to study community structures and estimate species richness. His research has also focused on population dynamics, biology of seals (diet, parasites and lipid composition), fish biology, biodiversity and detection of disturbance on communities due to human activity.

Egge together with Edvardsen, Eikrem and co-workers have explored the marine protist biodiversity at seven European coastal localities, including the Oslofjorden, within the EU project BioMarks by 454 pyrosequencing, bioinformatics, and electron microscopy. In the NRC-project HAPTODIV the diversity of marine flagellates in the phylum Haptophyta and their seasonal dynamics in relation to environmental factors were explored by 454 pyrosequencing and supplemented with electron microscopy. Samples have been collected monthly from outer Oslofjorden with R/V Trygve Braarud during two years and from Raunefjorden. A large unknown diversity among haptophytes has been revealed compared to previous records by microscopy. Most sequences could not be assigned to a cultured and sequenced species, and some may represent new and unknown branches on the tree of life. Some species, especially bloom-forming, are present at all times whereas most coccolithophorids were recorded mainly during summer and autumn with high salinities and temperatures. The abilities to detect and quantify haptophytes in mixed samples by 454 pyrosequencing were tested and a strategy developed. Gran Stadniczenko has in collaboration with Edvardsen and Egge investigated the nano- and pico-plankton protist and virus diversity in Outer Oslofjorden by 454 pyrosequencing, and by Assemble funding visited CNRS Banyuls, France together with Edvardsen to do bioinformatics on virus sequence data. She also stayed 2 weeks in Barcelona at CMI for training in bioinformatics of protist 454-sequence data.

Algal/protist systematics and evolution
Algal taxonomy, phylogeny and evolution are research areas at MB with long and strong traditions. The microalgal group, run by Edvardsen, Eikrem and co-workers, has described several new microalgal species and combined morphological and molecular data to systematically
place new species, and to revise the taxonomy within haptophytes. Harmful algae that bloom in Norwegian coastal waters and elsewhere have been studied for decades. These studies include morphological and genetic characterization and phylogeny, genetic diversity and distribution, molecular probe development for detection and monitoring, culture experiments to clarify growth preferences and toxicity, and genomic analyses of genes expressed. The research has been performed through the EU-project MIDTAL, the RCN projects ToxAlgae and HAPTODIV and UiO projects. Within MIDTAL a microarray assay for the monitoring of toxic marine algal species has been developed, now under patenting and ready for commercialisation. Molecular probes specific for toxic algae in the genera Dinophysis, Phalacroma and Pseudopectenella have been developed for the microarray assay by MB, which has been applied on 2 years of monthly samples collected from outer Oslofjorden. The results from the assay corresponded rather well with microscopic observations, but molecular detection is more sensitive. Molecular probes detecting the algal neurotoxin saxitoxin was also applied on the 2 years of monthly Oslofjorden samples using qPCR and this was more sensitive than chemical analyses of saxitoxins.

The RCN project Phytoscale has examined the effect of changing environmental parameters such as nutrient availability and temperature increase on marine phytoplankton of the type coccolithophores (Haptophyta). In this context, Gerecht and Supraha have carried out culture experiments to observe changes in the production of inorganic and organic carbon, important components of the biogeochemical carbon cycle. Furthermore, coccoliths formation has been studied using different microscopic techniques.

In the RCN project Genome (co-ordinated by Hessen at CEES) genomic and physiological changes and possible adaptation of genome size in response to nutrient and temperature conditions were examined in semi-continuous cultures of four haptophyte species maintained for more than 6 months (>200 generations).

**Scientific collaboration, representation and outreach**

The program has a close collaboration with IB and CEES on phytoplankton ecology and evolution. We collaborate with FI on marine biochemistry and bioprospecting and IMBV on fish physiology and electron microscopy. There is a well-developed collaboration with several researchers at NIVA, both on research and education. Two of our adjunct professors in MB come from NIVA. Other close collaborators are UiB on pelagic and benthic ecology and biodiversity, IMR on pelagic ecology; VI on harmful algae; and NTNU, UNIS and Norwegian Polar Institute on polar biology. Collaborators on fish and marine invertebrate behaviour to acoustic stimuli are Statoil, IMR, NDRE and University of Aarhus and Odense, Denmark. We also cooperate with leading marine biological research institutes in Europe (e.g. AWI, Germany; CNRS, France; ICM Spain), Asia, South Africa and USA, through EU and national projects.

Our staff regularly participates in outreach activities such as TV, radio and newspapers. The program supports yearly participation at conferences for scientists, students and technicians. Staff and students presented 22 contributions at conferences and workshops. Publication is in international journals, and in popular scientific journals and books. The publication record in 2013 was 18 peer-reviewed international scientific journal papers of which about half had 2-5 authors from MB. Three of the scientific staff were on maternal or paternal leave in 2013 (and 2012).

Members of MB lead (Edvardsen) or are members (Eikrem, Fredriksen) of species name committees for micro- and macroalgae at The Norwegian Biodiversity Information Centre (Artsdatabanken), responsible for updating the national species lists. In 2013 the Nordic Marine Science Conference (NMSC) was held in Oslo, and Edvardsen and Norderhaug was part of the organizing committee. Fredriksen was appointed as member of the Strategic advisory board for Institute of Marine Research (IMR) and Edvardsen in the Board for Norwegian Algal Society. Karlsen was part of the organising committee in the Aquaculture meeting in Oslo in January.
Microbial Evolution Research Group (MERG)

The research group MERG integrates ecological and evolutionary approaches to solve basic questions in microbial biology. We aim at answering ecological and evolutionary questions related to microorganisms, i.e. bacteria, fungi and unicellular eukaryotes (protists), and also address theoretical and methodological approaches to solve challenging questions within health, environment, climate, energy, and food production. MERG has a scientific staff of 8 professors, 2 associate professors, 1 adjunct associate professor, 6 post docs, 2 engineers and 1 infrastructure project leader. In addition, we have 15 PhD fellows and 11 master students in the research group.

The MERG staff has experiences from fieldbiology, stoichiometry, bioinformatics, genetics, taxonomy, systematics, mycology, protistology, general microbiology, limnology, ecology, evolutionary biology and statistics. Our research and teaching are interdisciplinary and aim at creating synergies across a wide range of sub-disciplines.

Microbial diversity
Several projects in the past have focused on revealing unknown microbial diversity (both prokaryotes and eukaryotes) by applying PCR on environmental sampled DNA. Beside marine habitats we have investigated freshwater lakes, terrestrial systems and air born spores. We have recently moved our attention to eukaryote microorganisms that act as symbionts and parasites in plants, marine animals and planktonic heterotrophic protists. These studies have revealed a tremendously large diversity that has been unknown. We have published new implemented next generation sequencing technologies. Another development is the use of whole genome amplification of single cells that are uncultivated. By picking cells from marine environments and optimizing this molecular approach we have been able to reveal both the host and symbiont diversity in selected groups of eukaryotes.

Microbial populations and communities
Microbial communities, their structure and dynamics, are analyzed using high throughput sequencing techniques in combination with traditional synecological approaches. Examples of such analyses include exploration of fungal communities in the plant rhizosphere, within living plants (endophytes) and within dead wood. We analyze the population and biogeographic structure of microorganisms and try to find out at which spatial scales microorganisms are structured and dispersed. We study interactions between microorganisms, such as symbiosis and parasitism, and how abiotic (e.g. climatic changes) and biotic factors (e.g. parasitism) affect and regulate the spatio-temporal characteristics of microbial populations. One of the projects aim at understanding the interaction between strains of fungi and cyanobacteria, e.g. interactions between cyanobacterial ecotypes and chytrid fungi. A project on the biology of the X-cell parasite, recently funded by the Research Council of Norway, has been initiated and already recruited one Postdoc, Phd and three master students. The project is headed by Dag Klaveness and involves several external scientists, including David Bass from Natural History Museum London, Mark Freeman from University of Malaya and Haakon Hansen from Norwegian Veterinary Institute.

The parasite X-cell infect cod and other fish species. Estelle Grønneberg is a master student and samples fish tissue for DNA diversity survey of X-cell and other parasites © Torbjørn Gylt
Microbial parasites in aquatic systems
MERG have for several years prioritized research on parasites and have initiated several projects on aquatic parasite diversity. These projects have aimed towards identifying diversity and interactions with the host by developing diagnostic methods, sequence environmental DNA and genomic approaches. One of these projects is on the mysterious X-cell (financed by Research Council of Norway), which is a eukaryote with previously unclear taxonomic affiliation. This organism causes pseudobranchial tumors in gadids, where the tissue has been infected and replaced by large cells with a particular microanatomy. In codfish (*Gadus morhua* L.), infections may influence growth and vitality, and the frequency of infection in natural populations may be considerable.

Following the employment of a postdoctoral fellow for the project, Dr. Jean-Francois Mangot, we have focused upon the exchange of new information, genetic markers and material with our partners and cooperators abroad (London, Malaysia) and in Norway (Oslo, Bergen). Their expertise within related parasites and protists, fish health and distribution of X-cell-related symptoms are of great importance for the project. We have acquired material and access to literature (from Institute of Marine Research (IMR), Bergen) on records of X-cell-like symptoms in Norway (in the Oslo fjord and along the coast of northern Norway). We are following up with field cruises and point searches within selected localities. Our partners (Håkon Hansen (Norwegian Veterinary Institute), Egil Karlsbakk (IMR, Bergen), Mark Freeman (University of Malaya) and David Bass (University of Oxford)) have contributed with infected material (for metatranscriptomics and positive controls) and our testing and improvements of methods have been promising. Our national cooperators and have provided instructions for dissection, sampling of specific organs and tissues. The Biological Station in Drøbak has been critical for the instruction of students and personnel, as well as a core facility for material collected. We have used their vessels, as well as the UiO research vessels “Trygve Braarud” and “Bjørn Føyn” for trawling and sampling in the Oslofjord area at large. The research group participated on board the research vessel “Johan Hjort” to examine a larger number of fish and take samples from outside the coastline Kirkenes-Tromsø.

Another NCR-project project owned by the Norwegian Veterinary Institute, but where the PhD-fellow David Strand was affiliated with MERG, focused on developing qPCR based detection systems directly from water samples. The intention was to identify the devastating freshwater crayfish parasite *Aphanomyces astaci* (Oomycete), which causes crayfish plague in European crayfish species. Our protocol applies large volume water filtration systems to capture up to 100 litre water per sample. The filtrate samples are then processed for DNA extraction and analyzed molecularly with species specific qPCR that detect down...
to one *A. astaci* zoospore per sample. We could then perform ecological studies of temporal and spatial crayfish plague spore fluctuations, but also offer a new practical method for environmental crayfish plague disease detection and surveillance that is of great relevance for European Authorities. The strategy is transferrable other aquatic microorganisms, and is particularly relevant for early detection of emerging diseases that might result from hitchhiking microbes of invasive species with subsequent host jumps to naïve native species, or increased parasite virulence due to e.g. climate change. The project also revealed new parasite-host interactions suggesting that the assumed crayfish specific parasite also infect freshwater crabs when cohabited with infected crayfish. Finally, microsatellite markers were used to decipher the Norwegian history of crayfish plague epizootics with respect to involved *A. astaci* genotypes. The project was finalized in 2013 and led to one PhD dissertation and seven presently published peer-reviewed papers involving in total eight partners from five countries: Norway (Norwegian Veterinary Institute, University of Oslo, Norwegian Institute of Nature Research), Sweden (Swedish University of Agricultural Sciences), Finland (University of Eastern Finland - Kuopio campus, Finnish Food Safety Authority Evira), Czech Republic (Charles University in Prague) and France (Universite de Poitiers).

**Bioinformatics, molecular methods and databases**

From its early emergence, MERG has focused on bioinformatics, and in integrating novel computational and molecular methods into our research. We have developed bioinformatic applications useful for ecological and evolutionary studies and built databases applicable for fungal species identification. These pipelines and applications, including applications for identification of genes, taxa, functional annotation, gene and genome comparisons, multiple sequence alignments and multigene phylogenies, make surveys of environmental DNA and phylogenomics more feasible to researchers in the field. The projects have resulted in papers and publically available services. Recently, we have developed better tools for diversity surveys of environmental DNA samples and for genomic studies of single cell. In 2012 we developed two such applications and pipelines. Both of these are available on Bioportal. The BIR pipeline (Kumar et al.) was developed to automate some of the most time consuming operations in the field of phylogenomics, which are to: 1) identify useful sequences, 2) find the right ortholog gene copy, 3) generate single gene alignments for all sequences intended for a supermatrix, 4) generate phylogenetic trees from each single gene alignments. The pipeline allows integration of newly generated sequences into manually curated single gene alignments. The other application we made is named BLASTGrabber (Neumann et al.). Its main function is to process the output from BLAST searches in the new sequencing era. The program is composed of a blast pipeline installed on Bioportal and a standalone program which imports the BLAST output and displays the content of a BLAST output file. It has several useful functionalities, such as text-mining, condensed matrix representation of the BLAST statistics and taxonomic ordering of the data.
The program aims at understanding life processes at several levels from molecules to organisms in the ecosystem. The main focus is on neurobiology and comparative physiology. Of particular attention are problems in muscle biology, hypoxia tolerance in vertebrates, neuroendocrinology, cellular electrophysiology, and development and adaption of the brain. The program utilizes not only model organisms such as rodents and medaka-fish, but also utilizes biodiversity, i.e. animal models with anatomical or physiological characters that make them superior for studying particular functions. The research program includes groups lead by; Kjell B. Døving (deceased), Marianne Fyhn, Kristian Gundersen, and Göran Nilsson, and one joint group led by Trude Haug and Olav Sand. In addition, two group leaders are associated with the research program through subsidiary positions at IBV; Finn-Arne Weltzien from NVH and Johannes Gjerstad from STAMI.

Sensory systems in fishes
The Kjell Døving group (deceased February 7th, 2014) was working on the sensory systems in fishes, in particular the sense of smell, taste, and nociception. He combined electrophysiology with morphological and behavioral studies.

Smell: The group has revealed that that the three types of olfactory sensory neurons converge to three distinct neural pathways to the brain. These pathways convey information about food, sex, and danger. Activation of these pathways induce food search, reproductive behavior, and alarm reaction respectively. The recent discovery of a ligand-specific endocytosis both in the sensory neurons of smell and in the receptor cells of taste buds, provide a new tool that can tell which type of sensory neurons is activated by a particular stimulus. Because once a dye is internalized in a sensory neuron it can be transported along the axons. Using particular odorants and fluorescent dyes the stained neurons can be visualized. Beside these studies in the crucian carp, the group also studied the dramatic development of the olfactory system in the salmon at different stages of their migration.

Taste: Carp fishes have numerous taste buds outside the oral cavity. Studies by endocytosis in the receptor cells of these taste buds have revealed functional differences and specificity of distribution.

Nociception: Pain in fish is a controversial subject and most studies have been performed on fresh water fish with limited economical importance for Norwegian fisheries. In collaboration with NOFIMA (Tromsø) the group engaged in a study of the nociception processes in cod.

The Kristian Gundersen group uses in vivo imaging and molecular biology methods to understand how muscle activity alters muscle properties such as speed, endurance and strength/size. Recently the group has described the biological foundation for the phenomenon of muscle memory, the finding that previously strength-trained individuals easily regain strength. Upon resuming training cell nuclei in the muscle fibers are not being lost during detraining and inactivity such as believed previously. By in vivo imaging methods the group has shown that strength training seems to recruit new muscle nuclei form stem cells, and these nuclei seems to be permanent. The group has demonstrated that anabolic steroids recruit nuclei...
and hence doping might have permanent effects. This discovery was ranked among the top 25 science stories of 2013 by ScienceNews. The group also work on several transcription factor systems such as myogenic helix-loop-helix molecules, PPARδΔ and HIF-1. The group is financed by FRIBIO (NFR), and Antidoping Norway and participate in the faculty initiatives BIFF and MURES. The group has several national collaborators, and collaborates internationally with groups in Lyon and at NIH (Washington).

The group members are Kristian Gundersen, researcher Jo C. Brusgaard, PhD students Ingrid M. Egner, Siobhan Anton, Julie Staruset, Einar Eftestøl and Master students Margrete Stoltenberg and Tine N. Alver.

Muscle fiber with cell nuclei imaged inside the living animal

Göran Nilsson’s group has for some 20 years worked on comparative respiratory and circulatory physiology, and comparative neurobiology. Three areas are presently in focus: 1) Mechanisms that allows vertebrates to survive with little or no oxygen; 2) Effects of elevated temperature and CO₂ on respiratory performance in fish; 3) Brain correlates to social behavior and stress in fish. All activities in this group have been intimately connected to the strategic initiative “BIFF – Biodiversity in Form and Function”, which has been selected as an emphasised research area by the Faculty of Mathematics and Natural Sciences.

The methods used in these project include molecular procedures such as cloning and sequencing of relevant genes, in vitro expression of relevant proteins, expressionual analysis of mRNA (micro arrays and real-time PCR) and proteins (2D gels and Western blot). Physiological studies are done using respirometry, in vivo and in vitro cardiovascular measurements, microdialysis, electrophysiology, and immunohistochemistry.

At least half of all projects are carried out through international collaborations, and our collaborators include research groups in Europe, Canada, USA, Australia, South Africa, Namibia and Abu Dhabi. National collaborators range from the Department of Thorax Surgery at Ullevål Hospital to the Norwegian Aquaculture industry.

Mechanisms of hypoxia and anoxia tolerance
Adaptations to variable oxygen levels in the brain, heart and respiratory organs are studied in various vertebrates. Of special interest are those animals that show an extraordinary high tolerance to anoxia. These include the crucian carp (no: karuss; lat: Carassius carassius) and freshwater turtles of the genera Trachemys and Chrysemys. Obviously, the existence of such species shows that evolution solved the problem of anoxic survival millions of years ago - something that medical science has attempted to do with very limited success during the last decades. It may be relevant to point out that anoxia related diseases are the most common causes of death in the western world.

Some key findings in these projects include the demonstration of a vertebrate heart that maintain cardiac out-put without any oxygen, revealing the capacity of fish to remodel their gills in response to ambient oxygen levels, characterization of the molecular mechanisms of ethanol production in a vertebrate, and demonstrating that animals can use GABA-mediated endogenous anaesthesia to reduce brain energy use.

Fish in a warmer future: effects of elevated temperature and CO₂ on respiratory performance in coral reef fish and Atlantic salmon
After having studied the ability of coral reef fish to cope with low oxygen levels, the focus is now turned to effects of elevated temperatures and CO₂ on brain function and the aerobic scope of fish. Aerobic scope is the difference between resting and maximal rate of oxygen uptake and determines how much energy can be devoted to activities like feeding and reproduction. So far, the results show that some coral reef fish lose virtually all of their aerobic scope when exposed to a 3
°C increase in water temperature, and this situation can be worsened by an increase in the water CO₂ level corresponding to that estimated to occur in about 100 years. The group has recently shown that neurotransmitter function in fish brain can be directly affected by a near-future increase in water CO₂ level, with drastic effects of behaviour.

A research grant from NFR-HAVBRUK, has allowed these studies to include temperature effects on aerobic scope in Atlantic salmon from different latitudes (from Bretagne to Finnmark), allowing us to evaluate how this important aquaculture species will cope with a warmer future.

Brain correlates to social behavior and stress in fish
Several years ago we could show that brain monoaminergic neurotransmitters, particularly serotonin and dopamine are intimately connected to stress reactions in fish, including socially induced stress. Our focus is now on the role of neurogenesis (formation of new brain cells) in stress reactions in fish and how neurogenesis is controlled. These studies, which are largely carried out in collaboration with the Norwegian University of Life Sciences and Uppsala University, have shown that stress reduces neurogenesis in the brain of salmonid fish, and that cortisol appears to play a key modulatory role in fish neurogenesis.

The group members are: Göran Nilsson, post docs/researchers Christine Couturier (NRF), Sjannie Lefèvre Nilsson (NFR/Carlsberg foundation), Ida Beitnes Johansen (NFR), PhD students Cathrine Fagernes (NFR), Floriana Lai (UiO), Mark Scott (UiO-MLS) and technician Tove Larsen.

In collaboration with the groups of Jon Nissen-Meyer (IBV) and Heidi Kiil Blomhoff (IBM, Med. fak) the group studies the membrane permeabilizing effects of plantaracins (PlnA), a peptide produced by lactic acid bacteria, on various eukaryotic cells. They also collaborate with Toshio Iijima’s group in Japan. For some cell types, PlnA selectively permeabilizes and lyses cancer cells, whereas their normal counterparts are unaffected. For other cell types, the selectivity for cancer cells is less pronounced. The aim is to clarify the mechanism of permeabilization and to test modified versions of the peptide, to explore if the specificity for cancer cells can be enhanced.

The group also studies a pore-forming protein complex (Nhe) produced by Bacillus cereus, in collaboration with Per Granum and Simon Hardy at NVH. Nhe inserts gigantic channels in cell membranes, and the conductance of these channels is the highest so far reported for any membrane channel.

The involvement of various signaling systems and ion channels in Vole regulation induced by hypotonic stress is also under investigation. The model cells used are clonal kidney (Vero) and pituitary cells (FRTL). Recently, the group demonstrated
an autocrine mechanism for Vole regulation in Vero cells. When these cells start swelling because of hypotonic challenge, they release ATP, which activate purinergic membrane receptors. This triggers a chain of events including Ca\(^{2+}\) release from intracellular stores, activation of Ca\(^{2+}\)-sensitive K\(^+\) channels, and K\(^+\) (and Cl\(^-\)) outflux. The loss of K\(^+\) and Cl\(^-\) contributes to the regulatory Vole decrease. Emeritus Kjell Fugelli also investigates the possible role of G-protein-coupled receptors as cellular Vole detectors.

The relation between electrophysiological properties and behaviour in different species of ciliates is also studied by the group, as well as pinocytosis and phagocytosis in Tetrahymena vorax. This species appears in two forms, microstomes and macrostomes, that differ in morphology, behavior and nutrition uptake. The macrostomes feed on other ciliates, while the microstomes feed on bacteria and soluble organic compounds. Transformation from micro- to macrostomes is triggered by the presence of suitable pray, for instance T. thermophila. This line of research is a collaboration with associate professor Heidi Grønlien from Østfold University College, who is an associated member of the group.

In collaboration with Hans Erik Karlsen, IBV, and Frank R. Knudsen, Simrad, Horten, the group investigates hearing and lateral line physiology in fish. Emeritus Per S. Enger is also involved in these studies. The role of the swim bladder in hearing is under study, as well as mechanisms for directional hearing, and the separate roles of the auditory and the lateral line systems in fish. Recently, the group demonstrated that fish are acutely sensitive to infrasound, even below 1 Hz, and that infrasound has strong behavioural effects on fish.

Group members are Trude Haug, Olav Sand, visiting associate professor Heidi Grønlien (40 % position), emeriti Kjell Fugelli and Per S. Enger, PhD students Rønnaug Strandabø, Isabelle Heikkinen, Kjetil Hodne, Eirill Ager-Wich, Kristine von Krogh and master student Michelle Rocha Lu.

A major challenge in neuroscience is the study of cortical processing in awake, behaving animals. The Hafting-Fyhn group aims to address basic questions about **activity-dependent plasticity in perception and memory** using approaches from sensory neurophysiology and the neuroscience of learning and memory. How we perceive the world is heavily influenced by our previous experiences and state of mind. However, most of our knowledge about the workings of sensory systems has been gathered from experiments using animals under deep anesthesia. Our main aims are (1) induce activity-dependent plasticity experimentally through sensory deprivation, perceptual learning, and fear conditioning, (2) directly assess the effects of the above processes on synapse dynamics and network activity in visual cortex, and (3) reveal fundamental principles of activity-dependent plasticity and learning, and identify cell type-specific contributions to these processes. To achieve this we use (a) electrophysiological recordings of large populations of neurons in vivo, (b) two-photon laser-scanning microscopy through a chronic cranial window, and (c) genetic tools for fluorescent labelling and cell type-specific genetic interference (optogenetics). A research focus in the group in the last year has been to understand how special extracellular matrix molecules, perineuronal nets (Figure), contribute to neural function and brain plasticity. These structures condense around a group of inhibitory neurons that play a key role in information processing and synchronizing neural activity.

Group members are Marianne Fyhn, Torkel Hafting Fyhn, post docs Christina Sørensen, Rachel M. Thomas and Mattis B. Wiggestrand, PhD students Ida E.J. Aasebø and Kristian K. Lensjø, master students Charlotte Christensen, Anne Marte S. Kvøllo, Elise H. Thomsen and Rune Lanton, and Erasmus student Elena G. Navarro.
The research groups within the Cell Biology Program have their focus on molecular aspects that operate on a cellular scale. This includes studies of protein glycosylation, mechanisms for intracellular sorting and transport, the cell cycle as well as molecular aspects of immunology.

The Cell Biology Program has in 2013 consisted of three research groups in Kristine Bonnevie’s hus and one at Oslo University Hospital. These research groups are headed by professors Oddmund Bakke, Gareth Griffiths, Kristian Prydz (program leader) and Inger Sandlie. Professor Norbert Roos at the Electron Microscopy Laboratory, is affiliated with the program. In addition, four professors at The Norwegian Radium Hospital (Rikshospitalet-Radiumhospital) have been associated with professor II (20 %) positions: Erik Boye, Andreas Brech, Kirsten Sandvig, and Per Ottar Seglen.

The research groups of Oddmund Bakke and Inger Sandlie are two of five research groups that participate in Centre for Immune Regulation (CIR). The centre was established in December 2007 (http://www.cir.uio.no), and has funding for a period of 2 x 5 years. Kirsten Sandvig is one of seven senior scientists in the Centre for Cancer Biomedicine (CCB) which is based at The Norwegian Radium Hospital.

Endocytosis, peptide loading of the MHC class II complexes

The main interest of Oddmund Bakke’s group is to elucidate at a molecular level the role of the endosomal pathway. Regulation of the endosomal pathway plays a critical role in all types of cells and all types of functions ranging from nutrition, signaling and metabolic reaction to protein secretion and cell migration. Therefore, we study the molecular mechanisms of intracellular protein sorting and trafficking, biogenesis and maturation of endocytic compartments in model cell lines in general and in immune cells in particular. Our projects are interconnected, however, each project focus on different aspects of the endosomal pathway and in particular we use live imaging techniques for the studies.

1) One of our main interests is to elucidate trafficking and regulation of molecules involved in MHC class II antigen presentation, in particular MHC class II and its associated chaperone Invariant chain (Ii). Our research has revealed several important functions of Ii in the endosomal pathway that favor antigen processing and presentation, including endosomal fusion (sampling of endosomes containing antigens and MHC class II) and delayed endosomal maturation (protecting antigens and MHC class II itself from degradation in late endosomes and lysosomes). The experiments are conducted both in model cell lines to understand the cell biological aspects of MHC class II antigen presentation, and in dendritic cells isolated from human blood, to investigate the mechanisms under more physiological conditions.

2) We have during the last decade contributed extensively to the understanding of how proteins are sorted between different organelles/compartments in the cell through sorting signals and adaptor proteins. During the last few years we have extended these studies to understand in more detail the molecular mechanism of protein sorting and endosomal communication. Our work has revealed a link between endosomal fusion and fission which is regulated by the cytoskeleton and specific motor proteins.

3) In general, trafficking of membrane proteins within a cell is regulated by the small Rab GTPases, and we investigate the role of Rab proteins both in immune cells and in model cell lines with regard to protein sorting, endosome biogenesis and maturation. Specifically, Rab7b is poorly characterized and has been shown in our lab to play an important role in regulating trafficking from the endosomal pathway to the Golgi apparatus. This work was published in 2010 and 2012 and is an ongoing study. Also, endosomal maturation from early to late endosomes has been a matter of debate for years and we contribute further to this debate by investigating the role of early (Rab5) and late (Rab7a) endosomal markers upon the conversion from early to late endosomes.
4) Also important for cellular communication is how the endosomal pathway contributes in receptor signaling events. Receptor tyrosine kinases undergo several steps of phosphorylation which in turn recruits specific adaptor proteins and other signaling kinases. Most of these receptor tyrosine kinases are internalized and either sorted into multivesicular bodies for degradation in order to turn off the signal, or they are subjected to recycling for new rounds of signaling. Regulation of the transport into multivesicular bodies is known to depend on protein complexes called the ESCRT machinery. Several molecules are involved in the ESCRT machinery and we investigate the kinetics of these molecules in order to understand in detail the regulatory role of ESCRT in multivesicular vesicle formation and sorting. All projects in the lab conduct advanced imaging techniques ranging from confocal imaging of fixed samples, to live cell and spinning disk confocal microscopy and high throughput fluorescence microscopy and superresolution microscopy. Fluorescent proteins are used in almost all our projects and are essential for the scientific output from the group. Bakke is head of the imaging facility NorMIC Oslo located at IMBV, which is a national imaging core facility initially supported by the FUGE program. The NorMIC Oslo facility was evaluated favourably as an Euro-bioimaging node in 2013 and we are on the National roadmap awaiting funding to become part of the ESFRI supported initiative.

Nanoparticle based drug delivery

The Gareth Griffiths group is focused on the development of nanoparticle based drug delivery and vaccine development for medical and aquaculture applications.

The main concept behind this project is the fact that conventional application of medicinal drugs, where one floods the body transiently with a drug, is not efficient, since it does not target the drug selectively to the diseased cells/organs. In contrast, when one encapsulates the drug within a nanoparticle (NP) made, for instance, from a biodegradable polymer, it is possible to selectively target the NP to the cells of interest, for example in a tumor. There, the cells take up the NP and a gradual breakdown of the NP leads to a slow, sustained release of drug precisely where it is needed. We started the project when Griffiths moved to Oslo in 2009, with a long-standing interest in macrophages and Mycobacterium tuberculosis (M.tb, the cause of the disease tuberculosis (TB)), after we realized that work in a number of groups, especially that of Gopal Khuller in India, had shown promising therapy using NPs (mostly made of one polymer, PLGA) encapsulating antibiotics in a number of animal models of TB. In many papers successful clearance of TB was observed, but the fate of the NPs was not followed, for example by microscopy. We decided to use the zebrafish model of TB (caused by Mycobacterium marinum)
(M.m) that had been established by the group of Ramakrishnan in Seattle. The advantage of this system is that the transparent embryo allows direct visualization of fluorescent bacteria, their infection of macrophages and the assembly of (human-like) granulomas, the hallmark of TB. We expected from the outset that this system would allow us to simultaneously visualize by fluorescence microscopy the bacteria, the host cells and the NPs, which turned out to be the case.

Given that we had no experience with making NPs or with zebrafish it took over two years to establish both systems; in the NP field we benefited greatly from the collaboration with the polymer group of Bo Nyström (Dept. of Chemistry). We succeeded in preparing PLGA NPs loaded with the anti-M.tb antibiotic rifampicin and showing that these could be taken up in a short pulse by mouse macrophages infected with the M.tb-like bacterium BCG in vitro; the drug was gradually released into the infected cells and completely killed the mycobacteria (Kalluru et al. 2013, J. Cell. Science). The group of our long-standing collaborator in Lisbon, Elsa Anes then showed that these NPs were also equally effective against M.tb (a Biosafety level 3 pathogen). In the zebrafish-M.m model, fluorescent NPs were found to be taken up by macrophages that were very effectively attracted (by chemotaxis) to bacterial-infected macrophages in granulomas, that had assembled a few days before injecting the NPs. We now have detailed information on the assembly of granulomas and their interactions with NP, based on the use of transgenic fish having fluorescently labeled macrophages, neutrophils or blood vessels. When the NPs loaded with rifampicin were injected into infected fish, they lead to effective clearance of most of the pathogen. The residual bacteria are likely to be phenotypically resistant to the antibiotic and efforts are now ongoing to combine antibiotic therapy with inhibitors of bacterial efflux pumps; efforts by Ramakrishnan and others argue that this is a promising avenue to pursue.

In an alternative approach aimed at novel vaccines against M.tb, we are encapsulating whole mycobacteria (starting with BCG) in biodegradable polymers in the form of microparticles. The idea behind this approach is to protect the bacterial surface components from degradation (e.g. after injection) until the bacteria are already in phago-lysosomes in antigen presenting cells. There the polymer can then be slowly degraded exposing the surface (and later internal) bacterial antigens to the antigen presentation system. In addition we are trying to combine this with stimulation of the innate immune system by attaching ligands of intracellular toll-like receptors such as double stranded RNA.

The M.m infection model of zebrafish provided an excellent technological platform for establishing other infection models for bacterial pathogens relevant for aquaculture, in collaboration with the group of Hanne Winther Larsen (School of Pharmacy). We have succeeded in characterizing three different species of intracellular macrophage bacteria from the genus Francisella: 1. F.naotunensis, a pathogen of cold water fish such as Cod, kept in cold water acclimated zebrafish at 22°C. 2. Forientalis, a pathogen of warm water fish such as Tilapia, kept at 28°C in zebrafish. 3. F.novicida, a pathogen of mice that is a widely used model for the notorious human pathogen F tularensis, kept in warm water acclimated zebrafish at 32°C (Brudal, Ulanova et al. 2014. Infection and Immunity, in press). In addition, it has been shown that PLGA-rifampicin NPs are also effective against Forientalis.

A separate focus on aquaculture pathogens has been targeted at salmon viruses with efforts made to encapsulate these for vaccination (in collaboration with the groups of Bo Nystrom, Tor Gjøen (School of Pharmacy, UiO) and Øystein Evensen (Norwegian School of Veterinary Science).

We recently initiated a project aimed at developing NPs against cancer in the zebrafish model, in collaboration with the Nyström group, the group of Gunhild Mælandsmo (OUS, Radium Hospital) and the group of Ewa Snaar Jagalska (University of Leiden). The idea here is to inject human cancer cells into zebrafish embryos to form human-like tumors. A number of groups have succeeded with this approach, facilitated by the lack of adaptive immunity (and therefore rejection of foreign cells) in zebrafish larva, which doesn’t develop until around 1 month of age. We have also succeeded in establishing human tumors in the zebrafish with different cancer cell lines and are now pushing the development of NPs made from different polymers enclosing either fluorescent compounds or anti-cancer drugs. This project is technically and conceptually much more difficult than the TB...
and Francisella projects (in which the NPs have a natural tendency to be taken up by the infected cells, the macrophages) because for cancer the NPs must: 1. Be very small (< 150nm) to reach the tumors. 2. Be conjugated with molecules such as PEG to prevent them being taken up by macrophages and 3. Ideally they should have a specific ligand on their surface that binds receptors on the surface of the cancer cells. These issues are being actively pursued with our collaborators, with complementary analyses being also carried out on the cancer cells and macrophages in vitro.

A separate series of projects have focused on applying state of the art electron microscopy and combined light microscopy and EM to address issues related to a number of intracellular pathogens. This is a project funded by the German research foundation (DFG) and involves collaboration between different pathogen groups within the Priority Programme SPP1580 "Intracellular compartments as places of pathogen-host-interactions".

In collaboration with the EM lab, we organized a very successful EM course for 7 students from the SPP1580 network between May 24-31, 2013.

In addition, we have collaborated with Claus-Michael Lehr (Saarbrucken) on the ultrastructure of alveolar epithelial barrier cell models.

A separate project analyzes the intracellular cycle of *E. novicida* in host macrophages. Francisella bacteria are extremely poorly preserved with chemical fixation and the ultimate goal is to establish a protocol for high pressure freezing and freeze substitution of *E. novicida*-infected primary bone marrow-derived macrophages. We will also quantify the fractions of cytosolic and vesicular bacteria at several time points during the infection. With immunolabeling we will characterize phagosomes containing bacteria that fail to escape into the cytosol and investigate the role of autophagy in the recapture of bacteria that escape into the cytosol.

Intracellular transport pathways for glycoproteins and proteoglycans in epithelial cells.

An epithelial cell is contacting neighboring cells with junctional proteins. Tight junctions seal the apical surface, to avoid leakage from the body cavities (lungs, intestine, kidney tubules, etc.) to the blood supply. Sorting of proteins and lipids in the two secretory directions is thought to take place in the Golgi apparatus, but more recently also in endosomes. Intrinsic sorting signals are recognized in molecules that undergo sorting in the apical or basolateral directions. The Kristian Prydz group investigates secretory transport routes in polarized epithelial cells. They are particularly following a group of proteins called proteoglycans (PGs), which are modified with long linear glycosaminoglycan (GAG) sugar chains in the Golgi apparatus. The groups previous finding, that PGs traversing both the apical and basolateral secretory pathways obtain glycan modifications that differ structurally, particularly with respect to sulfation intensity, underway to the two opposite surfaces of the epithelium, violated the textbook view that sorting towards the apical and basolateral surfaces takes place in the trans-Golgi network – the last stage of the Golgi apparatus. At present, focus is mainly on the intermediate compartment (IC) between the endoplasmic reticulum (ER) and the Golgi apparatus, to investigate whether this membrane system is an important sorting station in epithelial and other polarised cells. In this project the group has collaborated with Professor Jaakko Saraste and Dr. Michael Marie, UiB. The imaging knowledge of the Saraste group has combined with the Prydz’ competence in relation to studies of synthesis and polarized transport of glycoproteins and proteoglycans in filter-grown epithelial cells. Jaakko Saraste has pioneered investigation of the IC and has suggested a role for this compartment as an important crossing of the endocytic and secretory pathways. We have particularly studied sorting into Golgi-dependent and Golgi-independent secretory routes departing from IC.

Another project that has emerged from the previous studies of differential sulfation, particularly of chondroitin sulfate chains, in the apical and basolateral secretory routes, is a study of the role
of the Golgi membrane transporter of nucleotide sulfate (PAPS) into the Golgi lumen. While increasing the PAPS transporter 1 (PAPST1) level in the Golgi by transfection increased chondroitin sulfate in the apical secretory route to a similar level as in the basolateral route, was sulfation of heparan sulfate (HS) not significantly altered. Surprisingly, when reducing the level of PAPST1 by siRNA, HS sulfation was enhanced in the basolateral route, displaying enhanced binding capacity for growth factors. The data indicate that a basolateral transport route with particular priority when PAPS availability is limited exists in the basolateral direction.

In collaboration with Hedmark University College (Dr. Frøydis Myromslien), the Prydz group is engaged in a study of glycoproteins and proteoglycans synthesized by bovine oviduct epithelial cells, grown in a polarized manner in culture. The aim is to identify glycosylated proteins and proteoglycans that influence fertility in by capacitation of sperm cells, but also in other ways. The project is funded until the end of 2016.

The Prydz group has been part of the GLYCONOR network at The Faculty of Mathematics and Natural Sciences (http://www.imbv.uio.no/forskning/glyconor/), and Kristian Prydz headed the application that obtained support from The Research Council of Norway (NFR) via the FUGE II program. Both sources of support are now history, apart from one PhD student (Marlene Lundström) expected to defend her thesis in 2015. The GLYCONOR network still exists, however, and the role of glycans in diverse molecular mechanism attracts more and more scientists.

Group members in 2013 were Kristian Prydz, researcher Heidi Tveit, post docs Gunnar Dick, PhD students Linn Kristin Aasen Akslen, Gro Live Fagereng, Marlene Lundström, technician Frey Grendahl, master students Mohamed Soliman, Markus Wächter, Tomasz Konopka and associated members Anders Moen (research technician mass spectrometry) and Clara Jalland (PhD student).

The structure and function of antibodies and T-cell receptors
The Sandlie group studies the structure and function of antibodies and T-cell receptors, the specific detecting molecules of the adaptive immune system. The purpose of the work is to engineer soluble T-cell receptors, antibodies and antibody derived molecules to be used in therapy and as research reagents. We focus on two projects:

A) Studies of the interaction between Fc receptors, and in particular the neonatal Fc receptor (FcRn), with IgG subclasses and albumin. Key questions are how ligand binding elicits antibody effector functions and regulate biodistribution and serum half-life.

B) Expression of soluble T-cell receptors for the detection of complexes between antigenic peptides and HLA molecules, as well as peptide – HLA complexes for detection of T-cell receptors. The focus is on engineering to increase stability and affinity for molecules that are characteristic of disease models in groups at CIR.

Achievements in 2013:
• Increased our understanding of the interaction between the serum half-life regulating receptor, FcRn, and albumin. Designed and characterized novel albumin variants with increased binding to FcRn that will be used as carriers of biopharmaceuticals to increase their serum half-life.

• Demonstrated that conventional rodents have limited utility as preclinical models for analysis of the serum half-life of such biopharmaceuticals.

• Established a novel strategy for selection of stable protein variants using phage display. A soluble single chain T cell receptor was stabilized this way that allowed studies of specificity and binding kinetics using surface plasmon resonance.

• Designed and characterized a nondestructive IgG antibody variant that lacked binding to complement and all classical Fcγ receptors, while still binding to FcRn and having the ability to be transported across the placenta. This will be used to block the activity of maternal IgG antibodies that are harmful to the fetus.

Proteins in blood are short lived and normally degrade within a few hours or days, but the two most abundant proteins, IgG and albumin, are rescued from degradation and have half-lives of three weeks. The rescue mechanism depends on
their interaction with the neonatal Fc receptor (FcRn), and it is crucial to understand how FcRn rescues IgG and albumin, and to transfer long half-life to therapeutics, using the same mechanism. The Sandlie group works in collaboration with Novozymes Ltd, UK, who has filed several patent applications and developed the “Albufuse Flex” technology, a set of human albumin variants designed by us with greatly increased binding affinity for FcRn. Biopharmaceuticals fused to a new albumin variant can have half-life of months, which will decrease dose, dosing frequency and toxic side effects.

Furthermore, FcRn directs the transfer of maternal IgG antibodies across the placenta and thus provides the fetus and newborn with protective humoral immunity. Pathogenic maternal IgG antibodies will also be delivered via the placenta and can cause alloimmunity, which may be lethal. In 2013 we have designed a novel strategy to control pathogenic antibodies by administration of a non-destructive IgG antibody that retain FcRn binding and is delivered to the fetus and has the ability to blocks antigen binding of pathogenic antibodies.

To ask questions regarding the nature of the antigen presenting cell, the location and rate of antigen presentation and the interaction with T cells, specific detection molecules are needed. Soluble T-cell receptors are new tools for such studies in health and disease. The Sandlie group has explored how phage display may be used to improve stability and affinity of soluble T-cell receptors and MHC class II molecules. We have displayed not only soluble T cell receptors, but also MHC class II molecules, so-called “Phagemers”, which will be used as diagnostics for coeliac disease. Furthermore, a spin-out company, Nextera AS, commercializes and develops the new phage display- and Phagermer technologies, and utilizes libraries of Phagemers to search for disease causing proteins that drive pathological T cell activation in autoimmune diseases and chronic infections.

Group members in 2013 were Inger Sandlie, post docs Geir Åge Løset, Jan Terje Andersen, Kristin Gunnarsen, researcher Peng Lei, PhD students Lene Støkken Haydahl, Stian Foss, Algirdas Greivys, Malin Bern, Kine Marita Knudsen Sand, Nicolay Rustad Nilsen, master students Bergrun Eggertsdottir, Mira Børstad, Jeannette Nilsen and technician Sathiaruby Sivaganesh

The Electron Microscopy (EM) unit at the Department is headed by Norbert Roos. The laboratory provides primarily imaging services to researchers of the department, but also to external (e.g. industrial) users. The specialties of the lab are immunocytochemistry and cryo-electron microscopy as well as high resolution scanning EM.

In addition, the cell biology program has encompassed three professor II positions: The main interest of Erik Boye is the molecular mechanisms regulating cell growth and the cell cycle. In particular, he is studying the G1/S transition in fission yeast. His group has discovered a G1/S checkpoint that depends upon a growth regulator, the kinase Gcn2 (Tvegård et al, Genes Dev 2007). They are characterizing this checkpoint and follow new leads to mechanisms linking cell growth and cell cycle progression.

Kirsten Sandvig has as her main interest endocytosis and intracellular transport. Protein toxins from plants and bacteria are used as tools to investigate the different types of endocytosis, as well as sorting along the endocytic pathway and retrograde to the Golgi apparatus and to the ER, from where the toxins are translocated to the cytosol. Toxins provide information about basic processes in cell biology and changes occurring in cancer, and they can be used in medicine, either targeted for instance to cancer cells or to mediate transfer of other compounds into the cytosol.

Per O. Seglen studies the regulation of autophagic protein degradation, cytoskeletal organization and apoptotic cell death in normal and malignant rat liver cells. His group has developed a method for purification of autophagosomes from isolated rat liver cells and characterized these organelles biochemically as well as structurally. By the use of proteomics (protein separation by two-dimensional gel electrophoresis and column chromatography, combined with protein identification by mass spectrometry), they have been able to identify about 40 proteins that are selectively associated with autophagosomal membranes, including many novel enzyme forms. Several of these enzymes are functionally related, suggesting the participation of specific biochemical processes in the regulation of autophagic activity. Seglen retired at 70 in September 2013, but will continue to be involved in teaching at IBV. He is now associated part-time with the group of Ian Mills at NCMM, University of Oslo.
The Gene Program

www.mn.uio.no/lv/forskning/grupper/gener

The research in the Programmed for genomics, gene regulation and gene function is centered around transcription factors, epigenetics, functional genomics, and enzymes involved in modifying proteins and nucleic acids. Mammals (mice and cell lines), plants (Arabidopsis), and green algae (Chlamydomonas) are used as model systems.

The program consists of seven research groups, headed by the faculty members Winnie Eskild, Pål Ø. Falnes, Odd Stokke Gabrielsen (together with Ragnhild Eskeland), Uwe Klein, Fahri Saatcioglu, and one temporarily employed associate professor, Paul Grini. In addition, the following research group leaders from Oslo University Hospital are affiliated with the program through subsidiary positions: Ragnhild Lothe, Guro Lind and Ola Myklebost.

Epigenetics and cell-to-signaling
The Reidunn B. Aalen group has contributed to the epigenetics field by the identification of Methyl-CpG-Binding Domain proteins and histone methyltransferases (SET-domain proteins) in the model plant Arabidopsis thaliana, and aim at identifying novel readers and writer of the histone code. Such proteins are involved in gene regulation by modification of chromatin structure. Lately, the Aalen group has discovered a cell-cycle regulated SET-domain protein involved in controlling synchronization of cell divisions in the root, and Aalen presented this work at “The 3rd European Workshop on Plant Chromatin” in Madrid, Spain, in Sept 2013.

The group is also elucidating floral organ abscission and other cell separation events in plants. The lab has previously identified a ligand-receptor system, the small peptide IDA and the leucine-rich repeat receptor-like kinases HEASA and HEASA-LIKE2, absolutely required for abscission, and identified a transcription factor downstream of this signaling module. Interestingly this signaling module is also needed for separation of cells overlaying emerging lateral roots.

Epigenetic regulation and signaling in seed development.
The Paul Grini group studies the genetic and epigenetic regulation of the fertilization process in plants. Higher organisms inherit DNA from both a mother and a father and the expression of this DNA is equivalent from both male and female genomes. Some genes, however, are only expressed from the maternal or the paternal genome, a phenomenon called genomic imprinting and found in higher organisms ranging from plants to humans. Imprinting involves methylation of DNA and modifications of specific amino acid residues in histone tails leading to rearrangement of chromatin into repressive or permissive transcriptional states. To identify novel imprinted genes, the group has used a microarray screening strategy that identified an array of previously uncharacterized AGAMOUS-LIKE (AGL) MADS-Box transcription factors as candidates for novel imprinted genes. Much of the group’s effort has been directed towards the verification of these genes. AGL36 has been shown to be expressed from the maternal genome only, and the paternal silencing of AGL36 is maintained by the major DNA methyltransferase MET1. In addition, the maternal expression of AGL36 is targeted by a histone methylation through the Polycomb Repressive Complex 2 (PRC2).

The gene encoding the IDA peptide ligand is expressed (A, blue colour) in the cells that have to separate for lateral root to emerge (B, wild type root). In the ida mutant (C) or the haesa receptor mutant (D) the lateral root has to break its way through the overlaying layers to emerge. Cryo Scanning EM was performed at the EM lab. (Kumpf et al., PNAS, 2013)
Another research effort in the group has been the study of a cullin–associated factor that is required for seed survival. Protein ubiquitination by cullin (CUL)-RING E3 ligases (CRLs) regulates an extensive range of biological processes by attachment of ubiquitin to substrate proteins to either promote their degradation by the UBIQUTIN-26S proteasome pathway, or by changing their function or chromatin context. CUL4-RING ligases were recently shown to exert their specificity through the binding of various substrate receptors, which bind the CUL4 interactor DDB1 through a WDxR motif. In a segregation-based mutagenesis screen the group has identified a WDxR motif-containing protein (WDR55) that is required for transition to bilateral symmetry in the apical embryo domain and demonstrated that WDR55 physically interact with DDB1A in planta, suggesting WDR55 to be a novel substrate recruiter in CRL4 ubiquitin ligase complexes. The group has this year further shown that wdr55 display pleiotropic phenotypes in the seedling and adult stages, suggesting a novel regulatory role for WDR55 in vegetative development. In collaboration with Italian and German research groups they have shown that WDR55 is targeted by the floral homeotic gene SVP, and that WDR55 regulates the spatial expression pattern of AGAMOUS, another floral homeotic gene.

Transcription and Epigenetics

The Odd Stokke Gabrielsen group has become a joint group between a young investigator, Ragnhild Eskeland, and an established group leader, Odd Stokke Gabrielsen, combining expertise in epigenetics and chromatin analysis with broad knowledge of the field of transcription with focus on the transcription factor c-Myb.

Transcription projects. As a proto-oncogene, c-Myb can undergo oncogenic activation and was among the first retroviral oncogenes identified. Recently, c-Myb has gained renewed interest due to its role in regulating stem/progenitor cell homeostasis and the association with human leukaemogenesis. Some cancers may also be driven by a c-Myb-directed gene program (oncogene addiction). Despite being an old oncogene, our understanding of molecular mechanisms controlling c-Myb function remains incomplete. Understanding how the activity of c-Myb is regulated by post-translation modifications and cofactor interaction is our focus. Hence, the on-going research is directed towards three main objectives:

1) Defining molecular functions of novel coactivators of c-Myb. 2) Unravelling mechanisms of PTM-mediated control of c-Myb activity, focusing on SUMOylation and phosphorylation. 3) Identifying novel and robust c-Myb target genes.

Epigenetic projects. The main focus of Ragnhild Eskeland is to study basic mechanisms in epigenetics related to chromatin compaction and decompaction. One focus is to explore the epigenetic roles of the two histone H2A.Z1 and 2 isoforms, coded by two non-allelic genes which proteins differ in three amino acids. The approach is to endogenously tag H2A.Z1 and 2 isoforms in murine embryonic stem cells (ES) cells using a newly developed genome editing technique called the CRISPR-Cas9 system. In addition, recombinant histone octamers have been generated for all possible variants of histone H2A.Z and H3 for in vitro pull-downs and nucleosome assembly. The histone variants H2A.Z1 and Z2 are also studied in relation to breast cancer where both forms are significantly upregulated.

The CRISPR-Cas9 system is now being established in the lab after PhD Candidate Madeleine Fosslie had several weeks training in Edinburgh. This year was also a successful year for RE receiving both a Researcher grant from the Cancer Society and a Young investigator talent grant from the Norwegian Research Council.

Projects in the intersection between transcription and epigenetics. The epigenetic chromatin landscape is both a determinant of and itself critically
dependent on the transcription activity in a cell. Understanding this tight interdependence is a fundamental challenge in epigenetics. Problems addressed:

Investigations of how c-Myb, through binding to chromatin and cofactor recruitment, establish specific epigenetic signatures.

We address the concept of pioneer transcription factors (PTF), a subset of early transcription factors with a specialized role in priming the epigenetic landscape. The question is whether the family of PTFs may be expanded to include human c-Myb. This implies an ability of c-Myb to decompact specific loci de novo to prepare for specific gene programs to be launched.

Characterization of the physiological function of NCU-G1

NCU-G1 has been described as a lysosomal membrane protein and a possible transcription factor. As a means to understanding the function of this novel protein, the Winnie Eskild group has created a mouse model lacking NCU-G1 expression using the "gene-trap" approach. Homozygous NCU-G1<sup>gt/gt</sup> mice are healthy, grow well and produce offspring in the same manner as the wild type mice. Initial studies of six months old animals show that the most prominent phenotypic features are hepatic inflammation, high levels oxidative stress and liver fibrosis/cirrhosis.

Broadening our perspective, we have pursued the development of phenotypic features in this mouse model from new-born to old mice. Our data show changes in the extracellular matrix from birth and development of inflammation, oxidative stress and fibrosis/cirrhosis from approximately one month of age. At later stages in life the NCU-G1<sup>gt/gt</sup> mice develop hepatic tumors. Further characterization of this condition is in progress using a number of different techniques. As NCU-G1 is localized to the lysosomal membrane, studies of the integrity of the endocytic and autophagic pathways are in progress.

Most models used in liver fibrosis research are created by treatment with harsh chemicals or bile duct ligation, all of which result in acute liver fibrosis. Although liver fibrosis is a reversible condition provided the cause is eliminated, most cases of liver fibrosis in humans are chronic because its etiology is either unknown or impossible to change. It is therefore of great importance to develop suitable drugs, which can alleviate the symptoms and prevent progression to cirrhosis and organ failure. The potential of the NCU-G1<sup>gt/gt</sup> mouse as a model of chronic liver fibrosis is based on the fact that few such models are available.

Discovery of novel enzymes involved in macromolecular modification

The research in the group of Pål Falnes is focused on various enzymes involved in the methylation, hydroxylation, and demethylation of macromolecules such as DNA, RNA and proteins. Part of the work is based on the initial discovery of the function of the E. coli AlkB protein, which is an Fe<sup>2+</sup> and 2-oxoglutarate dependent oxygenase demethylating certain lesions in DNA, such as 1-methyladenine. In humans, nine AlkB homologues (ALKBH) exist, and the function of the majority of these proteins remains elusive. The group is trying to unravel the function of these proteins and has recently demonstrated that one such protein, ALKBH8, is actually involved in tRNA modification rather than in DNA/RNA repair. Recently, the group has initiated studies of uncharacterized human protein methyltransferases, and has revealed the biochemical function of several such enzymes.

Androgen signaling in prostate cancer

The main goal of Fahri Saatcioglu’s group is to understand how hormones exert their effects in normal physiology, as well as their role in disease states. The main topic of interest is sex hormone action, especially androgens. Androgens bind to an intracellular receptor, the androgen receptor (AR), that belongs to a superfamily of ligand-activated transcription factors, called nuclear receptors, and bring about changes in the phenotype of the cell through modulation of gene transcription. The group studies the molecular mechanisms that govern AR function, through molecular, cell biological, biochemical and genetic approaches. In addition to dissecting the ways in which AR interacts with chromatin, the aim is to understand how some of the AR target genes are regulated and the function of their gene products. Another interest is the interplay of AR with other signaling pathways in the regulation of growth and apoptosis of prostate cancer (PCa) cells.
‘Breakthroughs’ in 2012/2013: Several observations were made related to the AR target genes that the group has been focusing on. One of these is kallikrein related peptidase 4 (KLK4) which was cloned in the FS lab several years ago. The group has previously shown that KLK4 expression is highly prostate specific, is regulated by androgens, and it is overexpressed in prostate cancer compared with normal prostate. We now found that KLK4 physically interacts with promyelocytic leukemia zinc finger (PLZF) and thereby integrates optimal functioning of AR and mTOR signaling in PCa cells, two of the major proliferative pathways in a number of tissues and are the main therapeutic targets in various disorders, including prostate cancer. KLK4 interacts with PLZF and decreases its stability. PLZF in turn interacts with AR and inhibits its function as a transcription factor. PLZF also activates expression of REDD1, an inhibitor of mTORC1. Thus, a novel molecular switch is generated that regulates both AR and PI3K signaling. Consistently, KLK4 knockdown results in a significant decline in PCa cell proliferation in vitro and in vivo, decreases anchorage-independent growth, induces apoptosis, and dramatically sensitizes PCa cells to apoptosis-inducing agents. Furthermore, in vivo KLK4 siRNA delivery in mice bearing PCa tumors results in profound remission. These results demonstrate that the activities of AR and mTOR pathways are maintained by KLK4 which may thus be a viable target for therapy.

Similar studies are ongoing involving other androgen regulated genes implicated in PCa, including the STAMP family of proteins, their interaction partners, and TCTP.

Gene regulation in chloroplasts
The focus of the work in the group of Uwe Klein is on regulation of gene expression in chloroplasts, particularly regulation of mRNA degradation. This work is done in cooperation with groups at the University of Valencia (Spain). In cooperation with a group at the University of Bonn (Germany) the synthesis of the compatible solute ectoine in the chloroplast of the unicellular green alga Chlamydomonas reinhardtii is investigated in a biotechnology-oriented project.

Representation and outreach
Reidunn B. Aalen and research fellow Melinka Butenko gathered researchers from the cell signaling field in Oslo January 2013 by arranging "The 1st European Workshop on Peptide Signaling in Plants". The meeting was sponsored by Journal of Experimental Botany which launched a Special Issue on Peptide Signaling where the Aalen group has several contributions. Aalen gave invited plenary lectures at the Biochemical Contact Meeting of the Norwegian Biochemical Society (Lillehammer, January 2013) and at the conference of the International Plant Growth Substances Association (Shanghai, China, June 2013), and research fellow Melinka Butenko gave an oral presentation at the International Conference of Arabidopsis Research (Sidney, Australia, June 2013).

The Grini group arranged the conference “European Frontiers of Plant Reproduction Research” - www.plantreproduction.no - and this was a major highlight of the year. The event was the largest specialized meeting in this field in 2013 and gathered some of the most renowned experts in the genetics and epigenetics of plant reproduction. The conference was visited by more than 130 delegates from 25 countries - mostly from Europe, but also from Asia, Australia, the Americas and Africa.
The Protein Program

The Protein Program is headed by Michael Koomey and consists of four research groups led by professors K. Kristoffer Andersson, Michael Koomey, Tom Kristensen and Jon Nissen-Meyer. These groups are involved in structure and functional analysis of various proteins, especially bacterial proteins such as pili from pathogenic bacteria, various bacterial metallo enzymes, bacterial antimicrobial peptides and their cognate immunity proteins, and peptide synthetases from cyanobacteria. The groups of K. Kristoffer Andersson, Pål Falnes, Odd Stokke Gabrielsen, Jon Nissen-Meyer and Reidun Aalen participate in ProtStruc, a strategic research initiative at the Faculty of Mathematics and Natural Sciences.

The K. Kristoffer Andersson group has for a long time been combining modern spectroscopic methods (EPR X-band, high field EPR, CD, MCD, resonance Raman), single crystal protein spectroscopy (e.g. light absorption, Raman), structural protein analyses (X-ray), kinetic analyses (stopped flow, cryoenzymology) and theoretical modeling (DFT-MM) with protein expression/purification/mutagenesis on biologically relevant iron proteins (Ribonucleotide reductase, cytochrome c), copper proteins (Oxyhemocyanin) as well as biomimetic model complexes (including di- and tri-copper(II) complexes). The structural organization, the electronics and red-ox chemistry associated with the metal ion/s or organic cofactors present in such systems translate into the appearance of properties (e.g. paramagnetism/ferromagnetism and visible optical activities) that can be used to unveil details of the enzymatic or electron transfer mechanisms connected to the protein function. In 2013, the group actively worked on the analyses of the mechanisms of oxygen activation in mammalian, fish and bacteria Class I Ribonucleotide reductases. We solved a Ribonucleotide reductase class Ib protein. The group published a major review “Ribonucleotide reductase class I with different radical generating clusters” and novel structures of heme proteins; catalase-peroxidase (KatG) and a cytochrome c with mutant.

The group members in 2013 were K. Kristoffer Andersson, researcher Hans-Petter Hersleth, post doc Åsmund K. Røhr, PhD students Inger K. Olsbu, Marta Hammerstad, Marie Lofstad and master students Inger K. Olsbu, Marta Hammerstad, Marie Lofstad, Susanne Monka and Bernt Wu.

The Koomey group focuses on studies of the molecular mechanisms of microbial pathogenesis using species in the genus Neisseria. The genus contains two human pathogens that cause very different diseases, both of global significance: Neisseria meningitidis which causes meningitis and septicaemia; and Neisseria gonorrhoeae which causes gonorrhea and occasionally, disseminated infections. Comparative genomics have yet to yield clear insights into which factors dictate the unique host-parasite relationships exhibited by each since, as a group, they display remarkable conservation at the levels of nucleotide sequence, gene content and synteny, there are many commensal species that are not associated with disease. We aim to gain a better understanding of the mechanisms employed by these agents in X-ray crystal structures of N. europaea cytochrome c-552 and of a single-deletion mutant demonstrate that one heme pocket residue influences axial ligand conformation, heme conformation, and access of water to the heme, with significant consequences for electronic structure.
colonizing humans as a means to preventing and controlling disease. We have had and maintain today a strong interest in the structure, function and biogenesis of their type IV pilus colonization factors. We also focus on the broad spectrum, O-linked protein glycosylation (pgl) found in these species that we discovered in 2009. Although protein glycosylation systems are becoming widely recognized in bacteria, little is known about the mechanisms and evolutionary forces shaping glycan composition. Neisserial species display remarkable glycoform variability associated with their O-linked protein glycosylation (pgl) systems and provide a well developed model system to study these phenomena. Here, we focus on elucidating the levels of glycan diversity within and between strains and the genetic bases for this diversity. These studies have led to other work investigating the roles of neisserial glycoproteins, many of which are associated with electron transport processes and respiration. They have also served as a springboard to study protein glycosylation in other important pathogens including Francisella tularensis and Burkholderia pseudomallei. Finally, we continue to study the roles of unique post-translational modifications of neisserial proteins with phosphoethanolamine and phosphocholine, a process that we discovered in 2004. Current studies indicate that multiple proteins carry these modifications and that these modifications are associated domain targeted for protein glycosylation. The Koomey group is affiliated with the Glyconor research program (a cross-departmental strategic initiative at the Faculty of Mathematics and Natural Sciences hosted thru IMBV) and Michael Koomey was a group leader in the Centre of Molecular Biology and Neuroscience, an NFR Center of Research Excellence. The group is financed by funds from NFR, EMBIO and IMBV.

The group members in 2013 have been Tom Kristensen, Jon Nissen-Meyer, post doc Camilla Oppegård, PhD student Bie Ekblad and technician Randi Ose. In addition, the group has had close research collaboration with NMR research scientist Per Eugen Kristiansen (IBV), and with Professors Dzung B. Diep and Ingolf F. Nes at the Laboratory for Microbial Gene Technology, Department of Chemistry, Biotechnology and Food Science at The Norwegian University of Life Sciences.

The group were in 2013 Michael Koomey, researchers Finn Erik Aas, Åshild Vik, Marina Aspholm and Bente Berud, post doc Jan Haug Anonsen and PhD students Raimonda Viburiene. The Tom Kristensen and Jon Nissen-Meyer groups (The Peptide Group) is involved in research on antibacterial peptides produced by lactic acid bacteria. These peptides (often referred to as peptide bacteriocins) are of great interest because they are produced by “food grade” bacteria and might consequently be utilized as relatively safe agents for preventing growth of pathogenic/undesirable microorganisms. Our research focus has in recent years especially been on elucidating the mode-of-action and three-dimensional structure of peptides that group members have previously isolated, sequenced and genetically characterized. Some of the peptides have been shown to kill bacteria by a receptor-mediated mechanism, which entails that the peptides bind to specific membrane proteins, and thereby cause membrane-leakage and cell death. Through this receptor-mediated mode-of-action, the peptides show antibacterial activity at nanomolar to picomolar concentrations. The structure and structure-function relationships of these peptides have been analyzed using NMR-spectroscopy and site-directed in vitro mutagenesis. This last year, the receptors of several of these peptides have been identified by the use of whole-genome sequencing of spontaneous mutants of sensitive cells that have gained resistance to the peptides. Moreover, heterologous expression of these receptors in non-sensitive bacteria was shown to rend the bacteria sensitive to the peptides. The approach of whole genome sequencing of peptide resistant mutants combined with heterologous expression should be a widely applicable method for identification of receptors also for other peptide ligands.

Representation and outreach
Part of the on-going research results obtained by all three groups were communicated at several national and international meetings and conferences. Andersson is a member of the Managing Committee of COST CMST Action CM1003 (Biological Oxidation Reactions - Mechanisms and Design of new Catalysts) and the head of the ProtStruc initiative within the MN-faculty. Koomey was head and co-leader of the inter-institutional strategic research program CIM(Center for Integrative Microbiology) and Glyconor at MN-faculty respectively.
The Department of Biosciences at the University of Oslo is, in terms of the number of students and courses offered, the largest bioscience department in Norway. We offer two Bachelor’s degree programs, 3 Master’s degree programs and PhD degrees.

Altogether 23 different bachelor and 95 different master and PhD courses were given in 2013.

The Department also focuses attention on internationalization, and we encourage our students to take semesters abroad. In 2013 IBV had 30 (23 Erasmus) incoming exchange students, and 17 (2 Erasmus) of our students were taking courses outside UiO.

### IBV Courses in 2013

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### The Bachelor’s degree programs

Both Bachelor’s degree programs provide a broad understanding of biology and impart basic knowledge of natural sciences, such as mathematics, statistics and chemistry. The biology program later on emphasizes biodiversity, structure and function of organisms, interactions between organisms and their environment (ecology) and evolutionary processes. In the molecular biology and biological chemistry program emphasis is put on chemistry to orient towards biochemistry, or molecular, micro- and cell biology. Laboratory and field work are important parts of our Bachelor’s degree programs. 97 students enrolled in the Biology program, whereas 110 students enrolled in the Molecular biology program in 2013.
The Master’s degree programs

IBV offers three Master’s degree programs: Biology, Molecular Biosciences, and Biodiversity and Systematics. In the Biology program there are three options: Ecology and Evolution, Marine Biology and Limnology, and Toxicology. In the Molecular biosciences program there are also three options: Biochemistry, Molecular Biology and Physiology. Additionally we also offer master specialization in biology and molecular biology for students at the Educational Studies program.

The Nordic master’s program in biodiversity and systematics - NABiS - is a consortium aimed at providing students with the taxonomic skills needed to work on biodiversity and conservation in the future. The universities involved in the program are University of Gothenburg, University of Lund, Natural History Museum of Denmark, Uppsala University, Aarhus University, Swedish Museum of Natural History, Norwegian University of Science and Technology, Tromsø University Museum, and University of Oslo.

The Master’s degree program consists of courses and a science based thesis, both parts corresponding to 60 credits (for students enrolled in the Educational Studies program the thesis corresponds to 30 credits). The thesis shall provide skills within field and/or laboratory work, statistical analysis, report based writing and research presentation.

109 students enrolled in the Master’s programs (see fig. 7), and 64 students (listed below) were awarded the Master’s degree at the Department of Biosciences in 2013.

![Graph showing Master students enrolled at IBV 2011-2013](image)

*Figure 7 Master students enrolled at IBV 2011-2013.*
Masters in Biology 2013

Nicolai Skoglund Bach  “Pro-inflammatory responses by diesel exhaust particles in epithelial lung cells: Importance of Toll-like receptor 3 priming and role of soluble organic components”

Katrine Selse  “Seasonal abundance and distribution of gelatinous zooplankton in Oslofjorden, Norway. An ecological snapshot”

Tanya Cathrine Minchin  “Marine benthosalgær ved 6 stasjoner langs sør-øst kysten av Norge”

Hanne Fostveit Olaussen  “Do polychaete digestive fluids affect the bioavailability of sediment-bound PAHs”

Audun Østbye Pedersen  “Density Dependence in the Host-Parasite Dynamic of Gyrodactylus Salaris on Different Stocks of Salmon, Salmo Salar”

Siri-Dharma Kaur Khalsa  “Genetic structure and diversity of Sorghum bicolor at three geographical scales in Africa”

Fang Yao  “Distinct turnover in fungal communities along an alpine ridge-snowbed gradient”

Viljar Alain Skylstad  “Seasonal variation in phytoplankton diversity with an emphasis on the seasonality and morphology of Dinophysis Ehrenberg (Dinophyceae) in the outer Oslo Fjord”

Nita Kaupang Shala  “Multigenerational effects of diet and temperature on size and fitness associated traits in Daphnia”

My Hanh Tu  “Fine and broad-scale premating isolation between two closely related species, the house sparrow (Passer domesticus) and the Spanish sparrow (P. hispaniolensis)”

Cathrine Wisbech  “Toxicity of various mycotoxins to immune cells in vitro, with focus on morphological and phenotypic changes”

Johnny Peter Håll  “Linking light and productivity in lakes to zooplankton biodiversity, biomass and resource use efficiency”

Aubrey Jane Roberts  “Description of a new Upper Jurassic ophthalmosaurid ichthyosaur from the Slottsmøya Member, Agardhfjellet Formation of central Spitsbergen”

Synnøve Botnen  “Low host specificity of arctic ectomycorrhizal fungi”

Kjersti Svenskerud Bækkedal  “The influence of food access on spermatophore production in the pelagic copepod, Temora longicornis”

Marius Nordbotten  “The role of sex-ratio on male reproductive investment of Calanoid copepod Temora longicornis”

Sarasvati Jacobsen Bjørnaraa  “Indoor Population Structure of the Dry Rot Fungus, Serpula lacrymans”

Mitchell Stewart Fleming  “Deformity Prevalence and Meristic Characteristics in Atlantic salmon: The Effect of Ploidy, Incubation Temperature and Hybridization”

Adam Keith Solumsmo  “Testing the Host Specificity of European Myrmecophile Staphylinid Beetles”

Ida Margrethe Aalvik  “Life history and spatial ecology of Skagerrak coastal cod (Gadus morhua)”

Trude Magnnussen  “The female genitalia of Tipulidae, Trichoceridae, Ptychopteridae and mycetophilidae (Diptera)”

Kristian Brysting Kristiansen  “In search of cryptic species in two sawfly species with high mitochondrial DNA divergence”
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**Masters in Molecular Biosciences 2013**

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Ida Marie Johannessen  The role of small RNA in imprinting of MADS box Type I transcription factors
Jakob Katkjær  Molecular and genetic analysis of the role of the MADS-box Type I transcription factor AGL34 in seed development
Gudrun Yr Asgeirsdottir  Developing tools for, and characterization of a novel family of human protein methyltransferases
Marte Hotvedt Fauskanger  The potential of tumor-specific Th2 cells for cancer immunotherapy by adoptive transfer
Therese Pedersen  Differential effects of Bone Morphogenetic Proteins (BMPs) in human memory B cells
Aram Nikolai Andersen  Utilization of autophagy in the antigen donor cell for enhanced priming of Gag-p24-specific CD8+ T cell responses

**PhD study**

The doctoral program builds upon a Master’s degree in biology or molecular biosciences. The study is intended for those who want to qualify for academic positions or other occupations demanding high professional qualifications. The PhD study normally last from three to four years. 30 candidates defended their degrees in 2013:

Linn Kristin Akslen-Hoel  PhD  Classical and Non-Classical Transport of Proteoglycans in Epithelial Cells
Guri Sogn Andersen  PhD  Growth, Survival and Reproduction in the Kelp Saccharina latissima - Seasonal Patterns and the Impact of Epibionts
Magnus Øverlie Arntzen  Doctor Philos  Computational Proteomics: Applications in Isobaric Peptide Termini Labelling (IPTL) and Database Development
Jonas Bergan  PhD  Investigation of Membrane Dynamics in Cancer Cells by Following Shiga Toxin
Linn Grimsdatter Bjørnstad  PhD  Characterization of Human ALKBH4 - An AlkB Homolog with a Possible Function in Gene Regulation
Cathrine Arnason Bøe  PhD  Regulation of the G1-S Transition in Fission Yeast
Eric Jacques de Muinck  PhD  Deep Characterization of Escherichia coli in a Cohort of Mothers and Their Infants
Gro Live Fagereng  PhD  Sorting and Transport of Proteins and Proteoglycans along the Secretory Pathway of Polarized Epithelial Cells
Johannes Holmen  PhD  The Eurasian Minnow: Post-Glacial Dispersal History and Recent Invasion Patterns in Norway
Jan Husek  PhD  Match and Mismatch between Birds and Other Trophic Levels - Effects on Behavioural and Reproductive Traits
Erik Magnus Jakobsson  PhD  Characterization of Novel Human Methyltransferases
Marwa Jalal  PhD  Genome and Cell Size Responses to Temperature in Ectotherms
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<td>Russell John Scott Orr</td>
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<td>Space Use, Climate and Selective Harvesting of Red Deer</td>
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<td>Sebastian Seidl</td>
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<td>Hanne Sogge</td>
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<td>Kjetil Lysne Voje</td>
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<td>Sen Zhao</td>
<td>PhD</td>
<td>Origin, Diversity and Genome Evolution of Diphyllatia and Its Relatives</td>
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The Student Administration Office

The student administration office has five persons that are eager to help making the studies at IBV as interesting and rewarding as possible. The student administration is dedicated to give the new students a feeling of confidence and belonging from day one of the study, and is arranging a buddy week bursting with professional and social content before the proper studies begin. In 2013 all new students got an USB stick with important information regarding student life, and a welcoming letter from the Head of Department.

The Faculty announced that it would be possible to apply for money to enhance social activities offered and the quality of courses with regard to materials and teaching methods. IBV received 780 000 NOK in such funding. The money is spent primarily on courses in study technique and in presentation and writing technique; laboratory material for the course MBV1010; lab materials, microscopes, cameras, binoculars etc. for BIO1200 and a film and videos for recruiting new students.

Among the student social events being funded is the Student Monday morning coffee.

IBV started to podcast BIO1000 lectures as a trial project in the autumn 2013. Feedback from the students was positive and the podcasts were greatly appreciated.

The student administration office, together with scientific staff, the Laboratory School in Biology and students participate in the Dissemination Group. The group coordinates Department representation in events like “Åpen dag”, “Faglig pedagogisk dag”, “Forskningstorget” etc., and encourages staff to disseminate scientific result in arenas that are important for recruiting new students. The group also arranged Open House in May 2013, an event aiming at enhancing the knowledge among technical/administrative and scientific staff and students about research activities going on in Kristine Bonnevie’s House. The arrangement was a great success.

IBV exchange students at The University Centre in Svalbard © UiO
The Phytotron is an advanced plant growth facility allowing the study of plants in various environments and climates. The facility comprises 22 growth rooms and 3 green houses totaling climate-controlled growth areas to about 900 m². The phytotron area also includes laboratories, course rooms, cold and freezer rooms, seminar room, offices and machinery/technical rooms.

In 2013 the Phytotron was primarily used in UiO projects by researchers from the Department of Biosciences and the Natural History Museum/ Botanical Garden. External users came from research institutions and companies. The Park services at UiO uses the Phytotron for winter storage of cold-sensitive plants and for growing plants for the summer season.

**Personnel**
Manager: Associate Professor Uwe Klein

Technicians: Marit Langrekken, Ingrid Johansen (70% position) and Per Rudidalen (50% position).

**Finances**
Operation of the phytotron is financed by user fees. Internal users from the Department of Biosciences and the Botanical Garden pay a nominal fee while external users pay a fee that covers running expenses.

**Courses and education**
The Phytotron has two course rooms adjacent to climate-controllable growth chambers and laboratories. In 2013 about 250 bachelor students have taken laboratory courses in MBV1020, BIO2140 and BIO2150.

In addition to practical courses taught in the Phytotron, the facility provided plant material for several other courses at IBV. The plant collection has also been used in exhibitions, guided tours, and a number of research projects.

**Master and PhD students, publications, talks and posters**
In 2013 numbers of candidates, talks and posters related to Phytotron projects were: 3 post docs, 4 PhD students, 4 master students, 5 publications, and 5 talks.
Operation
Growth chambers were fully booked in 2013. Most users have long term projects that allow scheduling the use of growth rooms well in advance. Most climate controlled growth areas will be occupied in the years to come.

Research projects
Many research projects at the Department of Biosciences combine field studies and controlled Phytotron experiments to investigate the effects of factors such as climate, pollutions, nutrition and evolution. The focus of the different studies can be based on observations and measurements at the whole organism level to the molecular level.

Internal and external research projects that used phytotron facilities in 2013:

1. Partners and Networks - Peptide Ligand-Receptor Signaling in Cell Separation Processes in Plants
2. Dissection and comparison of cell separation processes in plants
3. Shaping active and silent chromatin: The role of CW-domain chromatin proteins
4. Genetic diversity in Sorghum and associations with cultural and ecological variables in South Sudan, Africa
5. Polyploidy and ecotype variation in the Cochlearia officinalis complex
6. Icelandic Cochlearia (scurvy grasses) - Arctic or European, or both?
7. Speciation in arctic plants
8. Examination of vitality of waxed spruce plug plants before, during and after cold storage by using the RGC method
9. Kartlegging og overvåking av spredningsvegen «Import av planteprodukter»
10. Effect of different temperature on gene expression of four varieties of wheat
11. Ash dieback in Norway - causes, impact and control
12. Epigenetic gene regulation: The ‘conspiracy’ between chromatin modification and transcription factors
13. Dissection of Epigenetic Mechanisms and Transcriptional Networks in Seed Development

Cooperation with commercial partners
The Phytotron has long time research cooperation with the Norwegian company “Norsk Wax” and the Swedish forest industry to develop mechanical means to protect spruce plug plants against attacks by snout beetles. Waxing of plant stems before planting them in the wild is a particularly promising approach that has been proven to be successful in field studies. The “WeevilSTOP” project is supported by grants from the EU to a consortium of 15 partners from 9 European countries.
The Animal Facility

www.mn.uio.no/ibv/forskning/om/infrastruktur/dyreavdelingen

The Animal Facility underwent a major renovation in 2009-2010 and is now a fully modern animal facility. The facility houses mice, rats, chicken, mountain rats and bank vole. In the aquarium part of the facility we generally houses stickleback, eel, cod, crucian carp and other carp species, rainbow trout, trout, salmon, and also the popular model organisms zebrafish and medaka.

In 2013, 5000 animals/fishes were housed in the section. The new clean section of the facility is now filled up, and there is a need to increase the capacity. Efforts are made to finance 2-3 new scandtainer hoods to achieve this. The main users of the facility is the Program for Physiology and Neurobiology, represented by Kristian Gunder- sen’s and Marianne Fyhn’s groups and Program for Genetics, represented by Fahri Saatcioglu’s group. The Department of Oral Biology has moved out of the animal facility and this will increase the capacity for our own users. Even the non-clean section is filled up, except for one outdoor cage with an indoor room. Glenn Peter Sætre from CEES keeps Spanish sparrows and Norwegian house sparrows here, and also sparrow hybrids. Other users are Winnie Eskild with small rodents, and Dag Hessen/ Marwa Jalal with hens.

The animal facility has also participated in field work with Karl Ugland and helped master students catching fish and seals for collection of parasites.

It has been some repairs in the aquarium section in 2013. All pressure tanks have got new metal stands and outlet pipes have been improved so the water pressure into the aquarium rooms has been increased. The salt water parameters are now good due to a complete water exchange. In the marine system we added bactoballs to remove nitritt and a pH computer has been installed. To obtain good sea water quality we still need a protein skimmer to remove nitrate.

A new stickleback fish facility for the Asbjørn Vellestad group was set up in 2013. This facility will be expanded in the near future. The aquarium section is now fully occupied, with only a few reserve rooms vacant. The other large users of the aquarium section are the groups of Göran Nilsson, Finn Arne Weltzien, Trude Haug, Ketil Hylland and Gareth Griffith.
Experimental Lab Facilities

The Department has the past years made major improvements in their experimental infrastructure by further re-organization of laboratories, co-localizing instruments, improving the HSE standards and support from larger community with similar interests.

**Microlab**
http://www.mn.uio.no/ibv/english/research/groups/merg/infrastructure/MicroLab/

The Microlab is established for storage and growth of microbial cells of prokaryotes and eukarote species as well as viruses, and other kind of cell tissues from multicellular organisms such as animals and plants. Currently the Micro-lab is used for research on algae, fungi, protozoa, several bacterial strains and salmon cells.

The lab is developed for experimental studies under class II safety conditions. Dedicated labs for studies of interactions between different organisms are provided for community studies. A separate room is set up for single cell studies providing stringent conditions to prevent contamination. This lab is at present used for studies of unculturable eukaryotes and their parasites. As more than 90% of microorganisms cannot be cultured, it is of most importance for us to provide best possible facilities for studies of such organisms. Material brought in from field can be handled in a special lab, where cells and samples can be prepared before cultivating or DNA/RNA extraction can be done in other labs.

**CEES DNA lab**
http://www.mn.uio.no/cees/english/research/about/infrastructure/dna-lab.html

The CEES DNA lab is a molecular research core facility and is fully equipped for DNA and RNA extraction from various types of bacteria, protists, algae, fungi, and animal and plant tissues (including blood, faeces, and ancient DNA). It contains all the basic instrumentation of a modern molecular biology laboratory, including equipment for gene cloning, genomic libraries, real-time PCR, DNA/RNA quantification, and chip-based analysis of DNA, RNA, and protein. The annual turnover of the DNA lab was 373 000 NOK in 2013, and 50 researchers used the lab. The CEES DNA lab is open to users from the Department of Biosciences, and is at present actively used by CEES and the Microbial Evolution Research Group (MERG).

**ABI lab**
The ABI lab is a Sanger sequencing DNA sequencing core facility at the Department of Biosciences. The lab functions as a sequencing service lab for all research groups at the Department of Biosciences, as well as other departments at UiO, and other research groups within Norway and abroad. The ABI service lab has operated since July 2005.

The ABI lab is a fully equipped laboratory with two ABI PRISM® 3730 Genetic Analyzers, each with 48 capillaries and providing DNA sequencing and fragment analysis. The ABI lab implemented automated dye-terminator removal protocol in 2009, based on paramagnetic beads and a Biomek® 3000 Laboratory Automation Workstation. We also have ten different PCR-machines, shared by the CEES lab, including three Eppendorf Master Cycler ep gradient S and a MJ Research Tetrad PTC-225 Thermo Cycler. This year the turnover from ABI lab activities has financed two qPCR machines (Roche Light Cycler 96) that will be placed in a new and specialized qPCR lab serving the entire department. The annual turnover of the ABI service lab exceeded 900 000 NOK in 2013, and approximately 23 000 samples were sequenced.
The NMR laboratory
http://www.uio.no/english/research/interfaculty-research-areas/mls/research-support/core-facilities/biomolecular-nmr-spectroscopy/

The Biomolecular Nuclear Magnetic Resonance (NMR) Spectroscopy laboratory at the Department of Biosciences is physically situated in the Department of Chemistry. It is equipped with one 600 MHz Bruker NMR instrument that is co-owned by the Norwegian Veterinary School, Norwegian University of Life Sciences (UMB) and University of Oslo (UoO). The instrumentation is well suited for studies of peptides, proteins, RNA, DNA and carbohydrates. Per Eugen Kristiansen is employed as a research scientist and assists research groups in structure determination by NMR- and Circular Dichroism-(CD-) spectroscopy.

The NMR laboratory is involved in teaching of master and PhD students. The laboratory is responsible for the NMR lectures in MBV 4020 – Methods in molecular biology and biochemistry II. The Biomolecular NMR laboratory is a member of the research school BioStruct and gives the two national courses in NMR spectroscopy MBV 9510 – BIOSTRUCT – Biomolecular NMR spectroscopy and MBV 9520 – BIOSTRUCT – Advanced Biomolecular NMR.

Ongoing research projects
- Structure determination of antimicrobial Peptides in Collaboration with professor Jon Nissen-Meyer and professor Dzung Diep at NMBU
- Structure determination of S4WYILD domain from Arabidopsis and its complex to Ubiquitin in Collaboration with professor Reidunn B Aalen
- Structure determination of hltk SH3 Domain in collaboration with professor Anne Spurkland at Institute of Basic Medical Sciences.
- Characterization of lipopolysaccharide binding to the E. coli heat-labile enterotoxin in Collaboration with Ute Krengel at Department of Chemistry.
- Determination of the structure and function of Slice-specifc variant of Protein kinase A cbeta2 in Collaboration with Professor Bjørn Skålhegg at Institute of Basic Medical Sciences.

The Clyconor Mass Spectrometry Unit
http://www.mn.uio.no/ibv/english/research/about/infrastructure/ms/

The Mass Spectrometry Unit at IBV established in 2008 has the goal to facilitate MS analysis of clinical and biological samples by offering state-of-the-art instrumentation and MS expertise in preparing, analyzing, and interpretation of experimental data within and outside the department. Current mass spectrometry instrumentation includes a high resolution Thermo LTQ– Orbitrap XL mass spectrometer with an Agilent Nano 2D HPLC system. Additionally, the unit has two data analysis workstations including the Maxquant and Proteome Discoverer search engines, and in-house software to search for peptide matches after unspecific protease cleavages. Methods have been developed for the analyses of glycopeptides, as well as for complex mixtures of oligosaccharides and for peptides with other focused modifications.

The major focuses in 2013 were different kind of protein modification, methylation, glycosylation and ADP ribosylation. In 2013, IBV MS Unit analyzed a total of 812 samples, using the Orbitrap XL.

In addition to project related to the department, several external users from the other departments at UoO, Canada and the National Veterinary Institute in Oslo visited the MS Unit for sample analysis in 2013.
The Norwegian Sequencing Centre (NSC)

www.sequencing.uio.no

Norwegian Sequencing Centre

The Norwegian Sequencing Centre (NSC) has two equal nodes hosted by the Department of Biosciences at the University of Oslo, and the Department of Medical Genetics (DMG) at Oslo University Hospital and the University of Oslo. NSC has recently been awarded a large grant (41 million NOK for the period 2014–2017) from the INFRAstructure programme of RCN for Phase II of the Sequencing Centre. This grant will allow us to keep up with technological developments, increase the number of staff, and enhance our services. Due to this large funding, NSC is from 2014 on the National Roadmap for research infrastructures and large national projects – a major achievement for NSC and UiO.

NSC offers the Norwegian research community access to a broad range of high-throughput sequencing technologies (HTS) and applications. We possess state-of-the-art facilities and provide services covering most applications within the deep sequencing field, e.g. de novo sequencing, exome sequencing, sequencing of ancient DNA and other degraded DNA samples, as well as transcriptome-, miRNA-, amplicon-, bisulphite- and chromatin immunoprecipitation (ChIP)-sequencing, and base modification detection for smaller genomes. In 2013, we implemented exome sequencing on our Ion Proton instrument as an addition to exomes on the Illumina HiSeq platform. This method allows sequencing of key exonic regions in up to three samples within just a few days, and is suitable for smaller projects.

The new INFRAstructure funding for Phase II will make it possible to keep up with the very rapid development within the HTS field and has enabled the purchase of two additional Illumina HiSeqs in 2013/2014. The Illumina technology is now established at both nodes and NSC has provided higher sequencing throughput and more flexibility in handling different projects. Further, this implies that we have the capacity to take on more large sequencing projects. At present, we have the following instruments available: 2 x Illumina HiSeq 2000, 2 x Illumina HiSeq 2500, 2 x Illumina MiSeq, 1 x Pacific Biosciences RS, 1 x Ion Torrent PGM, 1 x Ion Proton and 1 x Roche 454 (GS-FLX). This is by far the largest instrument park for HTS in Norway. In addition, NSC has a multitude of automation equipment (such as Hamilton, Beckmann Biomek FXs, Beckmann SpriWorks and BluePippin).

HTS technology is developing fast, and NSC has implemented important upgrades on our current instruments in order to continuously provide “state-of-the-art” service. This year, the PacBio RS instrument was upgraded to RSII resulting in a 50% increase in number of reads. Mean read length has increased to 5-6 kb as a result of launching a new polymerase and chemistry. New chips/kits have also been launched for Ion Torrent instruments providing increased number of reads and read lengths.

Services include project consultation, sample preparation, and running the sequencing reactions on the DNA sequencers, together with quality assessment of the data. For projects sequenced on Illumina and Ion Torrent instruments, mapping of the data to a reference is performed. For bacterial PacBio projects, an assembly pipeline was set up this year and fully assembled genomes are now delivered to our users. This represents an expanded bioinformatics service and is of great help to researchers who do not have vast experience with genome assemblies. In addition to de novo genomes, base modification analyses can be provided for bacterial and fungal genomes sequenced on PacBio RSII. NSC may also offer advice on analysis software tools. For more advanced projects, users are referred to bioinformatics services/help desks (such as ELIXIR), or to research collaborations.
when appropriate. The submission of projects is handled through our website (www.sequencing.uio.no) where there is a single contact point for both nodes (IBV and DMG), to help ensure that the optimal technology is applied for each project.

In 2013, the total number of samples sequenced increased with more than 40%, compared to 2012. In total, about 3300 different samples were sequenced at NSC, representing samples from more than 200 research groups – mostly from Norway, but also from several other European countries. The largest fraction of the samples was run on the Illumina platform (HiSeq/MiSeq). However, the number of samples sequenced on PacBio is steadily growing. There is still some demand for 454-sequencing, mostly for amplicon sequencing of PCR products longer than 500 bp.

This year NSC carried out sequencing of the Atlantic salmon (Salmo salar) genome using the PacBio long read technology. The salmon sequencing project was a collaboration between NSC, the J Craig Venter Centre Institute (JCVI) and the International Collaboration to Sequence the Atlantic Salmon Genome. The PacBio data generated at NSC will be an integral part of the salmon genome assembly to be launched in 2014.

Currently, the largest project that NSC is performing sequencing for is the Aqua Genome (AG) Project. In the AG project, 1000 individuals of Atlantic cod (Gadus morhua) will be sequenced with Illumina technology. The AG project is still in its initial phase and the bulk of sequencing will be performed in 2014. We anticipate that large projects will be increasingly important for NSC in the future, and for the next year we have several such projects in the pipeline – both within biomedical and biological research.

We have been involved in organizing a two week, hands on course on “High Throughput Sequencing technologies and Bioinformatics Analysis”, held at UiO in collaboration with the Computational Life Science initiative (CLSi), the FUGE/ELIXIR Bioinformatics platform, and the Norwegian Genomics Core Facility.
The EM-Lab was established in 1966 and has the last 45 years contributed to more than 900 publications (including master and PhD theses). The equipment of the laboratory has an estimated value of NOK 25-30 million and is, due to its methodological resources, the largest EM laboratory in Norway for the biological, molecular and biomedical sciences. Presently the laboratory includes 4 electron microscopes. Three are transmission microscopes, (CM200, CM100 and a CM12) and a scanning electron microscope Hitachi S-4800. One of the transmission microscopes is a standard instrument while the others are fitted with various types of auxiliary equipment that allows the use of advanced and special techniques for elemental analysis, cryotechniques and high resolution imaging. Images are captured digitally on high resolution, Olympus (Quemesa) cameras.

In addition the laboratory is equipped with a large and varied selection of preparation equipment that covers most of the techniques that presently are used. The resources of the laboratory, both with regard to personnel and equipment, are available to all scientists at the Faculty of Mathematics and Natural Sciences, although molecular biologists and biologists are given priority. PhD students, guest researchers and master students may perform EM investigations pursuant to an agreement between their supervisor and the head of the laboratory. External users are welcome as long as the capacity of the laboratory allows this. In addition to being a service provider, the EM-Lab is developing new electron microscopic methods.

The laboratory primarily analyses biological samples, but may also be used to solve problems within other fields. The laboratory organizes a annual course in electron microscopy (MBV4110/9110) that is a part of the master study programme of molecular biology, biochemistry and physiology. More advanced courses in high resolution electron microscopy and cryotechniques are organized when needed.

The laboratory has one permanent scientific position and two technical positions.
The NorMIC Imaging Platform at the Institute for Biosciences is a specialized microscopy unit for the subcellular study of living and fixed cells. The unit is in addition a part of the UiO imaging platform NorMIC Oslo, a FUGE supported facility. The aim of NorMIC is to strengthen and develop research in functional genomics in Norway. NorMIC is organized in a network with nodes in Bergen, Oslo, Stavanger, Tromsø, and Trondheim, and together these nodes cover all present modalities within molecular imaging.

The organization of the Imaging Platform as a core facility implies that all researchers in Norway are welcome users at equal terms through our booking system. The Imaging Platform offers courses, expertise, use of confocal instruments after booking/availability (new users will need to go through training/assessment procedure) and access to immuno-EM techniques. The Platform offers access to a range of advanced light microscopes including confocal laser scanning instruments, spinning disk confocal, TIRF, optical tweezers, and high-content wide-field fluorescence systems. The instrumentation is optimized for live imaging of a variety of biological samples from bacteria to cells to whole zebra fish embryos.

**Equipment**

1) **Olympus FluoView 1000 inverted IX81 confocal laser scanning microscope**

   The Platform has two inverted FluoView 1000 instruments, both specialized for the study of living cells, with incubators for maintaining 37°C and CO₂ supply. These are equipped with four laser lines and thus may detect four different fluorochromes. One instrument is equipped with a SIM scanner to allow fast and specific bleaching experiments, and this makes the microscope well suited for advanced techniques like FRAP, FLIP, FRET and photoactivation. The other instrument has a motorized stage for repeated imaging of multiple locations on a sample over time, and high speed autofocus to correct for drift during long time courses.

2) **Olympus FluoView 1000 upright BX61WI confocal laser scanning microscope**

   This upright system is suitable for the study of fixed cell samples as well as for living animals. The microscope has water immersion as well as oil immersion objectives with a large working distance, making it suitable also deeper imaging of tissues and whole organisms such as zebra fish embryos.

3) **Andor Revolution XD spinning disk confocal microscope**

   The spinning disk microscope enables live climate-controlled imaging of very rapid events, with three laser lines. The detector EMCCD camera has a high signal/ noise ratio that can record up to 300 pictures per second, making the instrument ideal for recording living cells with a low photo toxicity threshold, and for the time lapse study of cellular processes in 3D.

4) **Scan^R high throughput immunofluorescence microscope**

   The high throughput Scan^R system enables imaging of a wide range of sample formats with automated image acquisition and analysis. It can image hundreds of thousands of events in live or fixed samples, providing the opportunity to screen chemical or siRNA libraries and generate highly statistically robust quantitative results.

5) **Total Internal reflection fluorescent (TIRF) microscope**

   The Leica DMi6000B TIRF is specialized for the live study of membrane events with up to 100x objective magnification, 3 laser lines, EMCCD camera, and peristaltic perfusion system for real time addition of stimuli. This instrument also offers high speed parallel TIRF and epifluorescence imaging.
6) Optical tweezers
The JPK optical tweezers/micromanipulation, combined with a Nikon confocal imaging system, offers 3 laser lines, multiple traps with high trap stiffness, nanometer-position control and a quadrant photodiode for detection of fast dynamics and calibration for quantification of forces. This system enables users to quantify forces involved in cellular processes, as well as micromanipulating particles and organelles either intracellular in vitro or in a cell-free system.

7) Imaris software (visualization and data analysis)
Data sets from microscopy of living cells in 3D or 4D often comprise several gigabytes of data. Specialized high-end computers with specific software are needed to handle such large data sets. For analysis and 3D reconstruction Imaris from Bitplane is a software module that specifically can handle these large 3D and 4D data sets and is necessary to interpret data from the different microscope platforms.

Users
Approximately 100 researchers used the platform actively in 2013, from many groups at our department from different departments at the University and visitors from abroad. The microscope platform has additionally worked as a demonstration site for both Andor and Olympus.

Lectures and courses
In addition to the yearly IBV courses that include imaging (MBV1010 and MBV4030), we arranged a two day course in “Superresolution and standard live imaging” for 16 participants in January 2013. The course was divided into a theoretical part, with lectures given by the personnel at the platform, and a practical part. The practical sessions consisted of hands-on training at the microscopes, where all the participants were given the opportunity to test out their own samples. The personal at the imaging platform helped to optimize the image acquisition and discuss current issues.

In addition, the Imaging Platform will host the annual European Light Microscopy Meeting (ELMI) in May 2014, an international event attracting up to 400 imaging specialists from around the world.

Personnel
The head of the platform is Professor Oddmund Bakke. The personnel consist of the scientific engineers Frode M. Skjeldal and Linda H. Haugen (UiO 50%), and the post doc Catherine Heyward (NFR).

The platform personnel have given regular introduction presentations, supervised new users, advised trained users and provided expertise in imaging analysis software (such as Imaris and Image J).
The Two Photon Imaging Lab

The two photon imaging lab at the IBV is a specialized microscope unit for two photon laser scanning microscopy (2PLSM). The lab is run by Marianne Fyhn, Section for Physiology and Cell Biology. The two microscopes (Sutter MOM) are flexible and can easily be adjusted to the imaging of different specimens. The microscopes are funded by the UiO (AVIT and IBV) and by the NorMic Imaging Platform. A challenge with microscopy of living tissue is the strong light scatter of all biological tissue which blurs an image with traditional linear (one-photon) microscopy. With two-photon microscopy on the other hand, the image is reconstructed from the light generated when two photons arrive simultaneously at a molecule and combine their energies to promote the molecule to an excited state. Thus, all photons detected originate from the structure of interest resulting in high resolution images as deep as 1 mm into the tissue. The development of two-photon laser scanning microscopy combined with fluorescence labeling techniques has opened for imaging studies of e.g. cellular function in organs such as the brain, hearth and organ systems (e.g. fish larvae) in living animals that previously were only possible post mortem. To date, the scopes at the IBV have served studies investigating brain function in mice and fish. Studies of other model systems are under planning.

Cell specific genetic targeting of neurons (a) In vivo imaging of neurons expressing the genetically encoded Ca2+-sensor. (b) In vivo image of dendrites of layer III cortical cells expressing a red fluorescent protein (TatTomato) and GFP expression coupled to PSD-95 which is localized in synaptic connections (spines) (c) Shadow images of cell bodies in layer III (ca. 300 µm below dura mater) after pressure injection of a fluorescent dye (Alexa 594) into the extracellular space. With the pipette tip gently touching the cell soma, the cell immediately fills with pipette solution during current injection. (d) In vivo imaging of a dendritic branch expressing GFP.

Investigation of in vivo processes in the live medaka fish larvae using 2PLSM. A) the fluorescent dye is injected (blue lines) into the brain of the larvae and single cells are seen as shadow images. B) When the dye is injected into the cerebrospinal fluid it stays in the spinal cord and blood vessels (red arrows) and cells are visualized.
Central Engineering Workshop

The Central Engineering Workshop mainly serves the Department of Biosciences, though it also undertakes construction work for external organizations such as Veritas, NIVA and NINA. Our workshop stands out due to the close proximity to the research groups and the broad-ranged skills of the team. The workshop mainly assists in developing new equipment for research projects, and also carries out construction and repair work in mechanics, electronics and welding. The workshop is usually contacted when the user is faced with difficulties in buying necessary equipment.

If you have a bright idea and need help to build equipment to prove your theory, do get in touch with the engineering workshop!

In 2013, the workshop had full order lists and many interesting and challenging assignments. A total of 176 projects of varying complexity were undertaken for the Department. Many of our tasks in 2013 as in 2012 were related to physiology, for both mice and fish experiments. As in previous years, the workshop had close collaboration with the workshop at the Faculty of Medicine, where we conduct CNC processing. These two workshops have complementary equipment and machinery.

Researchers from the Department pay NOK 200 per job and 35% of material costs.

The personnel
Hans Borg, chief engineer
Johan Erland, principal engineer
Mads Granberg, senior engineer
Stein Høydahl, senior engineer
Bjørn Langrekken, principal engineer

Cars
The workshop administers 5 cars; 4 Toyota Hiace and 1 Ford Transit Connect. The cars can be lent to employees at the Department of Biosciences. To rent the cars, go to http://www.mn.uio.no/ibv/tjenester/sentralverkstedet/bilbestilling/

Floating rigg for marine research echo transducer, developed at the workshop © Mads Peter Granberg
The Faculty of Mathematics and Natural Sciences at the University of Oslo has two research vessels in the Oslofjord: F/F Trygve Braarud (70 ft) and F/F Bjørn Føyn (40 ft). The Departments of Biosciences, Physics and Geosciences all use the research vessels both for research and educational purposes. They are also utilized in collaborative projects with other national and international research institutions. The research vessels are additionally rented by external institutions that carry out research, environmental monitoring and environmental consulting. The vessels have their main mooring at Lysaker with docks and equipment storage-, engineering-, office and briefing facilities.

Ship equipment and design are tailored for research activity, but also works quite well for teaching purposes. The vessels have in recent years been prepped so that equipment can be changed rapidly in accordance to the needs of the users. Trawling, use of submersible acoustic sensors, large and heavy grabs and corers, deployment of large monitoring buoys are some of the tasks.

A status report for the vessels as the basis for a process of clarification of responsibilities related to the operation was prepared in 2013. The report showed the width and scope of the use of the vessels and their importance for research and publishing in the last five years. The vessels are used in the teaching of four bachelor courses, seven master courses as well as for collection of material for master and PhD projects. In recent years, this means that 160-170 students participate annually in courses at the bachelor level where vessels are an integral part. Corresponding figures for master courses are 80-90 students. The vessels provide the University with an opportunity to educate students who have good expertise in field work including methods and instruments.

In the last five years there have been 36 completed master’s theses and 16 PhD projects that would not have been possible without the vessels. Projects where the vessels have been an integral part resulted in more than 60 articles in scientific journals in the period 2008-2013, i.e. about 10 articles per year.

Activities
The vessels have been used extensively in connection with students’ field work, courses and research projects. Main UiO and external users in 2013 were the Department of Geosciences represented by Elisabeth Alve, Institute of Biosciences represented by Bente Edvardsen, Karl I. Ugland and Ketil Hylland, and research institutes (NIVA, NGI and NGU).

F/F Bjørn Føyn has mainly been used for school courses and in some extent for field work in Drøbak. The activity in 2013 remained at a similar level as previous years.

Organization
The Faculty of Mathematics and Natural Sciences has appointed a board which is responsible for the use and maintenance of the vessels. The board has four members, the chair being directly appointed by the Faculty; Ketil Hylland (chair), Elisabeth Alve, Josefin Titelman and captain Sindre Holm.

Applications for vessel time, sailing schedules and daily use is coordinated by the captain. The staff is employed by the Department of Biosciences: Sindre Holm – captain, Jan Sundøy – assistant captain and Tom Opsahl – engineer.

Use, Management and Maintenance
The use and management of the vessels have been satisfactory in 2013. There have not been any sudden cancellations, and the vessels are being kept in good order with regards to both yearly and long term maintenance. The routine maintenance is the responsibility of the crew.

The Engineering Workshop at the Department contributes heavily with mechanical repairs and maintenance towards the vessels and their equipment. There have been no accidents or damages involving people or equipment in 2013.
The HSE handbook is under continuous revision with new operating procedures and subsequent risk assessments. Implementation of new electronic maintenance system Mprog is well underway (implemented fully in 2014), which ensures systematic monitoring of maintenance and documentation requirements.

Goals
The vessels should be well maintained and be a safe work environment for the various users. The goal is to equip the vessels to a level which is purposeful and satisfactory for the users. This also makes the vessels attractive for external users. Health and Safety regulations are actively followed and implemented. The running and maintenance of the vessels in an ethical, secure and well organized manner is of great concern to all involved.
Marine Research Station

The Marine research station in Drøbak was established as a field station in 1894 and includes the original research station (Biologen) and a course centre (Tollboden). Both the research station and the course centre are today protected historic buildings in the heritage conservation zone in the city of Drøbak.

Personnel and Board

Director/manager: Associate professor Hans Erik Karlsen. Technicians in 2013 were Grete Sørnes (12 months, 50% position) and Jens Ådne Rekkeldal Haga (6 months, 50% position as project and field research assistant). In addition, a number of students were engaged as field course assistants throughout the year.


Courses and seminar activity

A total of 1316 overnight stays were registered at Tollboden in connection with courses, seminars and meetings, in all 2355 persons visited the research station in 2013, and in all 10 guest researchers stayed at the station. Teaching activities in 2013 included 10 UiO field courses (BIO1200 3 courses, BIO4140 2 courses, BIO4260, BIO4301, BIO4320, BIO4371 and MBV 4310), 2 UMB field courses (ZOOL100), 1 SABIMA field course, 1 AB-BVIE Inc. field course, 1 Sámi University College field course and 2 international university field courses. Seminars and meetings totalled 5 from UiO and 2 from external research institutions. The scientific outreach consisted of contributions in local radio Buskert (alien oyster) and national radio NRK P1 (fish noises). Representatives from the Norwegian Environment Agency, Marine section, visited the station in June.

Research projects at the station in 2013 were: “CollPen-Collective behaviour of penned herring: Observing the collective behaviour and investigating the effect of various sound stimuli” (NFR – Institute of Marine Research (IMR) project), “Behaviour of weakly electric fish to impulse sound” (Maria Wilson & Hans Erik Karlsen), “behaviour responses to sound in cephalopods” (Maria Wilson & Hans Erik Karlsen), “Effect of seismic sound on swimming and feeding in fish”...
School visits
The Research Station has for more than 40 years offered different types of 1-3 days of field courses in marine biology. This popular activity was continued in 2013 with a total of 19 days of field courses for 10 school classes, i.e. 233 pupils and 44 teachers. This activity was somewhat reduced compared to previous years due to an increased numbers of field courses from UiO.

Facilities
The Research station is equipped with seawater inlet, aquaria and culture facilities enabling studies of marine flora and fauna under controlled conditions. The station has a microscopy lab with sophisticated fluorescence microscopes and image analyzing software, a chemical analysis lab, cold storage facilities, seawater filtration system, air compressor for scuba cylinders, 3 small boats, field equipment and a marine sample collection. The station is additionally furnished with all relevant teaching aids for course and seminar activity. Tollboden has a seminar room, kitchen, laboratory and beds for 24 people. The laboratory is equipped with microscopes and stereo microscopes. It is seawater inlet and 2 aquaria for studies of marine flora and fauna nearby the house.

Restoration and development
A HMS inspection was performed at May 14th by the Department of Biosciences concluding that the station more than reached expended standards. Plans for expansion and future development of the station have been developed and are currently in review. An additional boat (Uttern S52, 2005 model) with a 60 hp Yamaha outboard engine was acquired in 2013.

Finn Jørgen Walvig’s Research Foundation
In his memory, the former long-time (37 years) station director Finn Jørgen Walvig (1925-2009) established a substantial research foundation at Unifor (UiO) with the purpose to stimulate and support basic aquatic research carried out at his beloved Marine Research Station in Drøbak. Grants from the foundation were available for the first time in 2013.
The Research Center at Finse is formally owned by the University of Oslo (UiO), but the funding to build the station was originally given on the condition that the University of Bergen (UiB) should have equal rights to the center. The center is managed by Department of Biosciences at UiO, and UiB contributes to the operating costs. The Technical Division at UiO is responsible for the buildings. The center has two main buildings: a Research Unit with laboratories and 14 beds, and a Course and Conference Unit with 44 beds. Research and teaching connected with the MN Faculties of both UiO and UiB have priority, but the research station is also much used by other research institutions from Norway and abroad. The station takes part in a EU-funded infrastructure network of 33 circum-arctic terrestrial field stations (see http://www.eu-interact.org/), and provide transnational access grants to researchers from other EU member states or associated states. Further information about the center is available on the station’s website: http://www.finse.uio.no.

Operation and administration
The daily operation and administration of the center is carried out by the Director, Torbjørn Ergon and the Manager, Erika Leslie, both from the Dept. of Biosciences at UiO. The station has a board consisting of two scientific representatives and one technical representative from both UiO and UiB. The board is appointed by the Department of Biosciences, UiO and the MN Faculty at UiB. In 2013, the board members were:

Chair: Atle Nesje. UiB (deputy: Göran Högstedt)
Scientific Representative, UiO, and deputy chair: Geir Hestmark (deputy: Klaus Høiland) Scientific Representative, UiO: Dag Klaveness (deputy: Ole Humlum)

Scientific Representative, UiB: Aage Paus, UiB (deputy: Vigdis Vandvik)
Technical Representative, UiO: Hans Borg (deputy: Johan Erland)
Technical Representative, UiB: Solfrid Hjelmveit (deputy: Knut Helge Jensen)

For the fifth consecutive year, the center employed a summer assistant for maintenance work and assistance in the practical operation of the center (e.g. transportation, cleaning, etc.). Users of the research station also had the opportunity to hire the assistant at a fixed hourly rate covering employment costs.

The catering agreement with Tajo a/s at the Course and Conference Unit works well and will be continued.

Research activity
The number of working days in connection with research activities at the station in 2013 was 421 (358 overnight stays). This excludes 68 working days by the summer assistant, who in part worked as a research assistant. 82% of the research working days took place during the summer months of June, July, August and September. In total 171 working days were registered in connection with maintenance and operation of the field station.

In total 45 persons from 17 institutions used the station for research activities during 2013. The station was used mostly by researchers and students from UiO (19 persons including field assistants and 226 working days), UiB (5 persons, 30 working days) and Norwegian University of Life Sciences (3 persons, 31 working days). Of the 19 researchers/students/assistants from UiO, 13 came from Department of Biosciences (179 working days) and 6 came from Department of Geosciences (47 working days). Other research institutions using the station were (number of persons in parenthesis): Norwegian Institute for Nature Research (3), Uppsala University (3), University of Gothenburgh (2), Swedish University of Agricultural Sciences (1), Granada University (1), MTT Agrifood Research, Finland (1), Norwegian Forest and Landscape Institute (Skog og landskap) (1), The Swiss Federal Institute for Forest, Snow and Landscape Research (1), University of Flensburg (1), University of Helsinki (1), University of Turku (1), University of Worchester (1) and University of Exeter (1).
Nine researchers in four teams received funding from the INTERACT Transnational Access Programme to work at the station in 2013 (in total 98 working days). We are currently secured funding to host research groups at the station for only one more year, but negotiations to extend the programme is under way.

A brief description of each research project at the center and a list of publications are published on the center’s website: http://www.finse.uio.no/research/

Courses and seminars
A total of 1500 overnight stays and 415 persons were registered in connection with courses, seminars and meetings in the course and conference unit of the center. The course and conference unit was in use during 80 days throughout the year.

The following regular university field courses were held at the center (chronological order):

- Atmospheric physics (GEF2200), UiO (3 days in February/March, 12 participants)
- Snow, Snow Hydrology and Avalanches (GEO4430), UiO (3 days in March, 15 participants)
- Alpine Ecology (BIO259), University of Birmingham (8 days in July, 30 participants)
- Biological Diversity (BIO1200), UiO (3 groups of 5 days in July/Aug, 84 participants)
- Physical Geography (GEO1010), UiO (7 days in August, 76 participants)
- Quaternary Geology (GEOL106), UiB (12 days in August/September, 57 participants)
- Glacial and periglacial geomorphology (GEO4410), UiO (7 days in September, 13 participants)
The station also housed four other academic events in 2013:

- SeedClim workshop, Department of Biology, UiB (6 days in March, 13 participants)
- Glacial research safety course, Department of Earth Science, UiB (4 days in September, 12 participants)
- The Norwegian Research School in Climate Dynamics (ResClim) communication course, Geophysical Institute, UiB (5 days in September, 25 participants)
- “Homes for science: The Anthropology of Tropical and Arctic Field-Stations”, an international workshop funded by the European Science Foundation, Institute of Social Anthropology, UiO (6 days in September, 32 participants)

Other activities and outreach
The station is part of an EU-funded network of 33 circum-arctic terrestrial field stations in the Scandinavian countries (including Spitsbergen), Russia, Alaska, Canada, Greenland, Iceland, Faroe Islands and Scotland (see http://www.eu-interact.org/). The leaders of the stations participate in a Station Managers Forum that meet about twice yearly. A handbook for “Good Practises of Research Station Management” was completed in 2013 (downloadable here http://www.eu-interact.org/station-managers-forum/report-deliverables/). Other activities in the network include a Transnational Access research funding scheme and coordination of joint research and monitoring programs and outreach.

The center participates in the Finse Forum, where representatives from local business, NGO’s and local governments meet twice a year. Several school classes visited the station and were given an introduction to alpine ecology. The summer assistant made a new notice board that will be placed along the railway construction road (the Navvy road/Rallarveien). The board will be filled with general outreach articles and summaries of research activities at the center, which will be seen by thousands of bikers during the summer months.

Annexes
The Garpen cabin, which belongs to the research station, is rented out on a daily basis to staff and students at UiO and UiB. The cabin has been renovated over the last years, and there has been increased interest in using the cabin. During the most busy summer weeks, Garpen is used for extra accommodation for researchers and summer employees at the station. In 2013 the cabin was used in 116 days. The station also has a lease agreement with landowners in Ulvik to have access of the Torbjørnstølen cabin for similar purposes.

Technical upgrades
The roof of the course and conference unit got a new corrugated steel surface that will reduce the build-up of snow during winter, and most exterior doors were replaced due to weathering.
Laboratory School in Biology

The following people have been employed at the Laboratory School of Biology in 2013:

- Maria Sviland in 100% position until July 15th
- Linn Kristin Akslen-Hoel in 50% position January and February
- Kristin Gjøen Gjøen Tsigaridas in 100% position from August. Kristin is a lecturer at Ullern videregående skole.
- Tone Fredsvik Gregers was hired in 100% permanent position from September as “førstelektor”.
- Ivan Myhre Winje, PhD student in Gundersen lab is doing 12.5% of his teaching duties in the Laboratory School.

For the first time since 1988 a permanent position at the Laboratory School of Biology was created.

The Laboratory School resource group consists of:

- Halvor Aarnes, Department of Biosciences
- Olav Sand, Department of Biosciences
- Pål Falnes, Department of Biosciences
- Anders Isnes, Norwegian Centre for Science Education. Doris Jorde, new leader of the Norwegian Centre for Science Education, replaced Anders in December 2013.
- Camilla Torsæther, Education Agency of Oslo municipality. Camilla ended her position in the Education Agency in August and will be replaced in 2014.

The resource group had two meetings during 2013, April 30th and December 18th.

Teacher training

We aim to perform teacher training in biology for teachers in Upper Secondary School, arranging both practical and theoretical courses. In 2013 we received a total of 93 teachers divided between 3 courses. The following courses have been arranged:

**Conference in biotechnology for teachers, January**

In collaboration with the Norwegian Biotechnology Advisory Board we arranged a two-day course in biotechnology and bioethics. 37 teachers attended the course, which was divided in a theoretical and a practical part. The theoretical part contained several lectures with invited speakers and the topics ranged from epigenetics, gene modified organisms, DNA-damage, forensic research and ethics. During the practical part we performed “transformation of E. coli” to create a gene modified organism.

**The cell – seeing is believing, September**

During the “Conference of Natural Sciences 2013” arranged by the Norwegian Centre for Science Education, the Laboratory School contributed with a teacher’s practical course in cell biology. We studied structure and function of different eukaryotic cell types using light microscopy: plant cells from Elodea and red onion, blood cells and muscle cells, and we performed different experiments illustrating their functions. 17 teachers attended the course.

**Course in “Text in Biology”, November**

Biology often differs from the other natural sciences in the way of writing answers to questions. Also, questions in biology may sometimes be vague and diffuse and thus difficult to answer correctly. The results from the exam in Biology2 for 2013 shows that only 0.6% of the pupils obtain the best result (character 6), whereas the average result for the whole country was the character 3. Compared to the other natural sciences (Physics2 and Chemistry2), biology is far the most difficult exam to obtain good results. Figures from the Education Authority shows that the result in biology has been decreasing in the past five years, and the Laboratory School wants to turn this trend together with the Norwegian Centre for Science Education.
Teachers often find it challenging to train their pupils in writing scientific biology; therefore we arranged a one-day theoretical course in biology texts. Here we worked with the exam from spring 2013 and answers from pupils were discussed. We also discussed strategies and ways to prepare the pupils towards the exam. The course was extremely popular and was fully subscribed three days after the registration had opened. 29 teachers attended the course and we will be arranging a new course in 2014.

Continuing education and training
As a result of the new Government in September 2013, the Norwegian Directorate for Education and Training announced the possibility for Colleges and Universities to offer continuing education and training programmes for teachers in natural sciences. UiO and the Faculty of Mathematics and Natural Sciences was selected to offer a 30 study point course in natural sciences level 2 (Naturfag 2) for teachers teaching 8th–11th grade. The course will start in August 2014 and is collaboration between the Laboratory School of Physics, Chemistry, Biology and the Natural History Museum in Oslo.

School visits
In collaboration with some of the research groups at the Department, we have developed several educational units designed for school visits. These units disseminate some of the research performed at the different research programs. Autumn 2013 we designed two new units in photosynthesis and cell biology. Some of the courses have been very popular among pupils in Upper Secondary School. In 2013, pupils from 9 different schools attended 6 different courses.

Transformation of E. coli, Gene Programme
We transform the bacteria E.coli with a gene from the jellyfish Aequora victoria that codes for Green Fluorescent Protein (GFP). The pupils are introduced to GMO, gene regulation and selection. 6 classes have attended this course. PhD student Ivan Myhre Winje gave a lecture on how to use GMO in research for one of the visits.

In this course we use the ELISA-method to illustrate important principals in immunology. Our context is detection of HIV-antibodies. 4 classes have attended this course.

Cystic fibrosis - a gene test, Cell biology programme
The pupils learn about genetic testing of the autosomal recessive disease Cystic fibrosis. They perform restriction digestion of different DNA tests and make a pedigree based on the results. 2 classes have attended this course.

Recombinant DNA-technology, Protein programme
In this course the pupils learn about how to do recombinant DNA-technology. 1 class has attended this course.
**Photosynthesis, Integrative biology programme**

In this course the pupils are introduced to photosynthesis through experiments with the green algae Scenedesmus quadricauda. The level of photosynthesis is investigated by varying the intensity or wavelength of the light in addition to varying temperature and cell density. A hydrogen carbonate indicator measures the level of photosynthesis. 1 class attended the course. Professor Klaus Heiland gave a lecture on plant evolution in connection to this course.

**The Cell – seeing is believing, Cell biology programme**

For schools lacking microscopes, teaching cell biology can be challenging. Here the pupils are introduced to microscopy and cell biology through studying their own blood cells and cells from red onion. They also perform osmosis/plasmolysis experiments to investigate the structure and function of animal vs plant cells. 1 class attended this course.

**Student information and campus tour**

The Faculty of Mathematics and Natural Sciences hired 2 biology students in August 2013 to a student recruitment program. We initiated collaboration with the Faculty in September and we now offer one-hour student information and a tour at the biology building and the campus in conjunction with the school visits. The feedback from the pupils and teachers are solely positive and is part of the faculty’s recruitment strategy. 5 schools received this program in 2013.

**Teaching**

NAT 2000 is a course held by the Department of Teacher Education and School Research, Faculty of Educational Sciences. The Laboratory School of Biology has contributed in both planning and teaching this course. In addition, the Laboratory School has written a compendium for use in the course. NAT 2000 is collaboration between the School laboratories in Chemistry, Physics and Biology, and gives the students a practical introduction to biology, chemistry and physics.

**Research**

The Faculty of Educational Sciences advertised in November a grant called “Såkormidler” which is part of the Knowledge in School (Kunnskap i Skolen; KiS) -program. KiS is a strategic and multidisciplinary cooperation between five faculties at the UiO: the Faculty of Education, the Faculty of Humanities, the Faculty of Mathematics and Natural Sciences, the Faculty of Social Sciences and the Faculty of Law. KiS is divided into three thematic areas of research in which Natural Sciences and Mathematics in Education is one of them. In collaboration with the Norwegian Centre for Science Education and Department of Teacher Education and School Research we applied for funding to a pre-project where we aim to investigate the education of biology teachers at UiO with particular interest in the pedagogical and didactic education (PPU). In December we were granted 50.000 NOK for the project which we aim to finish within the end of 2014.

**Social media**

In September 2013 we created a blog at www.blogg.uio.no/mn/lib/skolelab where we write about our activities; teacher courses, school visits and future activities and plans. Some of the posts have been visited several times and shared on facebook, linkedIn and twitter.

We also created a facebook page at www.facebook.com/skolelab. In the end of 2013 we had obtained approximately 80 likes on this page.

**Media**

Uniforum came for one of our school visits from Oslo Handelsgym and published an article in number 10-2013 (http://www.uniforum.uio.no/nyheter/2013/11/hiv-testing-pa-skolelaboratoriet.html). The Laboratory School was also invited to participate in one episode of the NRK programme “Folkeopplysningen-sesong 2”. This programme will be aired during autumn 2014.

**In summary**

Maria Sviland was on sick leave during parts of spring 2013, and a totally new staff from August 2013 made 2013 a somewhat less active year with regard to school visits and teacher courses compared to previous years. However, The Laboratory School aims for high activity in 2014 with new perspectives and ambitions. Our goal is to include more candidates from the researcher staff at the Department in order to increase the dissemination of research and education to the society.
The University Library’s main function is to support university research, teaching, communication and innovation. Our primary users are staff and students at the University of Oslo and the Oslo University Hospital, Rikshospitalet, but the library is open to everyone and also serves as a resource for users outside the university.

The Science Library supports researchers and students at the Faculty of Mathematics and Natural Sciences. The Science Library in Vilhelm Bjerknes’ hus hosts astrophysics, biosciences, chemistry, geology, physical geography and geophysics, mathematics, pharmacy, and physics. The Science Library also includes informatics in Ole-Johan Dahl’s hus, and the Natural History Museum library in the Geological Museum at Tøyen.

The Department of Biosciences is one of the main collaborators of the Science Library. We aim to provide its students and researchers with the best possible access and guidance to information and scientific material. The library keeps an extensive physical and electronic book collection, and the library’s regularly updated bioscience subject websites provide easy access to relevant resources in biology and biochemistry.

The Science Library offers subject specific courses in information literacy and scientific communication. Lectures and hands-on lab sessions include work with literature databases, systematic searching, reference management, scientific communication, -writing, and -evaluation, the publication process, peer review, open access, bibliometric indexes, academic integrity and ethics. The courses are to a large extent integrated into Department of Biosciences’ degree programs. Courses are also given on request, as is individual training for staff and students.

The Science Library organizes events and provides an arena for debates, dissemination and exhibitions about science and biology, their role in public life and their importance for societal development. Science Debate events are arranged in partnership with Fritt Ord (The Freedom of Expression Foundation).

Library staff 2013
In the Science Library the staff is organized in groups working on specific tasks, e.g. maintaining collections, digital subscriptions, researcher support, information literacy teaching, library routines, dissemination and arrangements for students, employees and the public audience. Heidi Sjursen Konestabo and Kirsten Borse Haraldsen are subject librarians for Biosciences. Live Rasmussen is the Head Librarian for the Science Library.

Collection and finance 2013
The Science Library acquired 2741 new printed books during 2013. However, e-books are the preferred format and the University Library holds more than 500 000 e-books from different publishers. These include new exiting bioscience books from for example Elsevier, Wiley-Blackwell, Oxford and Springer.
The University Library has maintained a few printed subscriptions of current journals, such as Nature, Science and some Norwegian journals. All in all the University Library uphold ca. 4800 printed titles, but most subscriptions are now found as e-only journals, currently ca. 225 000 titles.

Book loans still constitute a large portion of the library activity, also loans to and from other libraries. The Science Library had a total of ca. 53 000 loans and renewals during 2013. For the University Library as a whole more than 4 million downloads of full text books and journal articles were performed in 2013.

In 2013 the University Library of Oslo spent nearly 75 millions NOK on media purchases and subscriptions, i.e. databases, e-journals, e-books, printed journals and printed books.

Library teaching in courses at the Department of Biosciences in 2013
The library teaching forms part of the following courses:

BIO 5000 – Introductory course for master students in biology. The course includes lectures and hands-on lab sessions on searching, evaluation and use of information, reference management and scientific communication. In January 16 students attended, 37 attended in August.

MBV4010 - Methods in molecular biology and biochemistry I. A library PC-lab on work flow and reference management is included. 50 students.

BIO1000 – Elementary biology. The Science Library is included in the BIO1000 laboratory portfolio with “Bjørnelabben”, an introduction to Library resources and academic integrity. 240 students participated.

PhD on track – helping PhD students succeed
The free on-line resource www.phdontrack.net was launched in 2013. It is the result of collaboration between five Scandinavian research libraries.

PhD on track is a resource for PhD students who are beginning their research careers, and need to learn more about for example how to find and evaluate information, and how to publish their research.

Some events at the Science Library in 2013
Welcome to the Science Library! Do as 279 244 visitors did in 2013 - use the resources, facilities and services, and take part in social meetings.

Mr. Jespersen recommends “The Chemistry of Fireworks” and #uboslo #blindern © Science Library

Links to events at the Science Library:
www.ub.uio.no/om/aktuelt/arrangementer/science-debate/
www.uio.no/english/about/news-and-events/events/global-citizen/
March 14th: The Science Library in Vilhelm Bjerknes’ hus – one year anniversary! Activities, exhibitions, work shop and talks in Vilhelm Bjerknes’ hus.

April: Trenger Norge en “Chief Scientific Adviser”? with Anne Glover, EU-kommisjonens første “Chief Scientific Adviser”. Arr.: Center of ecological and evolutionary syntheses (CEES), Polytechnisk forening, the Science Library: Science Debate.

May: Maintaining Humanity’s Life Support Systems in the 21st Century: messages for policy Makers with Anthony Barnosky, Professor, Department of Integrative Biology ved University of California at Berkeley. Arr.: Center of ecological and evolutionary syntheses (CEES), the Science Library: Science Debate.

October: Global Citizens and Global Change: What is the connection with professor Karen O’Brien, Department of Sociology and Human Geography, UiO. Arr.: University of Oslo: Global citizen, the Science Library.

November: Biokonferansen 2013: Pest og Plage! Zoonoser: sykdommer som spres fra dyr til mennesker - en av de alvorligste truslene, før og nå with guest speaker Monica Embers, Tulane, USA, and other speakers. Arr.: Norwegian biologist Association (BIO), Seminar of Science Studies, Department of Bisciences, the Science Library: Science Debate.


December: Global Citizen lecture Global Health: Think globally, Act locally with Jeanette H. Magnus, Head of Institute for Health and Society. Arr.: Global Citizen, UiO.

The Biological students’ Committee (Biologisk Fagutvalg) is a student body for undergraduate and graduate students affiliated with the Department of Biology. The BFU works to create and maintain a good academic and social environment for biology students. The representatives from the BFU work on behalf of the biology students, and in favor of their best interests.

The group has two weekly events: “The Biographer” (Biografen) which presents different films or documentaries with biological relevance and “Breakfast with Kristine”, a popular science lecture with a complimentary breakfast. We also arrange debate evenings called “Fertile Friday”, which discusses relevant themes in biology. Last semester we invited political parties to discuss the importance of environment in the 2013 election.

The group also organizes several field outings per year, such as a mushroom trip with Trond Schumacher and Klaus Heiland, a fossil hunting trip, this year, with paleontologist Hans Arne Nakrem and a biodiversity mapping trip in collaboration with The Norwegian Biodiversity Network (SABIMA).

In August, the BFU organizes the week for welcoming new bachelor students. Each year we have social events as well as short lectures on biological topics by professors and master students from our Institute. We wish to emphasize as early as possible why we need biologists, and encourage new students to think about what they want with their education, and what kind of tools they need to get there.

To integrate the students we have several social events each year that include two yearly trips to one of SiOs cabins in Bærumsmarka, lunch in BFUs office, social evenings in collaboration with Students’ Committee at the Department of Molecular Biosciences and parties for biology and molecular biology students in the biology cantina.

In the spring term we organize winter party with food and live music, and in the autumn term we organize the traditional part «Biological night» with a lecture of biological theme, this year we heard a lecture called «sperm wars» given by postdoc. Terje Laskemoen. We also organize a summer party as a closure for the year.

In addition to organizing social events and activities for the students, the BFU distribute locker space in the biology building’s basement. Each year the student can vote for their favorite lecturer, the winner receives a prize called «The golden pointer» at the IBV’s Christmas party. This year winner was associate Professor Anne Brysting. BFU also organizes exam-preparation where the students can ask questions to senior students about the different courses.

For the first time BFU in collaboration with the Student Council for Molecular Bioscience, we this year arranged a career day for students at IBV, which was held in the Science Library. We invited different companies to present themselves, the companies are possible future working places for the students at IBV. We had free pizza, the companies had stands and we ended the day with a quiz in the science-pub. The arrangement was a great success with about 200-250 students participating. We hope to make this a yearly arrangement.
The Student Council for Molecular Bioscience

www.mn.uio.no/ibv/livet-rundt-studiene/fagutvalg/fuimbv.html

The Student Council for Molecular Bioscience (FuMBV) is a student body for undergraduate and graduate students in the study program Molecular Biosciences, and all students taking courses within Molecular Biosciences. FuMBV strive for the students to have the best possible environment here at the Department of Biosciences, both academically and socially. Thus, our slogan is: Of Cells, For Cells.

About every 3 weeks, the group arranges “Board Game Evenings”, where the students meet in the cafeteria for a relaxed and enjoyable evening. This event was established in 2013, and it has been a popular event among the students. The group also arranges “IBV Beer”, about every 3 weeks. This is usually off campus, where students from both study programs (biology and molecular biology) meet in a new setting. FuMBV also arranged several other social events in 2013 in collaboration with the Biological Students’ Committee, for both biology and molecular biology students.

Karrieredagen 2013: In collaboration with The Biological Students’ Committee, FuMBV arranged “The Career Day” for students at IBV. This event was a great success, with 200-250 students participating.

The Buddy system: In August, FuMBV welcomed the new students with an introduction week. This week included various social activities, both on and off campus, and academic lectures by professors and graduate students. Our ultimate goal was that the new students should get a good first impression of what it’s like to be a student at IBV.

MBV Cabin Trip: 2th-3th of November, we arranged a trip to “Tannlegehytta” in Nordmarka., where almost 40 students attended.

Oracle Service: FuMBV arranged Oracle Service, where the students worked on previous exam assignments while having the opportunity to ask questions and get answers from senior students.

The Golden Laser Pointer: Throughout the month of December 2013, we arranged the yearly petition where the students of MBV could vote for their favorite lecturer of 2013. The winner, Kristian Prydz, was announced at IBV’s Christmas party.

Throughout the year, FuMBV sold protective coats for laboratory work to students at the Department. We also organize the study hall spaces for graduate students at the department.

In addition to these events, FuMBV has continuously assisted students in various matters, study specific or not. With student representatives in the different boards at the Department of Biosciences we also make sure that the students’ interests are maintained in the best way possible.
Health, Safety and Environment

Risk assessment, handling chemicals and work environment are the chosen focus areas in the action plan for HSE 2012-2014. The action plan has been followed up throughout the year.

Systematic HSE work
There have been four meetings in the local working environment committee (LWEC) at IBV. The agenda for the meetings and the reports are published at the Departments web pages. HSE dialog meetings for the Department management, the chief safety representative and the HSE coordinator have been conducted as planned. As part of the standard OHSAS 18001 for Work environment introduced at UiO in 2012, the Management review for HSE was also conducted for 2013.

The HSE project 2010-2012 continued from July 2012 to December 2013
There have been four meetings in the HSE project group in 2013. A final report for the project was written in December 2013.

After evaluating the BIO-SOP pilot project a “BIO-SOP project 2012-2013” were started with the aim of developing Standard operating procedures (SOP) with risk assessment at the Department.

The HSE project was responsible for planning and arranging the “tidy up day” on 10th October. The result was better order and tidiness and a lot of old chemicals were also removed from the building. The day ended with social activities and a pizza party for the participants.

The Vision and goals for the HSE work: “A safe study and work environment for students and staff will inspire both research and study activities at the department. Through common responsibilities, involvement and contribution a thriving department is created.”

Goals, strategies and action plan for the HSE project:

http://www.mn.uio.no/ibv/om/hms/hms-mal-og-handlingsplaner/hms-handlingsplaner/

Safety inspections 2013
Safety inspections are an important part of the systematic HSE work and a tool for improving the work environment. The LWEC decided that the safety inspections in 2013 should focus on:

- Follow up the safety inspections from 2012 (handling of chemicals, labeling and responsibility in the laboratories, order and tidiness),
- Laboratory safety with focus on handling of chemicals
The safety inspections were carried through as planned with the laboratory areas as first priority. The head of the scientific center and programs, the chief safety representatives, technical staff and the HSE coordinator took part in the inspections. Written reports were made for the safety inspections at CEES, IB, MB, MERG, and the Phytotron, the engineering workshop, the administration and Laboratory School in Biology, and the field stations at Drøbak and Finse. In the reports good HSE work and follow up of the safety inspections from 2012 were recognized. Problems were pointed out, necessary corrective measures were suggested, responsible persons and the time limit for the improvement work were specified.

**Inspection from Norwegian authorities**
The Labour Inspection Authority made an inspection at IBV 18th June 2013. The Department was credited for the work that has been done regarding HSE in the last years.

**Risk assessment and risk analysis**
Norwegian law and regulations as “Internkontrollforskriften” demand that UiO and the Department should have a systematic approach to HSE tasks, perform surveys in problem areas, perform risk assessments, make priorities, follow up and document the HSE work. That is why the Department in 2013 continued Risk assessment and why one of the goals set by the HSE project is: “A well functioning system for risk assessment with a convenient emergency plan should be established and incorporated as a natural part of all activities at the department”.

The “BIO-SOP project 2012-2013” started firstly mapping the needs for Standard operating procedures (SOP) with risk assessment at the Department and then developing SOP’s for hazardous laboratory procedures. SOP’s are important for the quality assurance work in the laboratories and will be useful in teaching situations and can ensure that the right information is given. A procedure for risk assessment of Master student projects is adopted at the Department.

**HSE training**
The Faculty of Mathematics and Natural sciences (MN-faculty) are responsible for giving basic HSE information and training to bachelor and master students. HSE information specific for the different courses at the Department is always included in the introduction of each course. Before access to laboratories students must have specific information and training and sign the form “HSE training for working in the laboratories”.

The management at the department, safety representatives and the HSE coordinator have taken part in different HSE seminars arranged by the MN-faculty and by UiO.

**HSE information**
The HSE web pages at the Department are developed in the frame decided by the MN-faculty in 2011 and are continuously being updated and supplemented. Some HSE information was given in general meetings and in connection with the safety inspections and the “tidy up day”.

**Reporting injuries, accidents and HSE deviations**
Reports of injuries, accidents and HSE deviations at the Department have been low and probably a bit inadequate through the years. The importance of reporting deviations has been emphasized. We had fortunately only report of 4 minor personnel injuries in 2013.
## RCN projects

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<td>Identification of novel peptide ligand-receptor pairs in plants</td>
<td>Aalen, R.B.</td>
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<td>Dissection and comparison of cell separation processes in plants</td>
<td>Aalen, R.B.</td>
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<td>Partners and networks - peptide ligand-receptor signaling in cell separation processes in plants</td>
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<td>Biodiversity, community saturation and ecosystem function in lakes</td>
<td>Andersen, T.</td>
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<td>Watershed EUTROphication management through system oriented process modelling of Pressures, Impacts and Abatement actions</td>
<td>Andersen, T.</td>
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<tr>
<td>Watershed eutrophication management in China through system oriented process modelling of Pressures, Impacts and Abatement actions</td>
<td>Andersen, T.</td>
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<td>Developing methods for study of redox proteins by combining synchrotron radiation (e.g. crystallography) and single-crystal spectroscopy</td>
<td>Andersson, K.K.</td>
<td>RCN</td>
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<td>3D protein structure, active site structure, and function of metallo- and radical proteins</td>
<td>Andersson, K.K.</td>
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<td>A national subcellular imaging platform</td>
<td>Bakke, O.</td>
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<td>Centre for Immune Regulation (CIR) Bakke</td>
<td>Bakke, O.</td>
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<td>Population genetics of Silence acaulis in the High Arctic</td>
<td>Brysting, A.</td>
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<td>Regulatory RNA and the origin of multicellularity</td>
<td>Bråte, Jon</td>
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<td>Characterisation of novel peptide ligand-receptor complexes in plants</td>
<td>Butenko, M.A.</td>
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<td>Role of macrophages for cancer eradication by the immune system</td>
<td>Corthay, A.</td>
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<td>Diversity and dynamics of marine haptophytes</td>
<td>Edvardsen, B.</td>
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<td>Toxic algae: taxonomy, quantification and early warning</td>
<td>Edvardsen, B.</td>
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<td>Unmasking the interplay between pathogenic Neisseria species and host cells by quantitative proteomic analysis</td>
<td>Egge-Jacobsen, W.E.</td>
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<td>Eco-evolutionary dynamics in marine food webs and their interactions with fishermen - implications for management and society - Utenlandsstipend ophold ved Princeton, USA</td>
<td>Eikeset, A.</td>
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<td>Characterization of plant associated AlkB-like demethylases</td>
<td>Falnes, P.</td>
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<td>Wobble uridine modifications in mammalian tRNA - biogenesis and function</td>
<td>Falnes, P.</td>
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<td>Neural processing and plasticity in cortical circuits of behaving animals</td>
<td>Fyhn, M.</td>
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<td>Experience-induced synaptic plasticity and network activity in visual cortex</td>
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<td>Identification of molecules involved in the generation of the MHC class II peptide loading compartment</td>
<td>Gregers, T.F.</td>
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<td>Development of biodegradable nanobeads as vaccines against tuberculosis</td>
<td>Griffiths, G.W.</td>
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<td>Development of nanoparticle based therapies against tuberculosis in the zebrafish model</td>
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<td>Application of a new principle to combat infectious salmon anemia</td>
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<td>Explaining the Roles and Epigenetic Mechanisms of Imprinting in Seed Development</td>
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<td>The muscle excitation-transcription coupling</td>
<td>Gundersen, K.</td>
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<td>Maturation of the electrophysiological and intracellular signaling systems in teleost gonadotropes during puberty</td>
<td>Haug, T.M.</td>
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<td>Phytoplankton size: Climatic adaptation and long-term evolution</td>
<td>Henderiks, J.</td>
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<td>BiodiveRS/A Biodiversity dynamics and tipping points in our future freshwater ecosystems</td>
<td>Hessen, D.O.</td>
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<td>Effects of climate change on boreal lake ecosystems: productivity and community responses</td>
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<td>Genome size, cell size and growth; searching for the causal links</td>
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<td>Spatiotemporal variability in mortality and growth of fish larvae in the Lofoten-Barents Sea ecosystem</td>
<td>Hjerman, D.</td>
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<td>Combined effects of ocean acidification, climate change and oil related discharges</td>
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<td>Link populations to food-chain</td>
<td>Hjermann, D.</td>
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<td>Challenges towards sustainable aquafeeds-plant nutrients and contaminants interactions. Use of biological models and indicators</td>
<td>Hylland, K.</td>
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<td>Functional and comparative immunology of a teleosts world without MHC II</td>
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<td>Preventing heart pathology in farmed Atlantic salmon</td>
<td>Johansen, I.B.</td>
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<td>Pre-project for cable-based ocean observatory</td>
<td>Kaartvedt, S.</td>
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<td>Collective behaviour of penned herring: Observing the collective behaviour and investigating the effect of various sound stimuli -CollPen</td>
<td>Karlsen, H.E.</td>
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<td>Climate change effects on the fungal ecosystem component</td>
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<td>Klaveness, D.</td>
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<td>Novel vaccine candidates against meningococcal diseases</td>
<td>Koomey, J.M.</td>
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<td>Membrane nanotube formation from endosomes by cooperating motors: physical regulation and quantitative characterization</td>
<td>Koster, G.</td>
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<td>VANN - Evolutionary ecology and hydrology - the effects of stream flow dynamics on the white-throated dipper</td>
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<td>Characterization of the role of the small GTPase Rab7b in intracellular traffic</td>
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<td>Traffic through and around the Golgi apparatus in epithelia - determine the apical and basolateral surface glycoproteomes</td>
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<td>Taxonomy, Quantification and Early Warning</td>
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<td>Molecular mechanisms of androgen action</td>
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<td>Centre for Immune Regulation (CIR)</td>
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<td>Adaptive management of living resources by integrating different data sources and key ecological processes: A joint effort by IMR and CEES</td>
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<td>Managing resource and area conflicts in the coastal zone, exemplified by cod on the Skagerrak coast, NFR 216410/O10 - P.E. Jorde</td>
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On the evolutionary genomics and behavioural ecology of homoploid hybrid speciation in Passer sparrows

Explorer the epigenetic mechanisms of stress adaptation in plants

Applying a new demographic framework to understand, and project consequences of climate change in size- and age-structured populations

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<td>WeeviSTOP - Development of a cost-effective and sustainable insecticide-Free plant protection method, eliminating widespread catastrophic damage in the forestry caused by the pine weevil Hylobius abietis</td>
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<td>PlagueEcozGeno - Reconstructing the imprint of ecology on the genetic phylogeography of the Plague in Central Asia and China</td>
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## Other public sector/private sector projects

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<td>Studies of inhibition of ribonucleotide reductase with different metal-ion clusters</td>
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<td>Utvikling av et nytt modellsystem innen polyploid planteevolusjon: skjørbuksurt (Cochlearia) - Nansenfondet</td>
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<td>Oslo Prostate Cancer Symposium 2014</td>
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<td>Sandlie, I.</td>
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Dyrking og PCR som støtte for diagnostikk ved Lyme borreliose

Assessment of the effects of oil exposure on the population dynamics and abundances of Atlantic cod and haddock using stat-space models - 6159

Impacts of Deforestation on Biodiversity and Rural Livelihood - NORHED

PITRO III - Graz - Ecological modelling, interdisciplinary methodology and climatic variation in Africa

Barcoding of polychaetes and nematodes

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<th>Project Description</th>
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<tr>
<td>Dyrking og PCR som støtte for diagnostikk ved Lyme borreliose</td>
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APPENDIX

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