FUGE –

The national programme for research in functional genomics in Norway

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The Research Council of Norway

FUGE – enhancing national research in functional genomics

In an international perspective, biotechnology has emerged as one of the top priority areas within research. This field holds the key to new knowledge that will increase global understanding of fundamental biological processes and provide a basis for innovation and industrial development. Norway, too, has recognised the vast potential of this field of research, and has launched a national plan to enhance research in functional genomics (FUGE).

The FUGE research programme received an initial allocation of NOK 100 million over the 2002 national budget. In 2003, funding was increased by an additional NOK 50 million. A continuation of the allocation of NOK 150 million has been proposed in the budget for 2004. There are two primary objectives underlying the Government's focus on the FUGE programme: Firstly, to raise the quality of Norwegian research in this area to international standards, and secondly, to promote our national industrial development. At the same time, the programme should facilitate the identification and utilisation of our national advantages, for instance in the fields of marine research, environmental protection, agriculture and medicine.

In the Government's view, one of the most important elements of the programme is a national division of responsibilities within the context of a unified plan. FUGE is the first research programme in Norway to incorporate clearly defined national as well as regional modes of interaction and distribution of tasks. This has led to new lines of thinking and cooperation across the boundaries of disciplines and institutions. In my opinion, this is extremely productive. Another important aspect that the Government wishes to emphasise is the excellent opportunity that FUGE provides for stimulating international research co-operation. Top researchers from abroad are recruited to work in Norway, and Norwegian researchers are encouraged to carry out part of their research abroad. This will help to enhance our own expertise, while at the same time promoting Norway as an attractive partner on the international arena.

FUGE is a good example of how Norway can upgrade the quality of its research. The model has been applied to other areas, and can thus already be said to have achieved positive results. Now it is up to the authorities and research community to continue working together to further intensify these research efforts, so as to enable Norway – in a few years' time – to assume a leading position in strategically important areas within the field of functional genomics.

Kristin Clemet
Minister of Education and Research

Contents

The Genome: Key to Life

The genome comprises the complete genetic material, or the DNA, of each living organism. The genome contains all the information that is needed for an organism to exist, as well as the codes that give each species and each individual its own unique make-up. It consists of about 30,000 genes, each of which contains the code for other products in the form of proteins that have various features and functions within the organism. In the past decade, the human genome and the genomes for a number of other species have been mapped. The genetic material has been decoded, but we have not yet been able to completely decipher its message.

Functional genomics encompasses research to interpret the code and understand the intricate processes by which the genes and proteins in an organism function, alone and in interaction with one another. New technologies in this sphere are emerging at a phenomenal pace. Functional genomics is a wide-ranging and complex research field, and is thus by nature an interdisciplinary undertaking. It integrates not only biology and biomedicine, but also chemistry, physics, mathematics, informatics, statistics and more.

Biological processes are at the core of much of human activity, from fulfilling the fundamental needs of the body, through commercial activities such as fisheries, aquaculture and agriculture, to environmental protection and methods for dealing with medical problems. In each of these areas, functinal genomics is expected to generate new insights and a variety of pioneering products and methods. These will include new pharmaceutical products and medical treatments, new methods to increase the food production output of aquaculture and agriculture, methods to enhance the quality, e.g. nutritional status, of food products, and methods to remove or neutralise hazardous substances.
The new knowledge and technological possibilities brought about by research in functional genomics will also raise new questions relating to the legal, ethical and social aspects of these activities. It is therefore imperative that research be conducted on these aspects of functional genomics as well. The opportunities inherent in functional genomics research must be conveyed to the community at large as a basis for public debate.

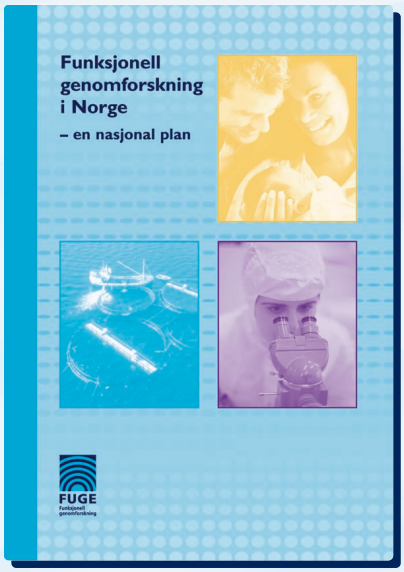
Excellent returns from functional genomics!

The mapping of the genetic material (genome) of humans and many other organisms represents a new era in science, and paves the way for a completely new understanding of the processes taking place in living organisms. This is the basis for the research programme in FUnctional GEnomics (abbreviated FUGE), which opens the door for a host of new prospects and challenges.
Research activities must be organised in a different fashion if we are to succeed in taking full advantage of these new opportunities. The need for advanced, high-cost technology and broadly differentiated know-how requires cooperation between many different research environments. FUGE represents an initiative in which the academic institutions within the university regions have agreed to allocate tasks and utilise shared resources and know-how. At the root of these efforts lie the 11 national technology platforms that have been launched to serve as competence centres responsible for developing their specific technologies in Norway. In addition to providing services and assistance to the research community at large, each centre will offer training for researchers and technicians as well as conduct its own research activities.
Norwegian society will benefit in great measure from increased research in functional genomics. This sphere of research is based on biotechnology that will form the basis for much of the industry of the future. The primary objective of the FUGE programme is to enhance the quality of basic biological, medical and marine research, and to help to ensure that this research is in turn implemented to generate innovation and strengthen industrial development.
Top-quality national research is also an important door-opener to participation in developments taking place in other countries, and will bolster Norway's ability to take part in the international arena. FUGE will provide Norway with the academic authority and cohesive voice needed to form alliances and establish cooperation with similar research programmes abroad. National research programmes are expected to play a central role in the development of the EU's Sixth Framework Programme as well as the European Research Area. FUGE will also generate benefits in terms of improved recruitment and education of researchers within priority research areas.
The challenges facing us are many. FUGE's national technology platforms need to be distilled into a dynamic resource. FUGE will also establish the expertise needed to elucidate and clarify the ethical, social and environmental consequences of research in functional genomics. Nonetheless, the most important factor for success will be found in our ability and willingness to cooperate – internally within our research community as well as externally, vis-à-vis industry, investors and the government authorities.

Ole Petter Ottersen
FUGE Board Chair

A National Plan

FUGE comprises a national plan for research in functional genomics in Norway. The plan is designed to strengthen research in this field to bring Norway up to top international standards.



At the same time, FUGE comprises a plan for restructuring and increasing the efficiency of the research establishment. It is vital that Norway's overall research resources and expertise be utilised as effectively as possible. Under the FUGE programme, responsibilities and tasks are delegated to the four university regions, and new models for cooperation between universities, research institutions and the industrial sector will be devised. This will help to make Norwegian research institutions attractive abroad, and ensure that Norway is considered an interesting candidate for equal partnership in international collaborative projects.

At the Nordic level, FUGE is in contact with similar initiatives (such as SWEGENE), and is establishing a framework for cooperation and shared utilisation of resources. FUGE's action plan integrates many features of the EU's Sixth Framework Programme, and provides associated researchers with an excellent basis for participation in EU projects.

FUGE encompasses three priority areas: Basic biological research (including bioinformatics), marine research and medical research. Within each of these areas, industrial development is a topic of main concern. In addition, funding is provided for research on ethical, environmental and social issues that need to be brought to light and clarified in relation to functional genomics.

Objectives

FUGE is designed to enhance Norwegian research in functional genomics in the following areas:

Basic biological research: FUGE will strengthen basic biological research and will help to ensure that Norway emerges as a prominent player in areas of particularly strategic importance or in which it has special national advantages.

Medical research: FUGE will make it possible for Norwegian health care services to utilise the new knowledge and products that result from functional genomics, thus ensuring that Norwegian health care remains among the best in the world.

Marine research: FUGE will play a role in establishing the knowledge base needed to promote further development of the aquaculture industry and optimal utilisation of Norway's marine resources. It is also important to facilitate the establishment of a biomarine industrial cluster in Norway.

Ethical, environmental and social issues: FUGE will enable Norway to acquire knowledge about the consequences and dilemmas inherent in functional genomics research in order to supplement the public debate and help to maximise the potential positive impact of such research on society, the environment and the individual.

Restructuring the Norwegian Research Establishment

National and regional allocation of responsibility

FUGE establishes a baseline technological capacity in functional genomics in each of the four university regions. Each region has been allocated responsibility to build up know-how and services in certain fields, and together they can supply the national research community with the services it needs. The regions are responsible for cooperating among themselves, as well as for maintaining contacts with the international research community.

Industrial development

FUGE is part of a long-term national effort to generate research-based industrial development. FUGE cooperates with commercialisation entities in each of the regions to strengthen the interaction between universities, university colleges, other research institutions and the industrial sector.

Internationalisation

It is an expressly stated objective that Norwegian functional genomics research is to be of top scientific quality. To achieve this, it will be necessary to recruit outstanding international researchers with broad-based international networks to come and work in national laboratories. At the same time, researchers in Norway must be encouraged to seek entry into eminent research institutions and communities abroad. FUGE provides support for both of these measures.

FUGE – More than Basic Research...

Part of the allocations to FUGE are earmarked for industry-oriented research and research relating to ethical, social and environmental aspects of functional genomics.

Industrial development

FUGE is designed to help identify ideas that have commercial potential, and will thus enable functional genomics research in Norway to lead to the development of new products. FUGE will stimulate industrial development and job creation through activities such as promoting the entrepreneurial awareness of researchers, enhancing cooperation with commercialisation entities in the university sector, and supporting emerging and established biotechnology industries. A maximum of ten per cent of the FUGE budget has been set aside for these measures, primarily with an eye to supporting activities that can be built up in Norway but that will at the same time be of value in the international arena. Opportunities worthy of further development have already been identified in the medical and analytical spheres, and great importance is attached to the tremendous potential of the marine sector, where FUGE will also work to promote innovation.

Ethics, society and the environment

The application of biotechnological methods to areas involving health, food and the environment is a topic of heated public debate. It is critical that all scientific and technological development takes place in keeping with the values and norms on which society is based. However, at times along the way, the reigning attitudes and norms may be challenged.
FUGE has set aside a maximum of five per cent of its budget for research projects on the ethical, social and environmental aspects of functional genomics. Activities include legal projects on patent legislation, regulation of access to genetic information, and the general public's need for and right to information. FUGE also funds social science projects on health policy, equitable distribution and on the attitudes and knowledge of the population. In addition, funding has been provided for environmental projects in connection with aquaculture.

High returns on research!

Functional genomics offers many benefits. For example, research in this sphere could make it possible to reduce the pigment costs for farm-raised salmon by 20 per cent, and still obtain the appropriate flesh colour.
The savings are enormous:

Current salmon production: 450,000,000 kg per year
Pigment costs: NOK 1.00/kg
20 % cost reduction in pigment costs due to research and improved understanding of biological processes:
450,000,000 kg x NOK 1.00 x 20 % x 10 years = ***NOK 0,9 billion saved***

The precautionary principle

In Norway, it is established practice to view gene technology research as subject to the precautionary principle. Thus, the consequences of utilising the know-how derived from such research must be carefully weighed, and the use of this know-how will not be approved if an unacceptable measure of risk is found to exist.
The precautionary principle and risk assessments are applied in situations such as those involving the dispersal of modified organisms into the natural environment, or the introduction of new treatment methods and technologies that cause permanent or temporary modification of an organism's genetic material.

The FUGE Tool Box...

Photo: P. E. Lillholm, PROBE

Eleven National Technology Platforms

Functional genomics requires advanced technology and highly-educated personnel. In light of this, 11 national technology platforms have been established as the pillars of the FUGE programme.

These platforms have been delegated national responsibility for developing their capacities and will become technical service centres providing special expertise and know-how within the applicable technologies. These platforms provide seminars and meetings for users throughout Norway. In addition, they conduct international research activities to enhance the development and utilisation of the platform technology.

Biobanks for Health

A genetic reference guide...

The causes of human disease are both genetic and environmental. In order to provide a better understanding of disease patterns among the population, health information is compiled in databanks known as biobanks. These contain biological samples as well as information about peoples' health, illnesses, environments and life histories. By linking this information together, it is possible to learn more about the separate and combined effects of genetic factors and environmental influences on health. Knowledge about genetic traits can help to improve preventive health care efforts as well as the treatment of disease. Data is being added to the biobanks on an ongoing basis, and thus they represent an important resource for the future as well as for the present.

Main responsibilities and activities

Two technology platforms have been established in this sphere of research: the *Norwegian Network of Human Research Biobanks and Health Studies (Biobanks for Health)* and the *Regional Research Biobank for Central Norway.* These platforms are responsible for establishing an operational network between Norwegian health studies and human research biobanks. The *Biobanks for Health* platform builds on the regional health studies that are cooperating on the *Cohort of Norway (CONOR)* and the *Norwegian mother and child (MoBa*) studies. These studies compile health information, clinical measurements and blood samples from the Norwegian population, and currently encompass data from roughly 230,000 individuals. When completed, the network will comprise biological samples and standardised health and exposure data from 450,000 Norwegian individuals of all ages, corresponding to approximately 1/10 of the Norwegian population. This data will provide a unique basis for medical research, especially research to study the interaction between genetic and environmental causes of disease.

The Regional Research Biobank for Central Norway is a national pilot project launched to assess various issues, such as the organisational and legal implications of human research biobanks.

The platforms are responsible for stimulating research projects and facilitating the optimal utilisation of data and biological material. The most important task in coming years will be to supply new knowledge that can lead to enhanced prevention and treatment of disease. Such knowledge will encompass discoveries of new genes associated with complex diseases and new information regarding the significance of environmental factors.

Core tasks

To develop a genealogy databank, i.e. a database that compiles genealogical data. This is necessary in order to conduct studies on genetically inherited factors. This databank is being developed in cooperation with Statistics Norway (the Norwegian central bureau of statistics).

To increase Norwegian expertise in genetic epidemiology and biostatistics by means of recruitment and cooperation with international research centres.

To conduct DNA extraction to isolate DNA from blood samples for genetic analysis. This is a demanding and costly task. *Biobanks for Health* utilises a DNA extraction robot to facilitate the extraction process for blood samples.

To create an IT system that makes it possible to link information on biological material from individuals together with health and genealogical data.

To establish common ethical guidelines as a basis for ethically responsible management of the material. These guidelines will apply to the access of researchers to data and biological material. All data collection activities have been approved by the Norwegian Data Inspectorate and the National Committees for Research Ethics in Norway.

To conduct research through participation in scientific projects in cooperation with Norwegian and foreign research groups on scientific projects that incorporate the technology platform.

Organisation

The Norwegian Institute of Public Health is the host and coordinating institution for the *Biobanks for Health.* The Faculties of Medicine at the four Norwegian universities are all cooperating on this platform. *The Regional Research Biobank for Central Norway* is located at the Norwegian University of Science and Technology and collaborates closely with the Central Norway Regional Health Authority and other biobanks, including *Biobanks for Health.*

Contact

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Bioinformatics

Interpretation and translation...

The "language" of the genes is difficult to understand, but with the help of computer technology, the codes can be cracked and the book of life can be read. Bioinformatics is an interdisciplinary science that analyses biological data using methods from informatics, statistics and mathematics, among others. In cooperation with its users, the platform for bioinformatics will work to develop methods and models that can provide Norwegian functional genomics researchers with the tools that they need.

Ill.: V. Eijsink, NLH

Main responsibilities and activities

The platform for bioinformatics is responsible for providing research-based services and training in bioinformatics, and for creating a technological foundation that may be utilised by other FUGE platforms as well as other researchers. The platform conducts research in theoretical bioinformatics (development of models and methods) and applied bioinformatics in biological or biomedical research projects. The platform supplies services such as databases and analysis software both nationally and abroad. The platform will take active part in Norwegian functional genomics and biomedical research, and will be a hub for a substantial network of international contacts. To achieve this, it is necessary to encourage closer cooperation between the research community and the industrial sector.

Core tasks

To provide services such as web-based databases and tools, advisory services and programming assistance.
To arrange courses and training programmes on central bioinformatics topics as well as a visitor's programme in which researchers can work directly with platform personnel for shorter or longer periods of time.
To conduct research in areas such as methods for analysis of gene expression data, evolutionary studies, clinically-oriented bioinformatics, structural biology and biological databases.

Organisation

The platform is a joint project hosted by the University of Bergen, the University of Oslo and the Norwegian University of Science and Technology in Trondheim. The University of Bergen is the coordinating partner, and has the overall responsibility for platform activities. The platform also incorporates activities from a number of other research and educational institutions in the Oslo area, including the Norwegian Radium Hospital and the Norwegian Computing Centre. In addition, several commercial enterprises are involved, including Sencel AS, PubGene AS and MolMine AS.

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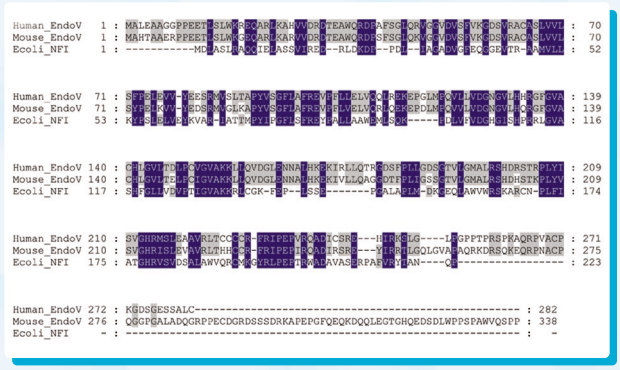
Ill.: Moe and Klungland, Rikshospitalet University Hospital Oslo

Biobanks for health

Columbia University researchers, in collaboration with researchers at the Norwegian Institute of Public Health, have received a five-year, USD 13 million grant from the US National Institutes of Health to fund one of the world's largest studies of neurodevelopmental disorders. The study (nicknamed the "baby Framingham" project) will track babies before they are born. Initially focused on autism, the study will follow up to 100,000 pregnancies from the first trimester through childhood – and possibly adulthood – via access to a birth registry in Norway and the "Mother and child" biobank. This interdisciplinary study provides a unique opportunity for Columbia and the Norwegian Institute of Public Health to conduct rigorous examination of the roots of autism and other neurodevelopmental disorders. Findings will be crucial in the context of improving global health.
More information: *http://www.fhi.no/publ/nyheter/2003-11-12-autisme.html*

Integrative Genetics and SNP Analysis

From genome to function...

Why do we look and function the way we do? How can we be so different and yet so alike? The appearance and characteristics of an organism comprise its phenotype, and are a product of both genetic and environmental factors. Tiny differences in the genetic make-up can lead to great differences in phenotype.
A gene is "coded" around four different nucleotides. Sometimes, one of these nucleotides is replaced by another, causing a point mutation known as a Single Nucleotide Polymorphism (SNP). SNPs may be used to find genes that influence disease in both humans and animals, as well as genes that are significant for commercially important traits in plants, fish and mammals.

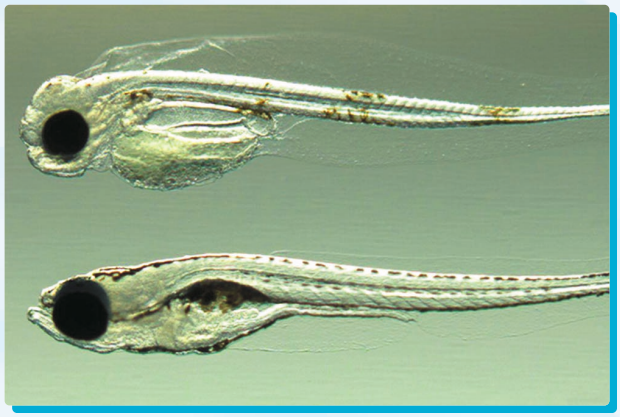

Photo: T. Becker, Sars Centre, Univ. of Bergen

Main responsibilities and activities

The platform for integrative genetics focuses on the detection, typing and interpretation of variations brought about by point mutations. This platform is hosted by the *Centre for Integrative Genetics (CIGENE).*

CIGENE is intended to be a highly visible player in the field of integrative genetics. The platform is responsible for facilitating a deep causal understanding of complex genetic characters in fish, plants and animals for scientific as well as commercial exploitation.

Integrative genetics

Both organisationally and scientifically, CIGENE is participating in the changes taking place in genetics research:

- Experimental and theoretical approaches are being integrated in concrete interdisciplinary research programmes.
- The processes and mechanisms which in the broadest sense link genotype data to phenotype data are being integrated by means of mathematical, statistical and computational tools.
- - In functional genomics, traditional scientific barriers between biomedical research, evolutionary biology and production biology cease to exist.

Core tasks

To provide a national service centre for the analysis and typing of point mutations (SNPs) on a large scale in biological material from humans, micro-organisms, plants, animals and fish.
To provide a national competence centre for the identification and methodological integration of experimental and theoretical methods to build bridges between genome information and phenotype characteristics in general.
To serve as a core partner in salmon and bovine genomics.
To organise courses and seminars, host national and international meetings and conferences, and provide advisory services to researchers.
To conduct research by participating in scientific projects in cooperation with Norwegian and foreign research groups.

Organisation

CIGENE is a cooperative effort between the Agricultural University of Norway, the Norwegian School of Veterinary Science, Akvaforsk Research Institute, the Norwegian Radium Hospital, the University of Oslo, the Norwegian University of Science and Technology and the Norwegian Computing Centre. Each of the university regions is represented on CIGENE's board, which also includes representatives from Norwegian biotech industry.

Contact

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Microarray Technology

When thousands of genes need to be compared...

Living cells contain approximately 30,000 genes that work together and influence one another. To enable scientists to understand how this takes place, a special technology for studying all of the genes at the same time has been developed. This method is called DNA microarray technology, and it is utilised to monitor variations in gene activity under different conditions. Microarray technology makes it possible to obtain better diagnoses and a better understanding of disease, as well as to develop pharmaceutical products that are specifically designed to provide the most effective treatment of the individual patient.

Main responsibilities and activities

The microarray technology platform is responsible for supplying researchers with access to high-quality DNA microarray technology. The platform follows international developments in this technology sphere closely, and plays an active role in defining the research tasks in which to apply microarray technology. This ensures that the platform will be able to provide the research community with the best possible support with regard to array-based laboratory techniques. The platform for microarray technology is hosted by the *Norwegian Microarray Consortium (NMC).*

Core tasks

To conduct analyses. The platform has compiled joint gene probe collections for humans, rats and mice, and can print microarrays from these as well as from other gene collections compiled by users.

To provide databases and infrastructure for storage of information about the microarrays, for storage of all experimental data, for simple data analysis and advanced analysis of microarrayed gene expression data. For the most part, these services are available without charge to users.

To build competence through the operation of networks for the exchange of expertise between microarray users. To supply and further develop vital expertise in bioinformatics.

To organise courses in microarray technology and advanced microarray data analysis for researchers and technicians.

To conduct research through participation in scientific projects in cooperation with Norwegian and foreign research groups.

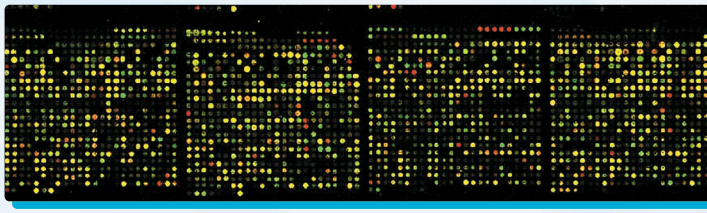

Photo: O. Myklebost, The Norwegian Radium Hospital

Organisation

The NMC is a collaborative effort between the University of Oslo, the Norwegian Radium Hospital, the Norwegian University of Science and Technology and the University of Bergen. There are operative platform centres at each of these sites. Cooperation also includes the development of methodology as well as research and education within the field of microarray techniques.

Contact

Platform Coordinators (rotating)
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Diagnostics using microarrays

Microarray analysis is being utilised to identify which breast cancer patients will need chemotherapy after surgery. Thus, women whose prognosis for survival is deemed just as good without chemotherapy do not undergo unnecessary treatment. Microarray technology is helping scientists to develop better diagnostics for diseases such as cancer, and will contribute to early disease detection as well as identification of the optimal targeted treatment for the individual patient. This will increase survival rates and reduce the incidence of over-treatment.

Proteomics

From thousands of genes to millions of proteins ...

The number of genes varies from organism to organism. No matter how many genes an organism has, however, there are far more products (proteins) produced than the number of genes would imply. This is because the gene codes can be read in different ways and the gene products are further processed within the cells. The approximately 30,000 genes defined for humans give rise to a much higher number of different proteins. Proteomics research is aimed at identifying, quantifying and defining the function of proteins. Such protein studies are likely to form the cornerstone of the diagnostic procedures and individualised medical treatment of the future. Proteomics will also comprise a vital tool for all types of basic biological research.

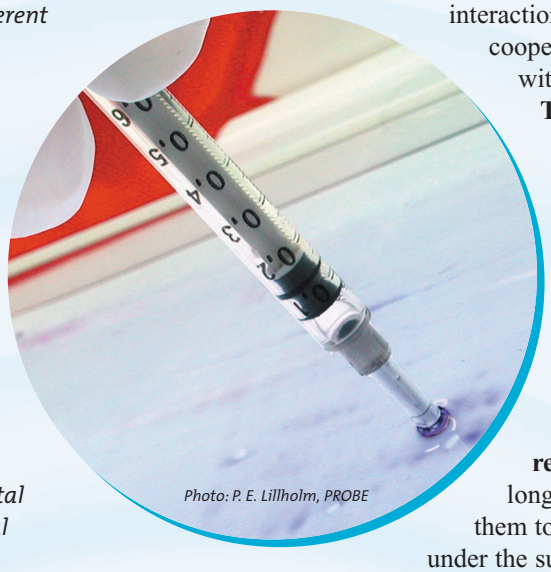
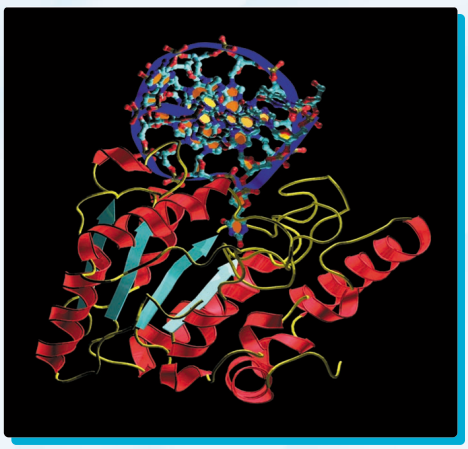


Photo: P. E. Lillholm, PROBE

Main responsibilities and activities

The FUGE platform for proteomics is hosted by the *Norwegian Proteomics Centre (PROBE)*, which consists of a service unit and a research unit. The service unit conducts protein analysis on samples of biological material from all of Norway, while the research unit carries out research to support *PROBE*'s services. Research activities at *PROBE* are focused on protein-protein interactions and post-translational modifications. In addition to its own researchers, the platform hosts two positions for international scientists, both of which are filled by renowned researchers with special expertise in the centre's priority areas and general mass spectrometry analysis of proteins.

Ill.: NORSTRUCT



Core tasks

To analyse, identify and characterise proteins and their functions.

To cooperate within the priority areas of post-translational modification and protein-protein interaction. The platform is also open to cooperation with external projects within these areas.

To organise national courses and workshops in proteomics for researchers. Courses are held annually to demonstrate technologies for various forms of protein separations, for sample preparation for mass spectrometry analysis and for carrying out mass spectrometry on proteins.

To provide guest facilities for researchers visiting for shorter or longer periods of time to enable them to carry out their own projects under the supervision of platform personnel.

To conduct research through participation in scientific projects in cooperation with Norwegian and foreign research groups.

Organisation

PROBE is based in the Building for Basic Biological Research at the University of Bergen, and is co-financed by the university and FUGE.

Contact

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Structural analysis

In mammals, enzymes are most active and stable at approximately 37 ºC. The enzymes of organisms that live at lower or higher temperatures function best at the organism's core body temperature. The variation in enzymatic functions may be due to differences in the enzyme's structure, which can be studied by generating three-dimensional images. Biotech Pharmacon AS, located in Tromsø, Norway, has commercially produced an enzyme that functions best at low temperatures. The company has employed the expertise and methods available from the *Platform for Structural Biology* in its search for greater understanding of how different enzymes work.

Structural Biology

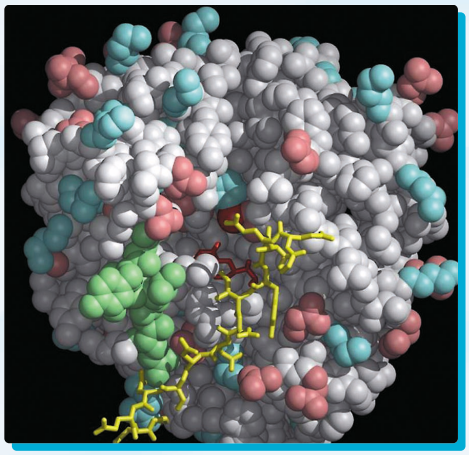

Photo: NORSTRUCT

Form fits function...

The three-dimensional structure (or shape) of biological molecules determines their function within the organism. In order to understand how they work, these molecules must be studied at the atomic level, and their spatial structures must be visualised. Understanding the role that the different segments of the molecule play in its function will help scientists to uncover what can sometimes go wrong, for instance in the case of certain inherited diseases. Enhanced understanding of molecular structure and function also has a wide range of practical applications, such as in the manufacture of biologically active proteins (enzymes) that function optimally at low temperatures.

Main responsibilities and activities

The FUGE platform for structural biology is hosted at the *Norwegian Structural Biology Centre (NorStruct)*, which is responsible for providing infrastructure and expertise in the 3D structure determination of biologically active macromolecules through the use of X-ray crystallography. The platform is designed to serve as a national service and competence centre in structural biology. NorStruct will establish facilities and procedures for an effective "assembly-line" production of biologically active macromolecules for processing and analysis with regard to their functions and three-dimensional structure. The platform will monitor developments in structural biology research by maintaining close contacts with top international research establishments in this field. *NorStruct* will provide cutting-edge expertise that can be used to strengthen relevant research projects throughout Norway. *NorStruct* is also responsible in practical terms for following up the Swiss Norwegian Beamlines (SNBL) at the European Synchrotron Radiation Facility (ESRF) in Grenoble, France, as well as enabling Norwegian biological researchers to make the best possible use of these facilities.

Core tasks:

To analyse protein samples, conduct crystallisation experiments and carry out X-ray data collection testing. These are part of the free services offered by the Centre. The methods used to determine protein structure will depend on the client's needs, the complexity of the project and the available capacity.
To conduct training and provide advisory services for project participants from research groups through Norway. The Centre will host and supervise visiting researchers. The instrumentation in Tromsø and the data collection equipment at SNBL may then be freely utilised both to conduct individual projects and to enhance expertise. The Centre provides partial funding for research visits to Tromsø.
To collaborate with external partners in need of full-scale structure determinations of proteins.
To organise courses in structural biology and crystallography.
To conduct research through participation in scientific projects in cooperation with Norwegian and foreign research groups. The Centre's internal projects will be targeted towards gaining new insight into the disease and disease-defence mechanisms of fish.

Organisation

NorStruct is organised under the Department of Chemistry at the University of Tromsø's Faculty of Science.

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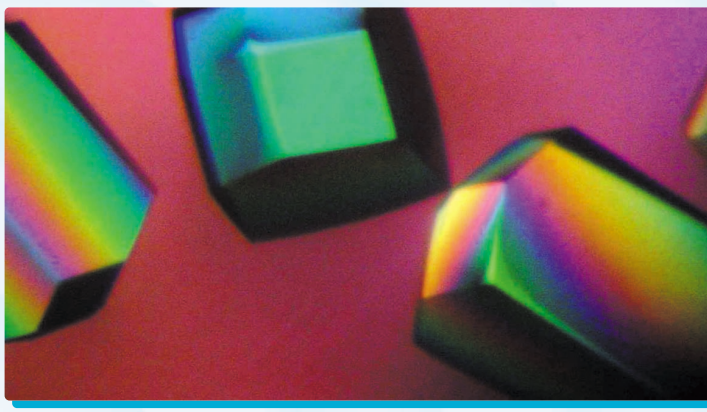

Photo: NORSTRUCT

Molecular Imaging

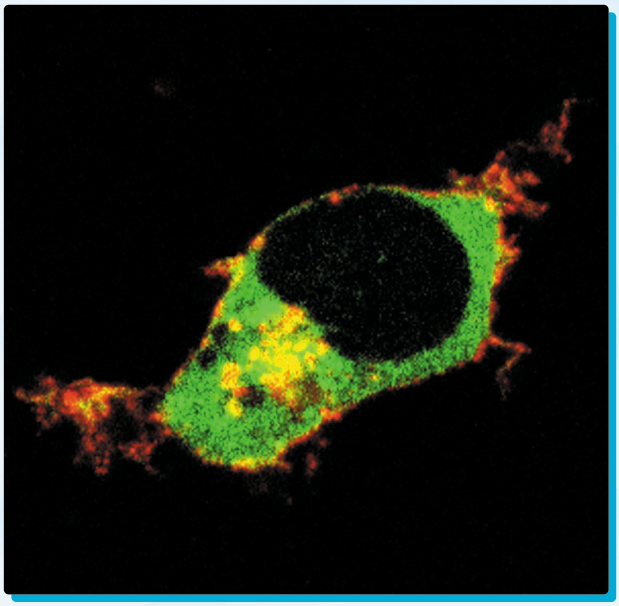

Photo:The Molecular Imaging Centre

Images provide insight...

How do genes and their products interact in living cells and organisms? It is easiest to understand something that can be seen with the naked eye. So the challenge in this sphere is how to make visible that which is not only minute but also well hidden.
Microscopy techniques have been in use for several hundred years, but the recent rapid technological developments in microscopy, laser technology, and data and image processing have completely revolutionised this field. It is now possible to visualise structures and processes in living cells both three-dimensionally and in time (4D). Molecular imaging shows how proteins and organelles "move" inside and between living cells. Together with other microscopy and molecular biology techniques, this will provide a better grasp of how molecules and cells function in healthy as opposed to sick individuals. This technology can be applied to single cells and tissues as well as to living test animals.

Main responsibilities and activities

The platform for molecular imaging is responsible for developing imaging technology and making equipment and technological know-how accessible to research in fields such as cellular and developmental biology, neurobiology and cancer research. This platform is hosted by the *Molecular Imaging Centre (MIC)*, which provides the Norwegian research community with services in advanced imaging technology. The *MIC* will offer state-of-the-art equipment and expertise, and there are long-term plans to establish a forum for researchers employing various types of imaging technology.

Core tasks

To provide analysis and methodology in *in situ* hybridisation; microdissection of cells and tissues; fluorescence protein studies such as fluorescence recovery after photobleaching (FRAP), fluorescence resonance energy transfer (FRET) and fluorescence lifetime imaging microscopy (FLIM); and magnetic resonance imaging (MRI) of live experimental animals.
To provide training and guidance to Norwegian research groups, who are entitled to visit the centre and work under the supervision of platform personnel.
To cooperate with Norwegian research groups.
To organise courses for researchers and technicians.
To conduct research through participation in scientific projects in cooperation with Norwegian and foreign research groups.

Organisation

The *Molecular Imaging Centre* has been established in cooperation between the University of Bergen and the University of Science and Technology in Trondheim. The University of Bergen is in charge of coordination of activities.

Contact

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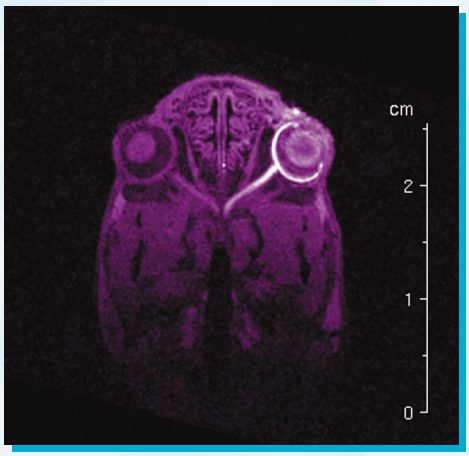

An example of the use of molecular imaging technology (magnetic resonance) using manganese ions as markers. Here, nerve regeneration after injury to the central nervous system is being studied.
Photo: Christian Brekken, Department of Circulation and Medical Imaging, NTNU

Transgenic Mice

Genes in different contexts ...

A variety of methods may be used to understand the functions of genes within an organism. For instance, it is useful to compare individuals who possess certain different traits. Such differences may be due to variations between the genes that code for the same product and may arise as a result of changes in the coding, known as mutations.

The intestinal bacteria E.coli, yeast and fruit flies have served as the most important model organisms used to study genetic and molecular biological change. Genes from other organisms, such as humans, may also be studied in model organisms. Today, transgenic mice comprise a vital model organism in molecular biology. By breeding mice that lack certain genes, termed "knockout" mice, it is often possible to find the explanation for how the normal gene functions. Among other applications, transgenic knockout mice are used to study genes relating to disease.

Main responsibilities and activities

The transgenic mice platform is responsible for producing transgenic mice for Norwegian research establishments, and for assisting researchers working with transgenic mice. The platform will also provide a variety of other services associated with transgenic mice, such as embryo transfer, DNA testing and cryogenic embryo preservation. The platform is hosted by the *Norwegian Transgenic Centre*. The Centre will maintain a stock of vectors and a DNA library for use in transgenic studies. In addition, the Centre offers animal care facilities.

All new projects must receive official approval from the authorities.

Research communities using the Centre are responsible for breeding their own transgenic mice.

Core tasks

To produce knockout mice through cultivation and gene manipulation of embryonic stem cells and mouse blastocyst injections.

To produce conventional transgenic mice by means of DNA injections in fertilised eggs.

To provide courses for researchers and technicians.

Organisation

The *Norwegian Transgenic Centre* is organised under the Faculty of Medicine at the University of Oslo. The Centre is located at the National Hospital of Norway, which features the country's most modern animal facility.

Contact

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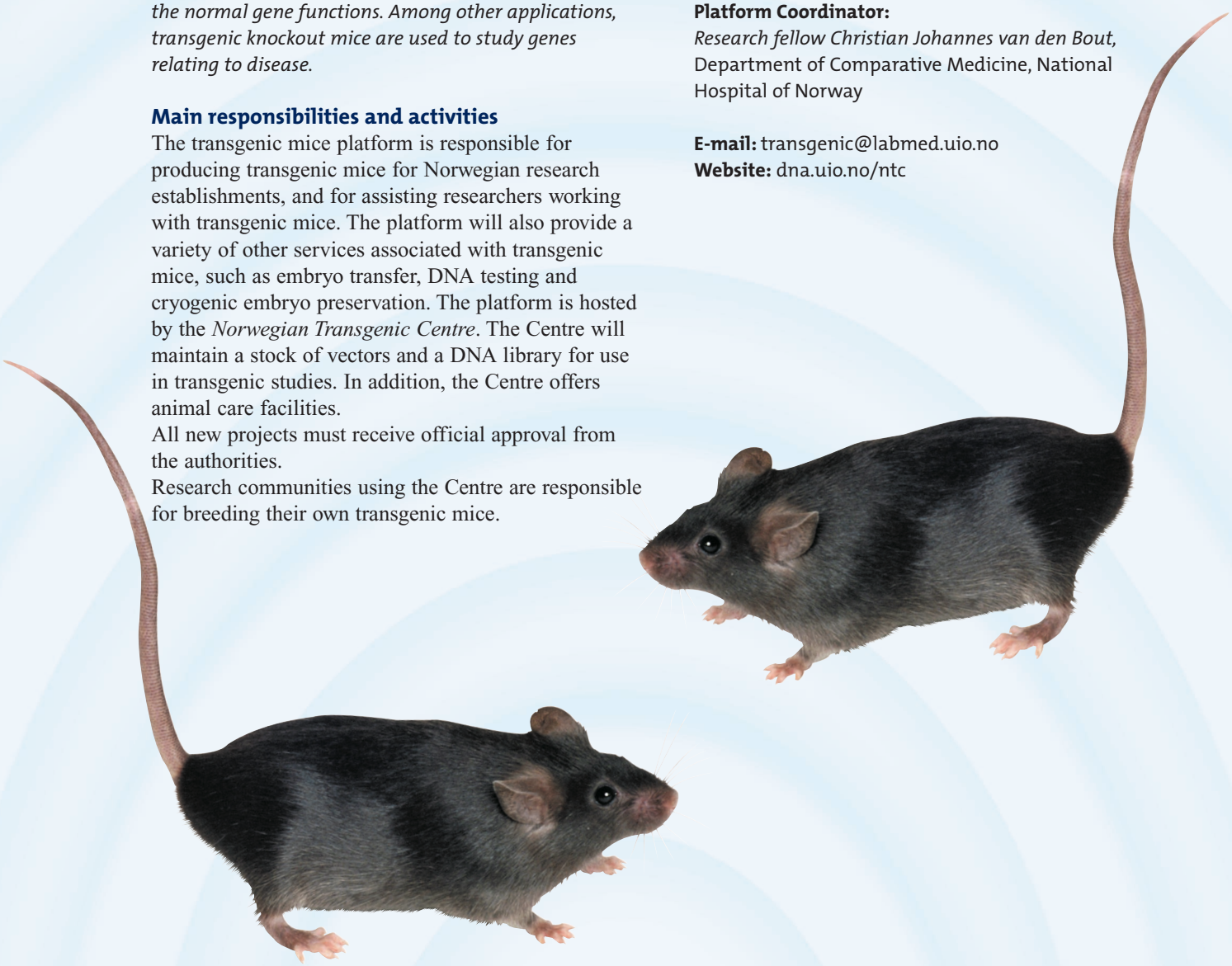

Microbial Science

Tiny organisms with a big impact...

Bacteria play a major role in many areas of human life, and carry positive and negative impacts for health and disease, for food production and other commercial activities, and for nature and the environment. Thus, knowledge and understanding of bacteria is crucial to advancements in industry and health. Basic research in microbiology is called for, and Norwegian research groups need access to the expertise and equipment required for microbiological research. Basic microbiology research is also important for promoting the development of commercial products.

Main responsibilities and activities

The FUGE platform for basic microbiology is based on the use of bacteria as genetic model organisms. Together with related advanced technologies, functional genomics may serve to revolutionise research in microbiology. However, strategies to maintain and encourage such research are needed if we are to successfully utilise Norwegian opportunities in this area. The microbial science platform is responsible for providing expertise, training and access to equipment and facilities for interested groups and individuals in these fields. Activities will include organising courses, conferences and meetings for Norwegian research groups as well as seminars with top-level international researchers. The platform is hosted by the *Consortium for Advanced Microbial Sciences and Technologies (CAMST).*

Microbiology

GENPOINT, a Norwegian company, develops and markets diagnostic kits utilizing its proprietary DNA-based technology for fast and easy detection of pathogenic and toxic microorganisms. With GENPOINT's technology a wide range of bacteria and other microorganisms can be isolated from a broad spectrum of samples. It is also possible to identify several different strains and species simultaneously.

Core tasks

Photo: Novozymes, Denmark

To build competence by strengthening ongoing projects in microbial genome research and integrating functional genomics into microbial science research.
To build up necessary infrastructure.
To conduct research through participation in scientific projects in cooperation with Norwegian and foreign research groups. The most important research areas include:

- Horizontal gene transfer, genome maintenance and studies of type IV pili in *Neisseria meningitidis.*
- Comparative genome studies (chromosomes, plasmids and phages) of the bacteria group *Bacillus cereus.*
- Horizontal gene transfer between streptococci.
- RNA-genes in DNA dynamics and microbial stress response.
- Molecular biology of DNA replication and coordination with the cell cycle.

Organisation

CAMST is comprised of six research groups with the following coordinators:
Professor Michael Koomey,
The Biotechnology Centre of Oslo, University of Oslo
Professor Anne-Brit Kolstø,
The Biotechnology Centre of Oslo, University of Oslo
Professor L. Sigve Håvarstein,
Agricultural University of Norway, Ås
Professor Erling Seeberg,
National Hospital of Norway, University of Oslo
Professor Tone Tønjum,
National Hospital of Norway, University of Oslo
Professor Kirsten Skarstad,
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Contact

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Plant Functional Genomics

Photo: R. Aalen, The Plant Genomics Centre, Univ. of Oslo

Plant Functional Genomics

Human civilisation is based on effective agriculture. Virtually all food for human and animal consumption comes from cultivated crops. In the future, aquaculture products may also be dependent on plant-based feed. Moreover, plants provide wood and fibre that may be used for paper and clothing, as well as bioactive compounds utilised in many medicines. Production of plants and plant products is the world's largest industry. Plant functional genomics will facilitate the production of healthier plants that provide a larger volume of higher quality, more nutritious foodstuffs.

Main responsibilities and activities

The platform for *Plant Functional Genomics* has been established for large-scale plant-based functional genomic analyses. The platform is run under the auspices of the *Norwegian Arabidopsis Research Centre (NARC)*. Activities are largely directed towards research on the flowering weed *Arabadopsis thaliana*, which is used as a model system for plant biology by researchers worldwide. Many of the findings associated with *Arabadopsis thaliana* can be applied directly to other plant species, including those comprising commercially important crops. *NARC* is responsible for providing a national competence and service centre for Norwegian researchers and research groups, and will work to promote enhanced activity in the field of plant functional genomics.

Core tasks

To provide analysis services in transcriptional profiling (cDNA- and oligonucleotide-based DNA microarrays), protein interactions (yeast two-hybrid analysis), and expression analyses (*in situ* hybridisation). In addition, services involving clone collection, transformation and formation will be made available.
To build national competence in plant functional genomics. The platform is designed to increase practical know-how in functional genomics and large-scale analyses.
To cooperate in Norwegian and international research projects. The platform will work to strengthen cooperation between national and international research groups.
To organise courses for researchers and technicians.
To conduct research through participation in scientific projects in cooperation with Norwegian and foreign research groups.

Organisation

The platform is coordinated from the University of Science and Technology in Trondheim, and is a collaborative effort that includes the University of Oslo and the Agricultural University of Norway (NLH) in Ås.

Contact

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FUGE
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