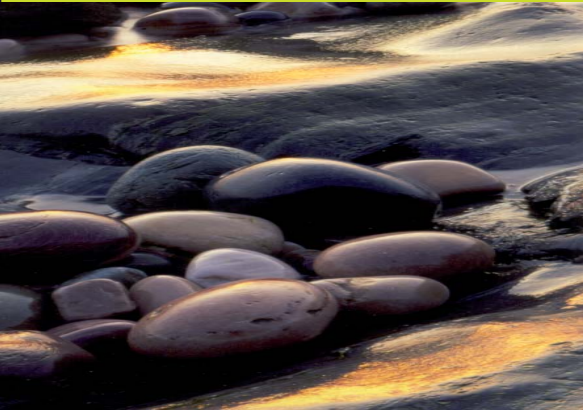


Norwegian Institute of Gene Ecology



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The Norwegian Institute of Gene Ecology - GenØk

The Norwegian Institute of Gene Ecology (GenØk) was founded in 1998 and is a non-commercial foundation located in the research environment at the University of Tromsø and Forskningsparken (the Science Park).

GenØk is engaged in research and teaching in the professional field Gene Ecology. The Foundation focuses in particular on the environmental and health related consequences of the application of gene technology and gene modification. GenØk is also engaged in the broad dissemination of information and offers advisory and consulting services in its field of expertise.

The Institute has 23 employees. The majority work in Tromsø (Norway) but the Institute is also represented in Trondheim (Norway), Christchurch (New Zealand) and Kuala Lumpur (Malaysia).

GenØk is part of a national and international co-operative network. The network encompasses Norwegian research institutions as well as internationally recognised research environments and independent NGO's. Our closest co-operating partners are Centre for Integrated Research in Biosafety (University of Christchurch, New Zealand), TWN (Third World Network) and the University of Tromsø.

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Managing Director, Trond Skotvold
Scientific Director, Professor Terje Traavik

Web

Further information on GenØk can be found at www.genok.org

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The professional field of Gene Ecology

Gene ecology is the study of interactions between hereditary materials and their surrounding environment in the broadest sense. This includes the organization, function and transmission of genes and nucleic acid fragments in different ecosystems and in the context of varying ecological parameters. Hence, gene ecological research must be based on knowledge from functional genomics and other modern biosciences, combined with ecology, evolutionary sciences, bioethics, social sciences and the philosophy of science. Since man-made changes crucially influence the ecosystems, social scientific approaches must be included in the working hypotheses, research designs and impact analyses of gene ecology

The term "Gene Ecology" was born in Tromsø, and the establishment of the term as a scientific field was initiated through GenØk. Gene ecology covers basic as well as applied science. Research into gene-ecological questions is carried out both in the laboratory and in full-scale projects in nature. The science of gene ecology aims at being inter- and overdisciplinary

The basis for gene ecology as an applied science is a difficult clash of interests: While genetic engineering (GE) opens the way to several potential advantages – in particular with regard to health, the environment and natural resources – there are also risks attached to the use of gene modified organisms. A set of known biological and ecological processes may contribute to the dissemination and unexpected functioning of modified genetic material in given situations, with potentially damaging, long-term consequences. Risk evaluation therefore becomes a key term in applied gene ecology, and a vital task will be to build

up a base of experimental models, knowledge and experience in order to implement such evaluations in scientifically credible fashions.

Risk evaluation

Risk and probability are not the same. Risk can be defined as the probability of an event or phenomenon occurring, multiplied by any consequences that may result from the incident actually taking place. Hence, it becomes obvious that an incident occurring extremely rarely may carry enormous risk if the consequences are serious enough. At this point in time we have little knowledge of both the probabilities and consequences in relation to theoretically possible consequences for health and the environment resulting from GE.

Gene ecology research starts with a list of "if", "perhaps" and "maybe". The objective of the research is to replace uncertain presumptions with exact knowledge. Until such knowledge has been established, gene ecology as a professional field has adopted a caution-first principle as its starting point for further research.

The ethical dimension

GE opens new potential opportunities for therapy and prevention of diseases, food production and environmental remediation. However, new technologies are always accompanied by new potential risks and dangers. The challenge is therefore to turn research in a direction where the advantages can be harvested while avoiding undesirable ethical, ecological and socio-economical consequences.

An ethical analysis is closely linked with the understanding of how the technology may affect the well-being of humans, animals and the natural environment. Important questions are: How are we to act when we do not know the long-term consequences? How "sure" is sure enough? Who makes the decisions? Who are the affected parties? Answers to such questions require ethical reflection with contributions from ethicists, molecular

Research Projects

Several of GenØk's research projects are being carried out in close cooperation with colleagues at the Institute for Pharmacy, the Institute for Medical Biology and the Norwegian College of Fishery Science at the University of Tromsø. We are also collaborating with colleagues at the University of California, Berkeley, the University of Erlangen, Germany, the Danish Institute of Agricultural Sciences and at the Karolinska Institute in Stockholm. All projects have basic components, but also contain elements related to a number of potential GE/GMO risk issues. The projects are implemented through food-web model and animal feeding studies, experimental genomics, molecular biology, ecology, social science and bio-ethics based approaches. All, except one of, the projects are supported by competition-based grants from the Research Council of Norway.

Introduction of genetic engineering in aquaculture: ethical and ecological implications for science and governance

Genetic engineering (GE) is emerging as a powerful way for breeding of fish and shellfish, and for producing feed with altered nutritional qualities. In addition, DNA and edible vaccines can rapidly initiate immunization of fish. Norway is a major producer of farmed marine products and therefore potentially a consumer of these technologies. However, using GE in aquaculture raises considerable ecological, ethical and socio-economic concerns that may decrease the benefits of these technologies. It is thus critical to perform appropriate ethical considerations and scientific investigations prior to commercialization.

In this project, a multidisciplinary approach is applied to analyze how the present frameworks for risk governance of GE in aquaculture perform and how they may be improved. The experimental approach is executed at The Department of Marine Biotechnology, University of Tromsø and concerns a study on the fate of DNA constructs administered to fish. Based on the achievements and results from the experimental studies and available scientific literature, we intend to develop and test a conceptual framework for application of the Precautionary Principle (PP) on the use and release of recombinant DNA for aquaculture. The motivation for the proposed project is to attain an integrative understanding and approach for governance of GE in aquaculture that is scientifically reliable and socially robust. The results will be of importance for ecological understanding of the fate of recombinant, e.g. vaccine, DNA molecules, and for the use of ethical principles in evaluation of the technology.

Feeding experiments investigating some Potential risk factors of GM (genetically modified) food.

In feeding experiments we investigate uptake, distribution and expression of foreign DNA in rats. The research project focuses on whether sequences from DNA constructs used to make transgenic plants or transgenic sequences from Bt-transgenic sweet maize are taken up and have biological effects. In addition we investigate whether the authentic Bt toxin that is expressed in transgenic maize has biological effects.

The use of antibiotic resistance genes as markers of genetic transformation in GMOs has put forward the question whether an antibiotic resistance gene may transform alimentary tract bacteria in vivo. In the feeding experiments we are also investigating if intestinal bacteria are able to pick up, stabilize and express resistance genes released from GMOs in the digestive tract. Furthermore we study whether the 35S cauliflower mosaic virus (CaMV) promoter used in GM plants) is active in mammalian cells. This promoter is frequently used in genetically modified plants.

Immunologic reactions in Filipino villagers exposed to Bt-transgenic maize pollen?

We have analyzed Bt transgenic maize harvested from a commercial field in the Philippines, and have proven extremely high differences in concentrations of Bt toxin between individual seeds. These observations have clear implications for the design of studies related to health effects, since the majority of published investigations of Bt toxins fail to report the actual toxin concentrations in the test materials.

The progress of blood antibody analyses of villagers living close to Bt-transgenic maize fields have been temporarily halted due to lack of resources. These analyses require that an assortment of immunologic tests is employed. No standardized methods for these types of analyses currently exist. The project is extremely demanding as it also presupposes the development of new robust methods. This is particularly important since the results may have major economic and regulatory consequences. Rigid quality control of the results is therefore an absolute requirement.



Interaction between foreign DNA and SECs (scavenger endothelial cells) in vitro and in vivo.

Contrary to a still dominant dogma, ingested DNA/RNA, in food/feed, is only partially digested and may be taken up in/from the intestines. Subsequently, nucleic acid fragments may enter the bloodstream. Scavenger endothelial cells (SEC), lining the liver sinusoids of the mammalian liver, play an important role in the clearance and degradation of blood-borne soluble waste macromolecules.

Preliminary results indicate that this may include DNA. Recent data suggest the existence of degradation “failures” for some types of circulating foreign DNA, which may lead to the incorporation of fragments of foreign DNA into the genome of the host organism. This represents an important problem concerning the safety of GM (genetically modified) food/feed, gene therapy and DNA vaccination.

The main purpose of the proposed project is to elucidate the interactions between foreign DNA and SEC. Experiments will be performed to determine the receptor-ligand specificities, routes of internalisation, intracellular transport, and catabolism.

Experiments will also focus on conditions and environmental factors, i.e. chemical pollutants which may alter the intracellular trafficking of endocytosed DNA and thus favor integration of foreign DNA into the genomes of pig, rat, cod and salmon. The results obtained will give valuable basic as well as risk assessment-associated knowledge of practical importance.



Poxviruses in Norway: Biodiversity, characteristics and recombinations between naturally occurring and genetically engineered

Both ortho- and avipoxviruses have now been modified by the insertion of genes from microorganisms and viruses that cause disease in humans and farm animals. Such GM (gene modified) poxviruses can represent highly effective and attractive vaccines. They can be applied directly for the protection of humans and farm animals, as well as for the immunization of free-living animals that are reservoirs of infectious organisms. A large number of GM poxviruses are currently in clinical tests or field trials in the USA, Europe, Australia and Africa. All indications are that we will see a rapid spread of GM poxvirus based vaccines worldwide during the course of the next few years. This underscores the importance of clarifying potential health and environmental risks as soon as possible.

We are investigating two areas of risk:

i. So-called non-target effects, i.e. whether other species than those intended can be infected and affected by GM poxvirus.

ii. So-called recombination effects, i.e. whether double infections between GM poxvirus and naturally occurring poxvirus can result in hybrid viruses containing DNA derived from both parental strains. Such hybrid offspring may have totally unpredictable characteristics, for example with regard to host species preferences and the ability to generate disease.

GMOs in aquatic ecosystems: pioneering ecological food-web model experiments

This project performs ecological food web experiments with genetically modified organisms in freshwater (bacteria – green algae – zooplankton) and marine ecosystems (bacteria – mussels). Foreign DNA is introduced and monitored in the food-web models with continuous comparisons to control experiment without foreign genes. Effects and consequences will be evaluated at the level of molecular biology (e.g. uptake, distribution and expression of foreign DNA), at an ecological level (mortality, growth, fecundity, behaviour), and on a system level (dynamics, stability). The project also works on food-web dynamics with mathematical simulation models.

The Gateways Initiative Program

GenØk has been carrying out the capacity building projects related to gene technology and gene modification in developing countries since 2003.

The Gateways Initiative Program consist of two elements:

- a) Training/Education
- b) Gateway Institute Program



Biosafety course participants

Training/Education

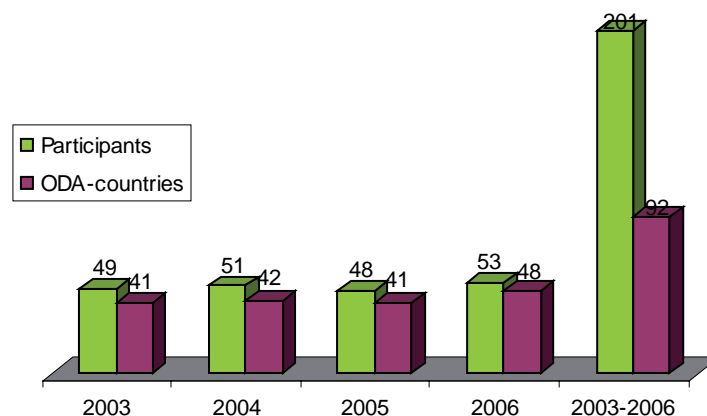
Biosafety course

Holistic Foundations for Assessment and Regulation of Genetic Engineering and Genetically Modified Organisms is a theoretical and hands-on course for NGO/Civil Society Leaders, Senior Scientists, Policy-Makers and Regulators from Developing Countries.

This 2-week course is a mix of lectures, group discussions, casework and practical laboratory sessions. 40 participants from ODA-countries are given full sponsorship. In addition there are 20 places available for participants with sponsorships from other sources.

The GE/GMO Biosafety Forecast service

BAT (The Biosafety Assessment Tool), a free Internet based service that provides forecasts, practical advice, checklists and access to literature on trends in development and products with biosafety implications, is being developed. The home page of the service will include general elements, but also special access ports for central and local administrations, research and popularized dissemination of information. The service is run in cooperation with INBI (Centre for Integrated Research in Biosafety) at the University of Canterbury, Christchurch, New Zealand. Further info and early BAT prototype



biologists, ecologists, social scientists, politicians and other interested parties.

demonstrations is available at the INBI home page:
<http://www.inbi.canterbury.ac.nz/BAT.shtml>

Book/CD-ROM project

Development of a book/ CD-rom is partly based on the course material. The book will give a scientifically diverse introduction to the topic of biosafety related to GE and GMOs. Including both a broad theoretical foundation and practical advice, it is an inclusive tool to a holistic approach to risk assessment and management.

Master of Science Program in Biosafety

Development of a) web-based Master of Science Program in cooperation with the Global Virtual University (GVU) / United Nations University (UNU), b) development of Master of Science Program in Biosafety at the University of Tromsø.

The Gateways Institute Program – pilot

The aim of the Gateways Institute Program is to establish a global network of genuinely independent research institutions. The institutions will serve as coordinating centers for research and training in biosafety matters related to GE and GMOs at the regional and national levels, and will contribute to a good and comprehensive implementation of the Cartagena Protocol. The pilot project has been supported by the Norwegian Ministry of Foreign Affairs/ Norad and has resulted in intention agreements with Zambia and China.



Pictures from GenØk's discussions with the National Institute for Scientific and Industrial Research (NISIR) in Lusaka, Zambia. April 2005.

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