Structure and Development Plan of the GSF-National Research Center for Environment and Health

Strategic Approach

The GSF investigates the foundations on which the future of medicine and healthcare are based, as well as environmental systems. Here, our interdisciplinary research focuses on the environment's considerable influence on human health and its role in the emergence and development of many complex diseases that are and will continue to be among the main causes of mortality and morbidity in the world.

In the future, medicine will focus more and more on prevention. It will concentrate on personal risk factors and look for causal therapies. For this reason the GSF concentrates on interactions between individual genetic disposition, biological systems and environmental factors. Current research approaches are directed towards elucidating the molecular mechanisms of environmentally related illnesses, including allergies and lung diseases, the effects of radiation, fine dust and aerosols on homeostasis and the therapeutic sensitivity of tumours.

We investigate natural resources such as plants, water and soils using a holistic ecosystem approach. Future research on health and the environment will have to analyse fundamental processes of disease development, the damage to organisms and how they defend against and compensate for this. Such investigations involve many different indications and disciplines, and the GSF is in a position to conduct them successfully thanks to its extensive range of skills and expertise, particularly in the areas of genome research, cell biology, bioinformatics, biomathematics, chemistry, physics, and medicine. The GSF brings together the fields of biomedicine and environmental research unlike any other organisation, both within the Helmholtz Association and worldwide. Using the close links that the GSF has with hospitals, it can analyse the molecular mechanisms of disease development and develop new individualised approaches in diagnostics, prevention, and causal therapy. We are continuing to develop this interdisciplinary and cross-indicational approach on the basis of the rapid advances being made in health and environmental research.

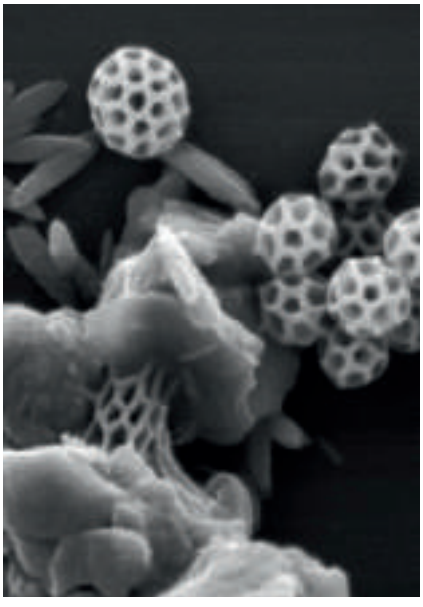
Ionising radiation made visible. Natural radioactivity can be proven using a mist chamber. Lines of condensed water form along the path of the particles.

In the future we will pay particular attention to the areas of systems biology, chemical and structural biology, scientific data processing and modern image-processing techniques. For this, the GSF relies on excellent fundamental research, internationally used experimental platforms, clinical co-operation groups and centres for translational medicine. The aim is to closely link research and clinical applications. As the national centre of competence, the GSF will also continue to carry out important tasks within the field of radiation research and radiation protection.

The GSF has the following organisational and procedural principles: grouping of projects in thematic fields for better interdisciplinary coordination; independent institutes and departments to ensure scientific excellence (directors usually appointed jointly with universities); technology platforms that are used mutually by all institutes and financing through the Helmholtz Association programme-oriented funding and by grants. The individual projects can be grouped into four complementary thematic fields. ■

Environmental Factors and Health

The field of *"Environmental Factors and Health"* investigates the mechanisms of chemical and physical environmental factors, as well as the defence and compensatory mechanisms of the organism. The main challenges here lie in the analysis of agents harmful to human health, such as chemical and physical environmental components, and in identifying the genetic basis and development mechanisms of human diseases. The aim is to identify particularly relevant components of biological systems and to characterise individual susceptibility to environmental factors. This creates a knowledge base for the prevention, diagnosis and therapy of ailments. This thematic field brings together internationally recognised institutes that work in the area of epidemiology using databases and platforms such as KORA, in radiation and aerosol research and in toxicology.



Wonders of nature. Leafhoppers produce brochosomes to protect themselves against water droplets. Brochosomes have been found in fine-dust samples taken from the air.

KOOPERATIVE GESUNDHEITSFORSCHUNG IN DER REGION AUGSBURG KORA

Biobanks will play an important role in the coming years, archiving samples from both epidemiologically registered population collectives and from genetically defined models from mouse projects. Future research will focus on the role of environmental factors in the development of cancer and, in particular, on furthering our competence in researching the biological effects of ionising radiation in a Munich centre for radiation research.

We will also put an emphasis on inhalation research, using our existing expertise on the effects of air pollutants to build up a main research focus on inflammatory and allergic lung diseases and the effects of pollutants on the cardiovascular system. The GSF is also establishing an interdisciplinary pneumology centre as a Helmholtz translational centre with institutes of experimental and clinical pneumology. And we are also looking into aspects of health economics and public health research. ■

Mechanistic Principles of Health and Disease

The focus in the field of *"Mechanistic Principles of Health and Disease"* is on the molecular mechanisms of hereditary diseases, development and neurobiological questions and the role of stem cells. We characterise the function of the genomes of model organisms, for example mice and zebra fish, and extrapolate the results to analogous mechanisms in humans.

The major results expected in the next five to ten years include the development of mouse models for human diseases, the detailed characterisation of these in the German Mouse Clinic and better accessibility to human genotypes. These advances will lead to a completely new information situation, which will require new instruments and structures both with regard to the experimental and genetic-epidemiological approach and for data analysis. The possibilities offered by chemical biology and the elucidation of functional modules will play a substantial role in this and lead us more and more into the realms of systems biology, which will contribute to the creation of mathematical models and simulations of disease processes.

The strength of the thematic field lies in joining experimental and theoretical groups. From monogenetic to complex diseases, which are particularly influenced by environmental factors, there are leading international research projects in many fields. These are not only pursued in the laboratory, but also in silico.

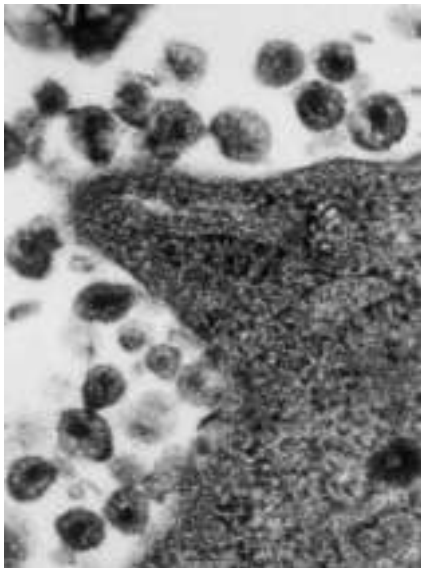
The GSF has initiated research consortia like the German Gene Trap Consortium and the ENU Mutagenesis Programme, which have achieved international prominence. The same applies to the bioinformatics annotation databases.
As a central instrument, the German Mouse Clinic II for "genome-environment interactions" is to be extended both for the GSF and as an international platform. Here, specific changes will be made in the environmental conditions using genetically defined mouse models, so that their molecular effects can be investigated.

An intensive collaboration within the GSF, especially with the field of Environmental Factors and Health, will take us to the next stage in the systematic research into genome-environment interactions. ■

Infection and Immunity

The focus in the field of *"Infection and Immunity"* is on the development of new immune and gene therapeutic strategies for the treatment of malignant tumour diseases and chronic virus infections. This research is primarily concerned with tumour diseases of the haematopoietic system.

We systematically characterise molecular mechanisms and genetic alterations that can be caused, for example, by viral infections or the reorganisation of existing genetic material. Using viral model systems, for example those based on the Epstein Barr virus and HIV, we investigate the interactions of viruses with their human target cells and the contribution of these viruses to the development of tumours and multifactorial diseases. The elucidation of principles of cell growth, virus replication, and signal transfer by cellular and viral receptors will contribute substantially to understanding of the



Foundations of the medicine of the future. One of the greatest challenges in AIDS research is developing a vaccination that stimulates the immune system to fight HIV (fig. scanning electron microscopic picture). Scientists at the GSF Institute for Molecular Virology achieved initial successes with a serum based on a genetically modified vaccine virus.

development of these diseases and will deliver new hypotheses for therapeutic approaches.

A further important focus in this thematic field is research into questions of how malignant cells avoid immune defence and affect immune regulation. Building on this, approaches for targeted modulation of the immune system for treating tumours can be developed on the basis of in vitro studies and animal models. The networking of the thematic field with both Munich universities through clinical co-operation groups, in which biomedical basic research is effectively linked with clinical research, is exemplary here. The establishment of a GMP (good manufacturing practice) laboratory will strengthen the transfer of new strategies for the prevention, diagnosis, and therapy of infectious and malignant illnesses into clinical practice. This facility, unique in the Munich area, will help us clinically test cell-based therapeutic approaches. ■

Ecosystems and Health

The thematic field *"Ecosystems and Health"* looks at the complex interactions between abiotic and biotic components in environmental ecosystems and their influence on the quality of the most important components of human diet: plants and water. An important goal here is to reduce the use of chemicals in agriculture and to optimise the use of soil and water self-purification potential by regulating microbial processes.

In microbial ecology, the description of microbial communities has reached a point at which compelling questions are being raised about the function and activity of organisms in their respective environments (particularly in soils and ground-water). Further, microbes do not exist isolated in their environment; rather they interact in a complex manner with other organisms such as protozoa, plants, and humans, which opens up completely new areas of research. Thus in this thematic field the emphasis will be on the interactions between micro-organisms and plants as well as microbial ecology.

The disciplines of plant pathology and microbial ecology established in these two areas are in the process of interlinking and starting to address new queries related to biological systems that go beyond their own thematic limits. We will continue to establish interdisciplinary foci on the interactions between micro-organisms and plants in the rhizosphere, and on the activation of plant immunity. In the long term, this thematic field contributes to the prevention of environmental diseases through research into environmental processes that are a prerequisite for a healthy basis to life, for example drinking water, soils, and foodstuffs free of pollutants. ■

One of the research focuses at the GSF is on ecosystems that ensure the sustenance of humans for the future. The ecological consequences of growing energy plants such as rape and maize are investigated at the experimental facility in Scheyern.

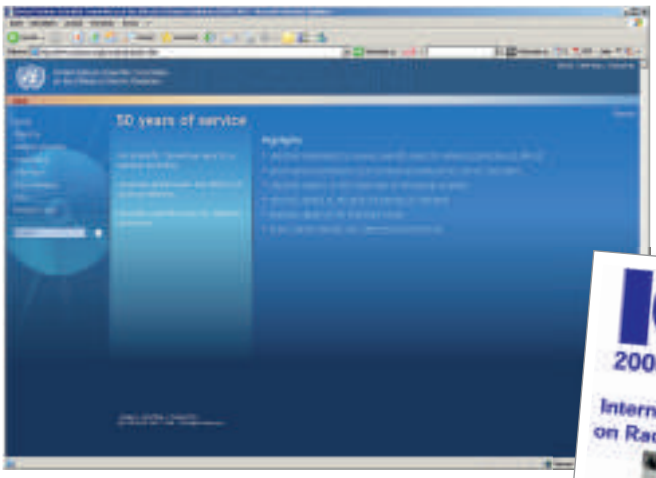
Clean water through research. The GSF Institute for Ground-Water Ecology looks into the reduction and transport of contaminants in ground water and their effects on ecosystems.

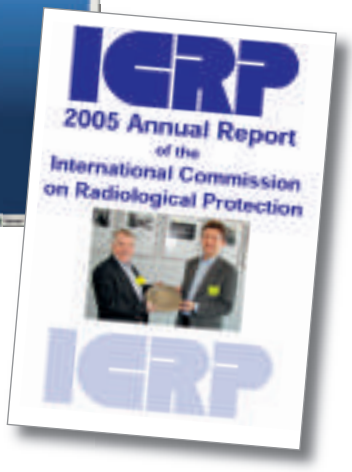
The outdoor lab. Lysimeters are stainless steel cylinders with a porous floor plate that contain soil from the original location. The plants in lysimeters are used to investigate how various environmental factors influence growth or how herbicides are removed from soil.

Supporting Activities

The creation of centres of excellence to promote top research requires interdisciplinary cooperation and a coordinated research strategy. They will further strengthen the existing co-operation with the Munich universities, other Helmholtz centres, and leading international institutions. The international experimental research platforms, such as the German Mouse Clinic, the Genome Analysis Centre and the environmental simulation facilities, and the technology transfer centres are an important tool in building these networks, and for closely linking research and application. Particular value is placed on the training and advancement of the next generation of scientists and on personnel development. We have implemented a number of measures to ensure equality of opportunity. Cooperation with industry will be developed further using new business models. We also aim to further the exploitation of new technologies and application of results in practice, for example by establishing spin-off companies. The work of GSF scientists in national and international advisory commissions also guarantees that new research results are included in the development of new guidelines and legal measures. ■

Translational research up close. This brochure, published in 2006, informs about how the GSF Research Centre for Environment and Health uses its findings in clinical applications and how it incorporates the expertise from the clinic into its biomedical research work.





There are GSF scientists in many committees and commissions, such as the International Commission on Radiation Protection (ICRP) and the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR).