Finnish

Programme for Centres of Excellence in Research

A creative research environment: What does it take?

A creative research environment often evolves around flexible networks of researchers or research teams working in different fields but addressing the same or similar problems. It may also evolve around a single innovative top researcher with good management and organisation skills. A creative research environment is not defined by the size of the research team, but by its intellectual capacity, know-how, and collaboration networks.

Key ingredients of high-level research include adequate intellectual and economic resources, a systematic, long-term approach to work as well as state-of-the-art tools and methods. For a good research environment to reach the international forefront in its field of specialisation, it needs to show at least three things: passion, openness, and the ability to focus on the essential.

Passion is the team's intellectual driving force; it shows in people's commitment, their enthusiasm and dynamism. The ability to focus on the essential is a matter of intellectual audacity, of leaving aside distracting and time-consuming details and focussing every attention on what one believes is the key issue. Openness, then, entails intelligent scientific debate and generous exchange of information both within the research team and with other teams. It also requires the ability to take in criticism and where necessary to alter one's course.

These three characteristics are highly prominent in all teams that have been granted centre of excellence status. Other distinctive features of centres of excellence include a high standard of scientific work, a strong international orientation, a commitment to researcher training, networking, and multidisciplinarity.

Reijo Vihko

President

Academy of Finland

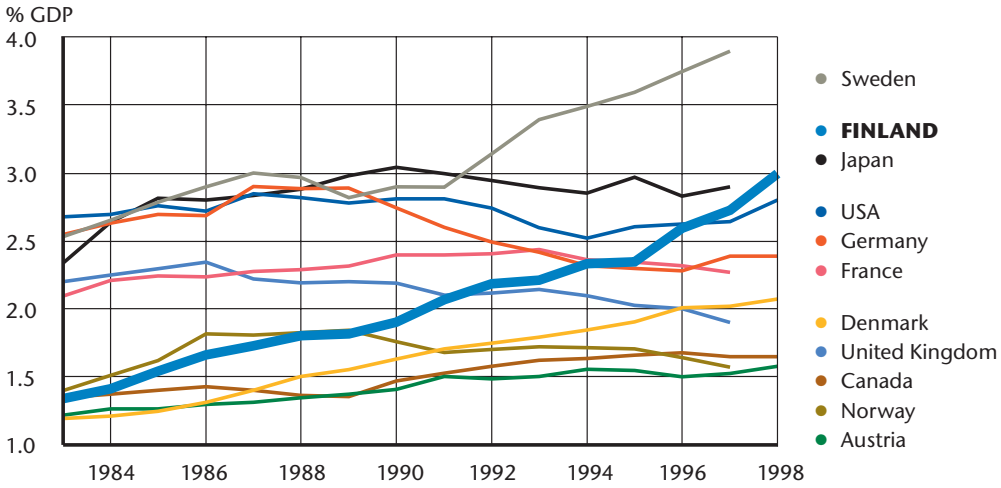
Contents

Finland invests in knowledge and know-how

Finland is working to build its future by investing in knowledge and know-how. The ongoing research work in the country's universities, research institutes, and businesses is generating new knowledge and know-how, which further increase Finland's intellectual and material prosperity.

Finnish investment in R&D has risen steadily throughout the 1990s. Spending on R&D has almost trebled during the past ten years, and in 1998 it was three per cent of GDP. Increased government investment in research combined with the high level of R&D activity in businesses has made Finland one of the world's leading countries in terms of R&D funding.

R&D Input in Some OECD Countries



Source: OECD, Main Science and Technology Indicators1998

Focus on research environments and research careers

The Academy of Finland is an expert organisation on research funding whose main function is to improve the quality and build the reputation of basic research in Finland. The Academy pursues this goal by means of selective research funding allocated on a competitive basis, by systematic evaluation, and by influencing science policy.

In recent years a core focus for the Academy has been the development of a sound basis for high-level research environments and the promotion of professional careers in research.

The key instruments in the development of creative research environments are the centre of excellence programme and research programmes. The aim of the centre of excellence programme is to support the development of strong research units that can reach or even form the international cutting edge in their respective fields of specialisation. As for research programmes, the aim here is to raise the quality of research in the fields in question, to create a sound knowledge base, to promote networking among researchers, and to intensify researcher training.

Finnish Programme for Centres of Excellence in Research

The development of creative research and training environments has been a priority issue in Finnish science policy ever since the 1980s. Plans to further develop a national innovation system in the 1990s incorporated the goal of creating a network of centres of excellence with a high international standard of research and training. The Ministry of Education nominated the first 12 centres of excellence in research for 1995–1999, and a further five units for 1997–1999.

An integral part of national research, education, and technology policy

In 1997 the Academy published a *National Strategy for Centres of Excellence in Research* (Publications of the Academy of Finland 6/97), which outlined a proposal for the content and objectives of a centre of excellence policy, laid down a set of criteria for the selection of centres of excellence, and set out guidelines for the evaluation of these centres.

The strategy states that the general aim of science policy in Finland is to raise the level of objectives and quality in Finnish science and to improve its international competitiveness, visibility, and esteem. The objective of the centre of excellence strategy is to enable the emergence of research and training environments that can generate top international research with social relevance. Also, the goal is to promote interaction between different types of research and a multidisciplinary approach to research. The centre of excellence strategy aims to support all disciplines from the natural sciences to the humanities and social sciences.

The national strategy for centres of excellence forms an integral part of Finland's research, education, and technology policy. Centres of excellence can obtain funding not only from the Academy of Finland, but also from universities, research institutes, the National Technology Agency (Tekes), ministries, business enterprises and foundations.

On the basis of the proposals set out in the strategy document, the Academy decided to launch a six-year National Programme for Centres of Excellence in Research in 2000–2005. The National Technology Agency has been closely involved in the planning and implementation of the programme.

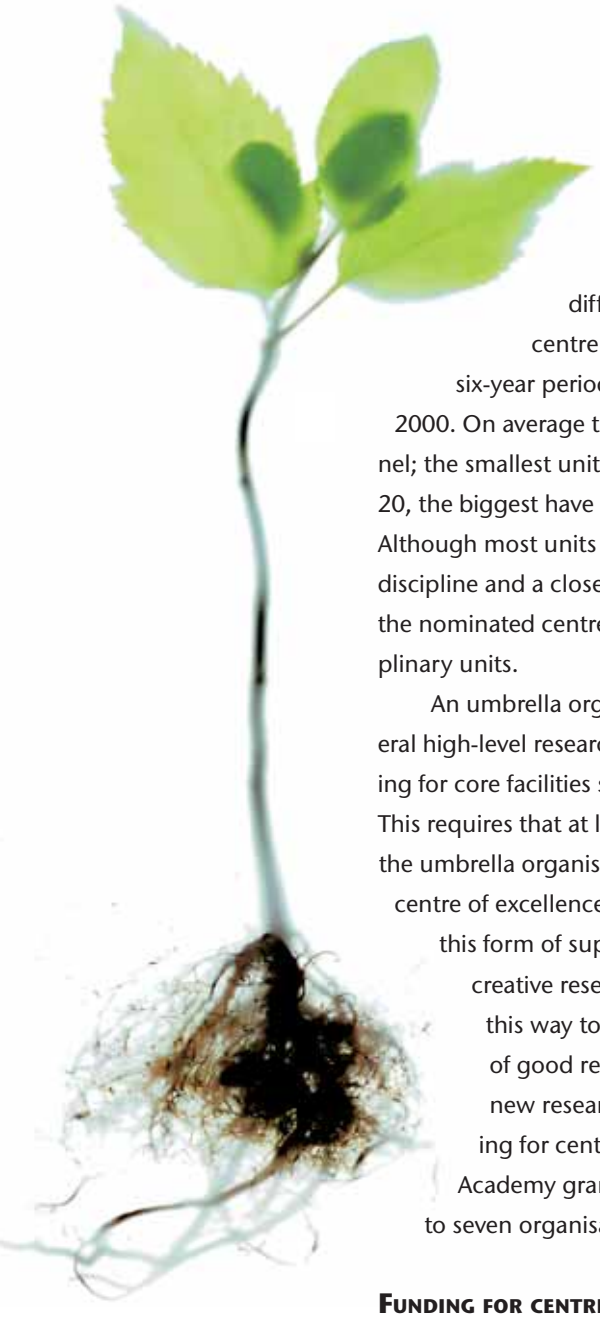
Twenty-six units selected for 2000–2005

A centre of excellence is a research and researcher training unit comprising one or more high-level research teams with shared, clearly defined research goals and good prospects for reaching the international forefront in its field of specialisation. Centres of excellence are selected for a term of six years on a competitive basis, with evaluations provided by international experts.

Evaluation of the centres of excellence is based on models that are appropriate for the field of science in question; units working in different fields are not directly compared to one another. The primary selection and evaluation criteria are the unit's scientific merits, outputs and activity, research and operating plan, research environment, and success in researcher training.

Applications for the centre of excellence programme were invited in two phases. In the first phase 166 research teams submitted their brief plans of intent in English. These were evaluated by a working group consisting of representatives of all Academy Research Councils as well as the National Technology Agency. Detailed applications were invited from 51 units. These applications were evaluated by 53 international experts. The experts visited all units before they submitted their statements.

In December 1998, a total of 26 units from



Cutting edge

different fields were granted centre of excellence status for a six-year period as from the beginning of 2000. On average the units have 50 personnel; the smallest units have a staff of less than 20, the biggest have more than 100 personnel. Although most units are dominated by one discipline and a closely related field of research, the nominated centres also include multidisciplinary units.

An umbrella organisation comprising several high-level research teams can obtain funding for core facilities shared by several teams. This requires that at least one of the teams in the umbrella organisation has been granted centre of excellence status. The purpose of this form of support is to further improve creative research environments and in this way to strengthen the cohesion of good research teams and to attract new researchers and groups competing for centre of excellence status. The Academy granted core facilities funding to seven organisations.

Funding for centre of excellence programme from several sources

In spring 1999 the directors of the centres of excellence, their host organisations, the Academy of Finland, and the National Technology Agency conducted a round of negotiations to agree upon resource allocation for the first three years of the programme. The parties will meet again in three years' time to negotiate on resource allocation for the second three-year period.

A scientific advisory board will be appointed to each centre of excellence to monitor and support its development. At the end of the six-year period each centre will be subjected to an international final evaluation.

During the first three years of the programme the Academy will be spending FIM 126 million (EUR 21 million/USD 22 million) in direct support to the units and FIM 21 million (EUR 3.5 million/USD 3.7 million) in core facilities funding. This sum represents around 6 per cent of the Academy's total annual research funding. In addition, centres of excellence may apply for Academy research posts and researcher training grants and take part in research programmes. The centres will not, however, be eligible for Academy appropriations made available through research project funding.

The National Technology Agency is supporting 11 units in the centre of excellence programme with funding that during the first three years is worth FIM 31 million (EUR 5.3 million/USD 5.5 million). In addition, funding through one business enterprise and one non-governmental organisation amounts to close on FIM one million (EUR 168,000/USD 175,000).

During the first three years centres of excellence will thus be getting around FIM 178 million (EUR 30 million/USD 31 million) in support from the Academy of Finland and the National Technology Agency. In addition, they will be receiving significant support from their host organisations, i.e. universities and research institutes.

Continued commitment to developing the centre of excellence programme

Finland's centre of excellence policy has the full backing of the government and the programme is set to continue in the future. It is crucially important that this policy is followed consistently and with foresight. As well as securing long-term and stable funding, another major challenge is to generate a healthy dynamics and turnover. The Academy will be closely monitoring the work of all centres of excellence so that it can continue to develop and improve its centre of excellence policy.

Centres of Excellence in Research in 2000–2005

Ancient and Medieval Greek Documents, Archives and Libraries

University of Helsinki
Director: Professor Jaakko Frösén

The Unit consists of three projects:

1. Publication of Greek Papyri (PGP)

The purpose of the project is to save, conserve, publish as well as to interpret new texts from ancient manuscripts. The focus is on texts that have been considered too difficult and time-consuming and that therefore have not received the attention they deserve. The difficulties have had to do with the state of preservation (the recycled waste papyri of mummy cartonnages and carbonised papyri) or with the contents of the texts. Conservation methods and methodological issues are essential in bringing this kind of material to scholarly attention.

2. The Finnish Jabal Harun Project (FJHP)

The focus of interest in this project is Mt. Aaron in Petra, Jordan. According to Jewish, Christian and Muslim traditions, Mt. Aaron is the burial place of the Prophet Aaron, Moses' brother. Most of the information comes from the Byzantine period, and the texts mention a monastery and a church on the mountain. The origins of the project can be found in the involvement of Finnish experts in the analysis of 6th-century carbonised Petra Papyri. One of them, with the earliest preserved date in the archive (15 June, 513), also mentions "the House of our Lord the Saint High-Priest Aaron" outside the city of Petra. While it is not possible to determine the exact date when the Christians abandoned the mountain, this must have happened no later than the mid-14th century when the Muslim shrine was constructed. Primarily, however, the Finnish Jabal Harun Project is interested in the extensive ruins of an architectural complex (ca. 3,000 m^2) located some 70 metres below the site on a wide plateau. The project is designed to uncover, preserve and publish archaeological remains located on the mountain. The project aims at a full understanding of the ruins of the monastic complex, the topography of the mountain, the history of human settlement on the mountain and in its immediate surroundings as well as the relations to the city of Petra.

3. The Patriarchal Library of Alexandria (GOPAL)

The Library of the Greek Orthodox Patriarchate of Alexandria is the remnant left of the Church Library, which originated with the foundation of the Church of Alexandria by Saint Mark. The ancient Church Library was famous for its collection of ancient manuscripts. The oldest identified remnant manuscripts bear the date of 952. The Library contains some 530 ancient Greek manuscripts, around 2,000 rare editions and more than 20,000 other editions. The Patriarchal Archives have been kept in the Library along with other unpublished unique sources of the history of the Church in Egypt. These immense treasures are housed in the buildings of the Patriarchate of Alexandria and All Africa in Alexandria. The manuscripts and rare editions need immediate attention and conservation. The most urgent measures for the repair and renovation of the buildings have been started already. They will be followed by a refurbishment of the interior and the installation of air-conditioning and a computer system.

One of the research projects under the leadership of Professor Jaakko Frösén is devoted to conserving and publishing carbonised papyri. Manna Vesterinen (seated) is working on the carbonised fragments of a papyrus scroll from Bubastis, Egypt. Once the layers are separated, the Greek text will show up against the matt surface of the carbonised scroll. Looking on are Professor Maarit Kaimio (right), Mari Mustonen and Erja Salmenkivi.

Cell Surface Receptors in Inflammation and Malignancies

BioCity Turku

Director: Academy Professor Sirpa Jalkanen

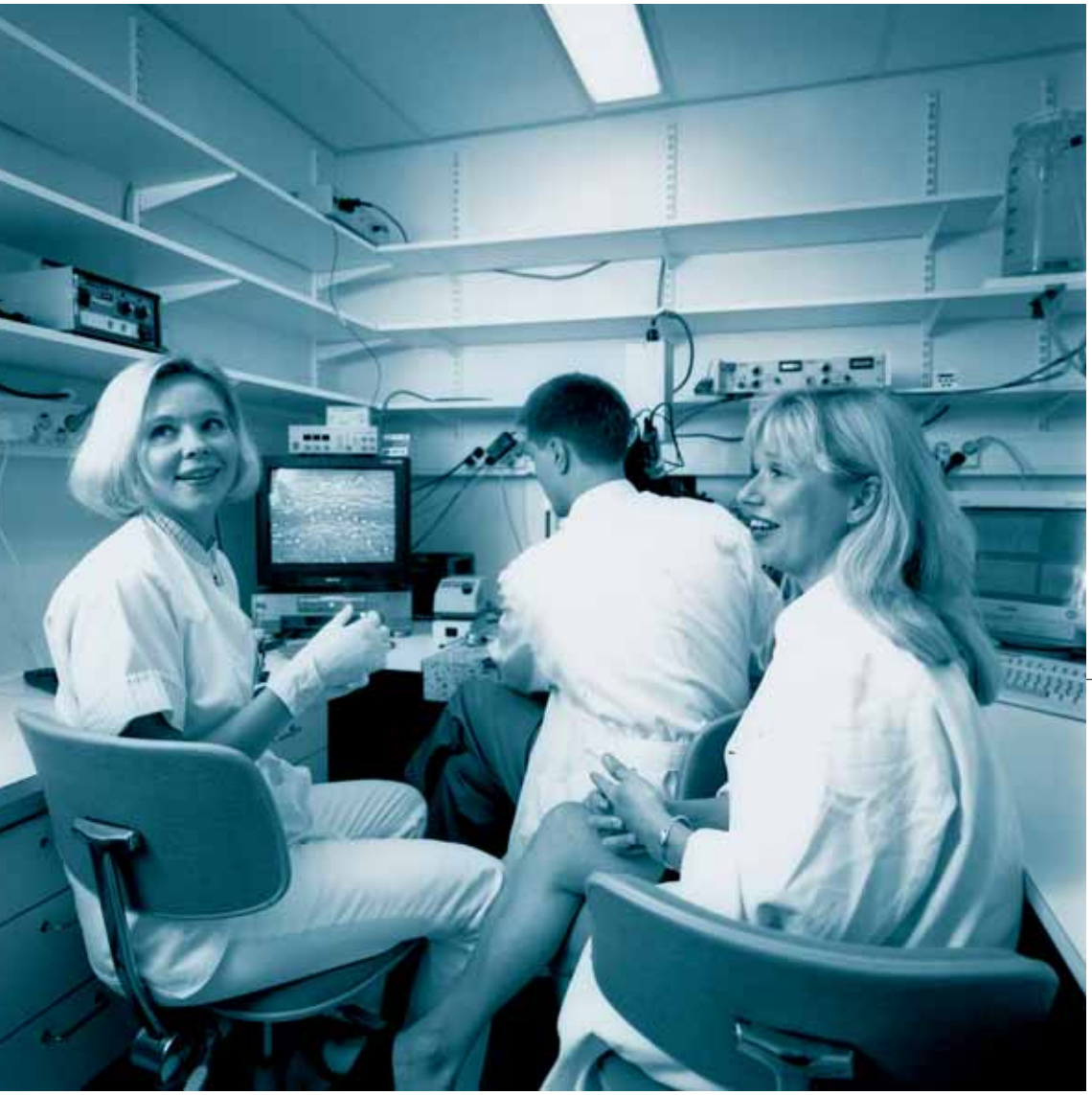
Academy Professor Sirpa Jalkanen and her group are based in the MediCity Research Laboratory at the University of Turku and the Turku Branch of the National Public Health Institute. Her research belongs to the field of immunology and deals with the mechanisms that regulate the migration of white blood cells (leukocytes) in the human body.

The harmful migration of leukocytes into the heart in myocardial infarction and into the joints in rheumatoid arthri-

tis are examples of diseases in which leukocytes cause irreversible damage. Organ destruction can be prevented by blocking the harmful movement of leukocytes into the affected tissues. In analogy, malignant cells need to migrate to distant sites of the body to form metastases, and they seem to use similar or comparable mechanisms as leukocytes do to travel into different tissues. Jalkanen's research group has identified and characterised a novel molecule responsible for leukocyte migration into the sites of inflammation. It has also thrown light on the mechanisms that cancer cells use for metastasising.

These results can be used in the development of new types of drugs for the treatment of harmful inflammations and cancer.

The Unit has 20 researchers, of whom eight have a doctorate, and eight assisting staff.



Researchers at BioCity Turku make use of special microscopy to study the real-time migration of cells in the vascular system. Riikka Lehvonen (left), Heikki Irjala, and Academy Professor Sirpa Jalkanen monitor the migration of cells using a microscope connected to a computer-aided video camera system.

Center for Activity Theory and Developmental Work Research

University of Helsinki
Director: Academy Professor Yrjö Engeström

The Center investigates changes in work, organisations and technology. A focal concern is with the question of whether people can learn from changes and master them instead of being downtrodden by the changes. The expansive learning theory that is the framework for the investigation seeks to explain how human communities can expand their potential and learn something that does not yet exist, i.e. how to function in a new way.

The Center consists of five groups, which are concerned with
– new forms of work organisation and learning processes triggered by changes (Academy Professor Yrjö Engeström)
– welfare related to work, i.e. work ability in the midst of changes (Docent Kirsti Launis)
– technological innovations and organisation of research, i.e. what makes a breakthrough in research and product development (Professor Reijo Miettinen)
– new forms of cooperation between vocational education and working life (Professor Terttu Tuomi-Gröhn)
– new intervention methods for the management of change and learning (Docent Jaakko Virkkunen).

The Center has a personnel of around 50.

Centre of Excellence in Disease Genetics

University of Helsinki, National Public Health Institute and Folkhälsan
Director: Professor Leena Peltonen-Palotie

The members of the Unit take advantage of the specific features of the Finnish population: isolation, the small original population and the excellent health care system.

When the genome project is completed, research in disease genetics faces new methodological and strategic challenges: how to understand the cellular and tissue consequences of disease mutation, how to cure them with gene therapy, and how do genomes and environment or lifestyle predispose to common public health problems in Finland?

In particular, the research carried out at the Centre aims at understanding the function of the disease genomes damaging the central nervous system and at identifying the genetic component in common Finnish diseases such as multiple sclerosis, colon cancer and asthma.

Directors of the research teams:
Docent Lauri Aaltonen (team of 11)
Docent Anu Jalanko (team of 13)
Professor Juha Kere (team of 17)
Docent Anna-Elina Lehesjoki (team of 15)
Professor Leena Peltonen (team of 30).

Director of the Evolutionary Ecology Centre of Excellence, Academy Professor Rauno Alatalo (left) and Professor Veijo Kaitala are looking for spiders in their experiments to assess the impacts of mate choice on offspring viability.

Computational Condensed-matter and Complex Materials Research Unit (COMP)

Helsinki University of Technology
Director: Academy Professor Risto Nieminen

Working in the field of computational and theoretical condensed-matter and materials physics, COMP focuses in its research on the physical and chemical properties of materials and related phenomena, using extensive mathematical modelling and large-scale computer simulation. The main topics of interest are the electrical, optical and mechanical properties of different types of materials. Other major research themes include multi-scale modelling, spanning length and time scales from microscopic (atomic) properties to mesoscopic and macroscopic phenomena. Another important line of research is represented by the unusual properties of large complex and non-linear systems, which are tackled by both theoretical methods and computer simulation.

Examples of recent research problems include novel semiconductor materials and devices, quantum dots and wires, magnetic materials, polymers and fibrous structures, materials processing and surface reactions.

The Unit's research areas are:
– Electronic properties of materials (Professor Martti Puska)
– Statistical physics and complex phenomena (Professor Tapio Ala-Nissilä)
– Disordered systems (Docent Mikko Alava)

The Unit hosts three professors, three docents, nine post-doctoral researchers, 21 post-graduate students and 14 M.Sc. students (in total 50 personnel).

Evolutionary Ecology

University of Jyväskylä
Director: Academy Professor Rauno Alatalo

The Unit's research is strongly based on the evolutionary approach to the study of ecological processes: natural selection and adaptation to the environment provide the tools with which we seek to understand animal and plant life. The Unit's research can be grouped into four main topics: signal evolution, evolution of reproductive strategies, population ecology and soil food webs. Research on aposematic and sexual signals involves scientifically challenging and innovative research on key questions of evolutionary theory. Reproduction is the key component of fitness, and the Unit is particularly interested in mating success and reproductive effort. There is also a close link to the more applied studies of the significance of genetic diversity and local adaptation to individual fitness and population viability. The Unit's population studies combine the analysis of spatial and temporal patterns with experimental and theoretical work. Experiments on food chain dynamics, on factors affecting biodiversity and on mutualistic processes characterise the Unit's ecosystem studies.

The Unit has eleven senior researchers, nine post-doctoral researchers and 19 post-graduate students.

Helsinki Bioenergetics Group

University of Helsinki
Director: Academy Professor Mårten Wikström

The Helsinki Bioenergetics Group is an interdisciplinary team of researchers whose main concern is with biological membrane proteins, particularly those that move ions through membranes. These proteins include the cell respiration enzyme, which catalyses the release of energy from foodstuffs in a "combustion" process using oxygen and which stores that energy for use by the cell by generating a proton gradient. Virtually all the oxygen we breathe is consumed in this process. The aim of the research is to unravel the three-dimensional structure of membrane proteins at atomic resolution and their function at microsecond resolution. The analysis of function involves the use of sophisticated biophysical methods. The links between structure and function in the membrane protein are also studied by means of targeted mutagenesis, which applies genetic methods to transform parts of the protein structure in bacteria and then looks at the functional effects of these changes.

The Group has a staff of 20, including two professors, five senior researchers, two post-doctoral researchers, five post-graduate students, two undergraduate students and four administrative and technical staff.

Institute of Hydraulics and Automation (IHA)

Tampere University of Technology
Director: Professor Matti Vilenius

The Unit's research focuses on fluid power and automation. The aim is to combine these two elements so that they complement each other in machines and equipment. Fluid power is used for power transmission, while automation technology is used for controlling the system. The main areas of research are water hydraulics and mobile hydraulics.

Water is used in water hydraulics as a pressure medium, which enables the design of a clean, environmentally friendly and hygienic system that is protected against fire and explosion. Modern water hydraulics is a new area of research within mechanical engineering and the Unit is one of the world's leading research institutes in this area. The main focus of the Unit's research is on systems and components, the effect of the pressure medium and water-hydraulic motion control.

Mobile hydraulics concentrates on the hydraulics of mobile machines such as forest machinery, tractors, excavators, drilling machines, etc. The aim is to improve the efficiency of fluid power systems and to develop new methods for design and control.

The Unit has a staff of five professors, four laboratory technicians, one laboratory engineer, one secretary and some 50 researchers and research assistants (in total some 60 persons).

Researchers at the Institute of Hydraulics and Automation are working to develop higher efficiency mobile hydraulics applications: Matti Linjama (left), Kalevi Huhtala (in the background), Janne Uusi-Heikkilä, Mika Ijäs, Professor Matti Vilenius, Markku Kämäräinen, and Markku Luoma-ranta.

Low Temperature Laboratory

Helsinki University of Technology
Director: Professor Mikko Paalanen

The main lines of research pursued at the Low Temperature Laboratory include ultra-low temperature physics, neuromagnetic brain research, nanophysics and cryoengineering.

The Low Temperature Laboratory is famous for its world records in low temperature. The major research topics in low temperature physics include superfluid 3He, quantum crystals and nuclear ordering in metals.

In brain research the Laboratory is a pioneer in the magnetoenchephalographic (MEG) method. It has developed a multichannel magnetometer that covers the whole head and that is used to locate brain functions on the cortex with high temporal and spatial resolution. MEG is used to study the functions of both healthy and diseased human brains during various tasks.

In nanophysics, small metallic components, smaller than one thousandth of the diameter of human hair, are manufactured and studied at low temperatures, where their properties are dominated by quantum phenomena. Practical applications of these devices are also under investigation.

The Laboratory has a personnel of around 90, who work in eleven research groups. The personnel includes 14 senior scientists (including five professors and six docents), ten post-doctoral students, 25 post-graduate students, 10–15 students and 14 people in administrative and service jobs. The number of foreign visitors varies between 10 and 15 scientists.

More than 30 researchers are working at the Low Temperature Laboratory's Brain Research Unit to characterise human brain functions by recording weak magnetic signals from the human cerebral cortex. The information is used to assess both the location and temporal behaviour of brain functions.

Molecular Biology and Pathology of Collagens and Enzymes of Collagen Biosynthesis

University of Oulu
Director: Academy Professor Kari Kivirikko

Collagens are a family of extracellular matrix proteins whose members have various important functions. The Collagen Research Unit at the University of Oulu is interested in many questions related to the structure, synthesis and functions of collagens and their alterations in diseases. The aim is to produce new information on the structure and function of specific enzymes of collagen synthesis, on the functions and significance of three new types of collagen discovered by the Unit and on the distinctive characteristics of cartilage collagens. The results will help to shed light on the mechanisms involved in the emergence of certain muscle diseases, degenerative arthritis and back illnesses. They may also pave the way to the development of drugs that can prevent excessive collagen accumulation as well as to "collagen therapy" for the treatment of rheumatoid arthritis.

Simo Vanni is working on the secrets of visual processing in the human cerebral cortex, while Yung-yang Lin, Marjatta Pohja, Katri Kiviniemi, Hanna Koivikko, Topi Tanskanen, Linda Stenbacka, and Academy Professor Riitta Hari discuss the results of their previous analysis.

The Unit is also continuing work to develop a method for the recombinant production of human collagens in yeasts. These kinds of collagens have numerous applications in medicine and considerable commercial potential.

The Unit consists of three groups. Its staff includes 10–15 post-doctoral researchers, some 30 post-graduate students and ten laboratory technicians.

New Information Processing Principles

Helsinki University of Technology
Director: Professor Erkki Oja

The Neural Networks Research Centre and the Laboratory of Computer and Information Science have long scientific traditions dating back to the 1960s. The main research topic for the last 20 years has been the study of neural computing, especially methods for unsupervised learning and their applications. The best-known innovation is the Self-Organizing Map (SOM), developed by Professor Teuvo Kohonen.

Theoretical work on SOM will be continued. Special attention will be given to applications of SOM in data exploration and statistical data mining from large collections of text documents, images, financial data, industrial measurements and telecommunications data.

Independent Component Analysis has recently been under intensive research. Its algorithmic development will be continued. In the near fu-

networking

ture key applications will include the analysis of brain signals through MEG, finding hidden factors in financial data, separating telecommunication signals and finding new methods for signal preprocessing.

The Unit has a personnel of 50: four professors, eight scientists with doctorate, 16 doctoral students and 22 other staff (research assistants and administrative staff). The number of foreigners is eight.

Nuclear and Condensed Matter Physics Programme at JYFL

University of Jyväskylä
Director: Professor Matti Manninen

The Department of Physics research programme comprises basic research in nuclear and accelerator-based physics and materials physics, as well as the development of applications in these areas.

The basic research in nuclear physics concentrates on the study of the structure, decay properties and production of exotic nuclei, and on nuclear theory. Applications of accelerator-based physics include several lines of apparatus development, the use of energetic ion beams for working materials and studying various defects, and medical applications. Nuclear and accelerator-based physics is studied at the JYFL Accelerator Laboratory, which was elected a European Union Large Scale Facility within the new EU programme “Improving the Human Research Potential”. An additional programme on nuclear and materials physics is carried out at the ISOLDE

facility at CERN.

Studies in materials science include the physical properties and fabrication of micro- and nanostructures, as well as the physics of disordered materials and nonlinear systems. Nanotechnology applications include a nanothermometer, and a microcooler and ultrasensitive radiation detectors applicable to space research. In the study of disordered materials and nonlinear systems, notable results have been obtained on mechanisms of fracture and on flows in porous materials, with main applications in paper machine technology.

The number of personnel is 110: 25 professors and senior scientists, 15 post-doctoral researchers, 43 post-graduate students and 27 administrative and technical staff. The number of foreigners is 17.

Plant Molecular Biology and Forest Biotechnology Research Unit

University of Helsinki
Director: Academy Professor Tapio Palva

The growth of plants, their distribution, productivity and product quality are all directly dependent on the growth environment and on the stress factors occurring within that environment (e.g. frost, drought, pollution). Basing their work on the models of *Arabidopsis thaliana* and birch, researchers at the Unit are aiming to find out how plants adapt to stress situations caused by the environment, how they identify internal and external stimuli, how they convey this information to the nucleus and activate the response genes and how these genes produce the relevant physiological response to increase the plant's tolerance of stress. Research focuses on exploring signal routes and their interaction as well as on trying to gain a deeper understanding of how response genes function in the plant's defensive responses against disease-causing microorganisms. This is important to ongoing work aimed at breeding transgenic plants that are more resistant, that grow faster and that produce better quality wood.

The Unit consists of eight groups. In addition to the group leaders who are professors or docents, there are eight post-doctoral researchers, 25 post-graduate students and five assisting researchers.

Program in Cancer Biology: Growth Control and Angiogenesis

University of Helsinki
Director: Academy Professor Kari Alitalo

The Research Programme under the leadership of Academy Professor Kari Alitalo brings together four research groups from the Haartman Institute and the Biocentrum of the University of Helsinki. Through the research groups' joint efforts and common goals, the aim is to concentrate on the key interactive aspects of molecular and cellular cancer biology: on the regulation of cell growth through the cell cycle checkpoints and their deregulation by genetic insults, the invasion of the extracellular matrix and tumour angiogenesis. The groups are already collaborating in several joint experiments and considerable synergism is expected to develop during the Research Programme as all groups focus on cellular signal transduction. During this Programme, new research technologies will be introduced, which will benefit not only the participating laboratories but also other scientists in the Finnish biomedical community. In particular, mouse molecular ge-

passion

netics, gene array methodologies as well as protein interaction studies will be extensively employed to address the problems described below.

The research team consists of four research groups working in close proximity to one another at the Meilahti biomedical campus, currently at the Haartman Institute and from the year 2001 as a part of the Molecular Cancer Biology Research Programme at Biomedicum Helsinki. The team's expertise covers a wide spectrum of modern molecular biology techniques from yeast genetics through biochemistry to in vivo animal models.

Academy Professor Kari Alitalo: The main aim is to understand the mechanisms involved in the development of blood vessels from pre-existing ones in a process called angiogenesis and to learn about the analogous mechanisms of lymphangiogenesis. We are currently investigating angiogenesis and lymphatic vessels particularly in malignant tumours, focusing on growth factor-receptor signalling and growth factor-mediated endothelial cell reprogramming. We have discovered mechanisms involved in the regulation of angiogenesis and a number of new vascular endothelial growth factors (VEGFs) and their receptors, as well as the end-othelial Tie receptor tyrosine kinase.

Professor Jorma Keski-Oja: The main focus of research is on the structure-function relationships of TGF-ß binding proteins (LTBPs) and the activation processes of the latent TGF-ß. Another major focus is the regulation of gelatinase A activity at the cell surface, and the interactions of the plasminogen activator-plasmin system with the MT1-MMP-mediated targeting and activation of the gelatinase.

Docent Marikki Laiho: The main research interests are growth factor actions and interactions in the cell cycle. The current focus is on the steps leading to p53 transcriptional activation and its target genes in biological models, especially its function as a DNA damage response protein.

Professor Tomi Mäkelä: The main concern is with cell cycle regulation and specifically with the characterisation of the CDK-activating kinase CAK leading to the identification and cloning of cyclin H as the partner of CDK7, as well as to the identification of CAK as part of the basal transcription

factor TFIIH. This observation has been extended to the study of the functional role of the CDK7 kinase in the TFIIH regulating transcription and DNA repair. Recent studies include the use of budding and fission yeast model systems to study the CDK7 homologues by genetic means.

The individual research teams have well-defined research programmes and they have considerable expertise in their respective research areas as detailed above. The strength of the Programme lies in the overlapping research interests and in the joining of the projects under a common theme, which covers the most important aspects in cancer biology. This gives the individual teams access to the most recent knowledge and technologies and creates considerable synergism. The function of the individual teams is to maintain and enhance the quality of their research and to develop it in directions that will benefit everyone most.

The number of personnel is over 60.

Programme of Molecular Neurobiology

University of Helsinki
Director: Professor Heikki Rauvala

The research programme deals with the formation of neural connections during development and their modulation in an adult (plasticity). Formation of neuronal connections during development underlies the functional neural networks of the adult. On the other hand, plastic changes in the adult involve similar mechanisms as the cell interactions that control development, and they form the basis for many important nervous system functions, such as memory and learning. The mechanisms that control development and plasticity also play an important role in many nervous system diseases, such as Alzheimer's disease, characterised by disorders of cell-to-cell communication.

The Unit has a staff of 61: four professors, ten senior researchers, eight post-doctoral researchers, 31 academic researchers and eight technical staff.

Programme on Structural Virology

University of Helsinki
Director: Professor Dennis Bamford

Viruses are obligate cellular parasites which use the cellular machinery for their multiplication. Outside the cell, the virus particles are not capable of reproduction. Cells infected by viruses die or their viability is compromised. For this reason viruses cause severe diseases.

The programme focuses on how viruses are assembled, on exploring the detailed structure of component proteins and even large assemblages and how these work. The aim is to obtain new and more accurate information on the rules of how biological macromolecule complexes are assembled and use this information to combat viral infections.

In addition to the principal investigator (a professor), the Unit has a staff of five senior scientists, three post-doctoral fellows, six graduate students, three undergraduate students and three technical personnel. The programme has close links to eminent internationally recognised research groups.

Research Centre for Computational Science and Engineering

Helsinki University of Technology
Director: Academy Professor Kimmo Kaski

The Unit focuses on problems of computational science and engineering, including the modelling, analysis and visualisation of complex physical, engineering and cognitive processes and systems. In addition, computational algorithms, graphical visualisation and animation, and parallel computing methods are developed for various information technology applications. The research is conducted in three mutually supportive fields:
–Computational materials research (Professor Jukka Tulkki) focuses on the structural, electronic and optical properties of materials and micro- and nano-electronic components. Recent research topics include the fracture and growth properties of metals, semiconductors and complex materials like smart fluids and fibre composites; electronic and optical properties in novel semiconductor structures, e.g. quantum dots and wires; and electronic, photonic and microelectromechanical components.
–Research in computational information technology (Professor Jouko Lampinen) concentrates on modelling and analysing complex physical, technical and economic processes, as well as systems involving vast amounts of data. The studies employ advanced probabilistic and information theoretic methods and soft computing, for instance artificial neural networks. These methods are developed and applied for problems of pattern recognition, machine vision, data mining and intelligent human-machine interface.
–Research in cognitive science and technology (Professor Mikko Sams) focuses on studies of neurocognitive mechanisms in human communication. The results are utilised in information technology applications, for instance in developing user interfaces that allow for natural human interaction. An example is a system ("talking head") that can produce and recognise audiovisual speech. Knowledge of human communication mechanisms can be applied in developing advanced aids for disabled people, for example.

The Unit has a staff of 50: five professors, seven adjunct professors, nine post-doctoral researchers, 20 Ph.D. students, eight M.Sc. students, and one secretary.

Research Unit for Forest Ecology and Management

University of Joensuu
Director: Professor Seppo Kellomäki

The Unit's aim is to promote ecological research in northern forests and the principles of sustainable forestry.

The Unit consists of four research groups:
– Dynamics and modelling of the functioning and structure of forest ecosystem with implications for the sustainability of forest production and climate change impacts (Professor Seppo Kellomäki)
– Biodiversity of forest ecosystems: patterns, processes and ecosystem functioning (Professor Jari Kouki)
– Atmospheric impacts on tree-herbivore relationships and ecosystem processes (Professor Pekka Niemelä)
– Herbivory in relation to variable defences of northern woody plants (Professor Jorma Tahvanainen)

The Unit consists of some 25 senior researchers, 15 post-doctoral researchers and 50 post-graduate students.

Research Unit for Variation and Change in English

University of Helsinki
Director: Professor Matti Rissanen

The Unit is divided into five teams concentrating on the following areas of research: (1) Processes of linguistic change, (2) Historical sociolinguistics, (3) Dialectology and regional variation, (4) Text conventions and genre evolution, and (5) Pragmatic variability.

The work of the Unit advances on both methodological and theoretical fronts. While its individual research teams aim at producing new syntheses in their given fields, the overall objective of the Unit is to promote a comprehensive model of language variation and change based on these syntheses at a level of abstraction that can also benefit the study of languages other than English.

Between the years 2000 and 2005, the Unit will concentrate on the following three goals:

1. To maintain and further develop its position as an international research and information centre for English corpus studies, with particular focus on historical and regional corpora.

2. To produce syntheses of the special methodological and theoretical issues in the five areas of research mentioned above. These syntheses will contribute to the understanding of the influence of various language-internal and language-external factors affecting the development and present-day variation of the English language.

3. To outline a general model of an integrated variation-based analysis of language.

The most widely-known material and methodological tool produced by the unit so far is the Helsinki Corpus of English Texts, a large, structured database of continuous English texts with a time-span of a millennium, which is now being used in hundreds of universities and research centres all over the world. In the 1990s, comprehensive electronic corpora were produced by the research teams on "Sociolinguistics and language history", "Older Scots" and "Scientific thought-styles". These projects have created the Corpus of Older Scots, which is the only historical corpus of Scottish English in the world now completed, and the Corpus of Early English Correspondence, which is the most extensive historical letter corpus in English.

The personnel consists of twelve senior scholars, ten collaborating scholars from other universities and 27 postgraduate students.

Research Unit on the Formation of Early Jewish and Christian Ideology

University of Helsinki and Åbo Akademi University

Director: Professor Heikki Räisänen

The Unit is divided into seven research teams. A central research interest is the beginning of Christianity as a Jewish movement and the gradual parting of ways of the two religions. Special attention is paid to the significance of social situations and legitimation strategies. One goal is a comprehensive overall account of early Christian ideology.This project is supported by specialised research in selected areas which have been insufficiently explored by international scholars. The boundaries of the biblical canon are programmatically ignored.

quality

Jewish ideology is studied both as a matrix for emerging Christianity and in its own right. The roots of Judaism and Christianity are (to a considerable extent) traced back to the religion in the ancient Israel, which is also studied in its own right in its Near-Eastern context. The use of texts that have recently become accessible plays a crucial part: the Dead Sea Scrolls, the Coptic texts from Nag Hammadi and the state archives of Assyria.

A number of different methodological approaches are being used. Classical historical-critical methods are complemented with fresh social-scientific and literary approaches; critical syntheses of the old and the new are being sought. Ideological criticism, coupled with reception history, pervades many studies.

The Unit deals with sources and convictions that form the root of Western culture. Its work should clarify our identity as Europeans; its results have a bearing on debates concerning social structures, values and symbol systems in our society. In a more or less secularised world it is helpful to have access to an analysis of Christian origins that is not limited to an inner-Christian perspective, but takes a more detached comparative approach to religion.

The Unit has 18 senior researchers (including eight professors), eleven junior researchers and 21 doctoral students, total number of personnel 50 (of which 37 at the University of Helsinki and 13 at Åbo Akademi University).

Signal Processing Algorithm Group, SPAG

Tampere University of Technology
Director: Professor Jaakko Astola

The Group is internationally recognised for its research work on nonlinear and linear signal and image processing. Research within SPAG currently covers various areas of digital signal processing (DSP), which can be divided into the following fields:
1) Compression techniques, with an emphasis on speech and audio signal (Professor Ioan Tabus)
2) Image and video signal analysis and processing (Professor Moncef Gabbouj)
3) Digital linear filtering and filter banks (Professor Tapio Saramäki)
4) Spectral and algebraic methods in DSP (Professor Karen Egiazarian)
5) Biomedical signal processing (Dr. Alpo Värri)

These fields interact in a number of ways. Spectral techniques can for instance be used in compression and biomedical signal processing. Moreover, these fields share common applications, such as telecommunications, multimedia communication, image and video processing and analysis and biomedical signal processing. Practical applications include more powerful transfer mechanisms of data over digital networks; good quality digital radio and enhanced television pictures; speech controlled terminals (e.g. mobile phones which understand spoken language); data retrieval from large databases; and automatic analysis of brain research on fundamental signal processing problems in these fields.

SPAG members cooperate with visiting professors and international experts hosted by Tampere International Center for Signal Processing (TICSP). The personnel of SPAG comprises four professors and some 80 researchers from 15 countries.

Technical Research Centre of Finland, Industrial Biotechnology

Technical Research Centre of Finland
Director: Research Professor Hans Söderlund

This research programme aims to generate means for the utilisation of renewable natural resources, to increase their value and to develop environmentally friendly industrial processes. The Unit will specifically focus on the enzymatic bioconversion of carbohydrates and lignocellulose into valuable products in vivo and in vitro.

In order to reach this aim, the Unit will be using and developing some of the most powerful tools in modern biotechnology. These include mutagenesis and gene shuffling linked to protein display and high-throughput screening; metabolic pathway engineering and physiological engineering linked to selection and to the transcriptional and translational profiling; and the integration of these molecular level approaches to biochemical engineering to ensure the applicability of the results.

The Unit's research teams and their primary interests are as follows:

– Protein production (Dr. Sirkka Keränen): integrated design for improved production of secreted proteins by eukaryotic microbes, yeasts and filamentous fungi.
– Molecular recognition (Dr. Kristiina Takkinen): the improvement and utilisation of highly specific interactions between proteins and ligands.
– Enzyme technology (Research Professor Liisa Viikari): the development of oxidative enzymes and enzyme-based processes to promote cleaner production technologies and to improve the utilisation of renewable raw materials.
– Metabolic pathway engineering (Research Professor Merja Penttilä): the engineering of metabolic routes in microbes to achieve efficient production hosts for the conversion of low-value resources into useful compounds.

The Unit has a personnel of around 30.

The Human Development and Its Risk Factors Programme

University of Jyväskylä
Director: Academy Professor Lea Pulkkinen

The Human Development and Its Risk Factors Programme comprises three cores.

(I) Socio-emotional Development and Its Risk Factors. This core includes (1) a longitudinal study from childhood to middle age, focusing currently on facing middle age with an emphasis on family, work and health; (2) analysis of the cognitive, emotional and behavioural processes underlying the regulation of emotions and (3) a study of the effects of risk factors involved in children's daily activities, such as playing electronic games.

(II) Cognitive Development and Its Risk Factors. The study focuses on (1) an intensive prospective follow-up from birth to reading age of children from families with a dyslexic parent (and controls); (2) the development of methods for assessing development risks and identifying means to prevent nonoptimal development and (3) basic research into learning disorders, especially dyslexia. The main aim is to identify the precursors and causal paths leading to dyslexia and to create a basis for sustained progress in the early identification of children showing nonoptimal cognitive development, and in the methods of prevention and intervention.

(III) The Longitudinal

researcher training

Study of Health and Behaviour in Twin Children, which is a large-scale longitudinal study carried out on international funding. It assesses the genetic, social and environmental factors predicting children's social development, health and health habits.

The Unit has a personnel of around 40.

The Metapopulation Research Group

University of Helsinki
Director: Academy Professor Ilkka Hanski

The Metapopulation Research Group at the Department of Ecology and Systematics, University of Helsinki, has established an internationally solid reputation as the leading research group in metapopulation ecology. The director, Professor Ilkka Hanski, is well known for his wide-ranging contributions to the biology of spatially structured populations and his successful combination of modelling with empirical research.

The two most visible achievements of the Metapopulation Research Group are the development of an effective modelling approach to metapopulation dynamics (the incidence function model and related models) and a large-scale empirical research project on a species of butterfly, the Glanville fritillary (*Melitaea cinxia*). The latter started as an ecological project but has now expanded to cover metapopulation genetics and evolution as well. This field project allows the researchers effectively to test many model predictions and it therefore functions as an important interface between theory and empirical research.

The strategic goals of the Metapopulation Research Group are to strengthen its position as the leading research group in metapopulation biology worldwide; to integrate genetic and evolutionary studies into the existing strong ecological framework; to promote a well-integrated population-biological approach to metapopulation biology in general; to build up on its current strength in combining modelling with empirical studies and to facilitate the application of metapopulation biology in landscape-level environmental planning and management and the conservation of populations.

The Research Group comprises eight researchers (senior and post-doctoral researchers), twelve post-graduate students, and five assisting persons.

Tissue Engineering and Medical, Dental and Veterinary Biomaterial Research Group

Tampere University of Technology, University of Helsinki and Helsinki University of Technology
Director: Academy Professor Pertti Törmälä

The Unit is concerned in its research work with the interaction between synthetic biomaterials, surgical implants made of these materials and living tissue. Each year tens of millions of surgical implants are used in Western countries in the treatment of different kinds of injuries and illnesses, either to join tissues together, to separate tissues or to grow new tissue in place of the damaged or destroyed tissue. Research at the Unit is aimed at reaching an in-depth understanding of the mechanisms of interaction between the implant and the tissue and in this way to find ways of designing better biomaterials and implants.

The Unit has a personnel of around 70 (researchers, research assistants and other staff).

Åbo Akademi University Process Chemistry Group

Åbo Akademi University
Director: Professor Mikko Hupa

The Process Chemistry Group consists of four research teams at the Faculty of Chemical Engineering at Åbo Akademi University. The Process Chemistry Group is based in the Faculty's two buildings (Gadolinia and Axelia), but it also has operations in the Turku Technology Centre (DataCity).

The leaders of the research teams are:
Pulp and Paper Chemistry (Academy Professor Bjarne Holmbom)
Process Analytical Chemistry (Professor Ari Ivaska)
Kinetics and Catalysis (Professor Tapio Salmi)
Combustion and Materials Chemistry (Professor Mikko Hupa)

In addition to the four professors in charge of these teams, the Group has 25 senior researchers involved in projects that cover a wide range of process chemistry related topics, but still sharing the same general approach. All work is concerned with detailed physico-chemical processes in complex environments of industrial interest, aiming to find novel solutions to industrial processes and products. The Group calls this approach in which the focus is on reaching a detailed understanding of process chemistry mechanisms, Molecular Process Technology.
Molecular Process Technology implies:
– Identification and modelling of elementary reactions and interactions in complex heterogeneous industrial processes
– Exploring chemical phenomena and mechanisms in industrial processes, at the molecular level
– Developing advanced process models based on a detailed and sound physico-chemical understanding of the process elements
– Designing relevant molecular structures for industrial products
– Identification and characterisation of environmentally significant components in discharge streams from industrial processes

In addition to professors and senior researchers the Group has 37 post-graduate students.

Core facilities organisations supported by the Academy of Finland

Department of Ecology and Systematics, Division of Population Biology, University of Helsinki
Biocentrum Helsinki
Digital Media Institute, Tampere University of Technology
Advanced Materials Pool, Helsinki University of Technology
Biocity Turku
Biocenter Oulu
Psykocenter, University of Jyväskylä

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Finnish Programme for Centres of Excellence in Research

The Academy of Finland has two main priorities in advancing scientific research: to support the development of creative research environments and to promote professional careers in research. One of the instruments with which these objectives are pursued is the national programme for centres of excellence in research, which ultimately aims at promoting Finland to the international forefront in high-quality research.

This brochure describes how the Academy of Finland implements the national strategy for centres of excellence in research and briefly introduces the 26 centres of excellence nominated for the six-year period 2000–2005. Further details on these centres of excellence and on other forms of research funding available through the Academy are provided on the Academy of Finland web pages.

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