The Finnish Programme for Centres of Excellence in Research is one of the key funding instruments through which the Academy of Finland seeks to promote the development of creative research environments. The fourth Centre of Excellence Programme (2008–2013) involves 18 units, all at the international cutting edge in their respective fields. This brochure describes how the Academy implements the National Strategy for Centres of Excellence in Research and introduces the Centres of Excellence appointed for the 2008–2013 term.

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SPEARHEADING FINNISH RESEARCH

Finnish Programme for Centres of Excellence in Research 2008–2013

ACADEMY OF FINLAND
RESEARCH FUNDING AND EXPERTISE


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Academy of Finland – the prime funding agency for science and research

The Finnish Programmes for Centres of Excellence in Research are one of the key funding instruments for internationally cutting-edge research and large-scale research teams.

A Centre of Excellence (CoE) is a research and researcher training environment with shared aims and clearly defined research goals. Working under a common management, the CoE can consist of one or more research teams based at a university or research institute or spread across several different organisations. CoEs can also have collaboration with private sector companies.

CoEs are funded for a period of six years, which means they are well-placed to pursue entirely new avenues of inquiry and engage in high-risk research. CoE funding also provides a great chance for breakthrough research in technically oriented fields where funding is not as long-term.

Funding for CoEs comes not only from the Academy, but also through their host organisations, i.e. universities and research institutes. Depending on the programme, contractual funding is additionally provided by Tekes, the Finnish Funding Agency for Technology and Innovation, foundations and business companies.

Both the public and private sector benefit from the transfer of know-how from CoEs. Centres of Excellence are encouraged to work closely with business and industry, for example through Strategic Centres for Science, Technology and Innovation. As well as putting research results to work, businesses can themselves contribute to research by networking with CoEs or even by working as part of a CoE. This allows for the free movement of researchers between research teams if and as necessary.

Long-term cooperation between the scientific community, business and industry, society and research funding agencies is key to improving the international competitiveness and impact of Finnish science and research.

Centres of Excellence and internationality

Researchers are keen to find the best partners who can help advance and promote their own research. Top-level research is therefore an exercise in international cooperation that requires both national and international funding.

The Academy has a number of bilateral agreements with science funding agencies and research organisations from China, India, Japan, Russia, South America and other countries. Under these agreements, funding can also be provided to support cooperation among CoEs. Funding is made available for purposes of research cooperation, researcher mobility and training, and the organisation of joint seminars and scientific meetings. CoEs not only give added visibility to research and strengthen cooperation, but also boost the growth of multidisciplinary and interdisciplinary research.

A well-established funding system

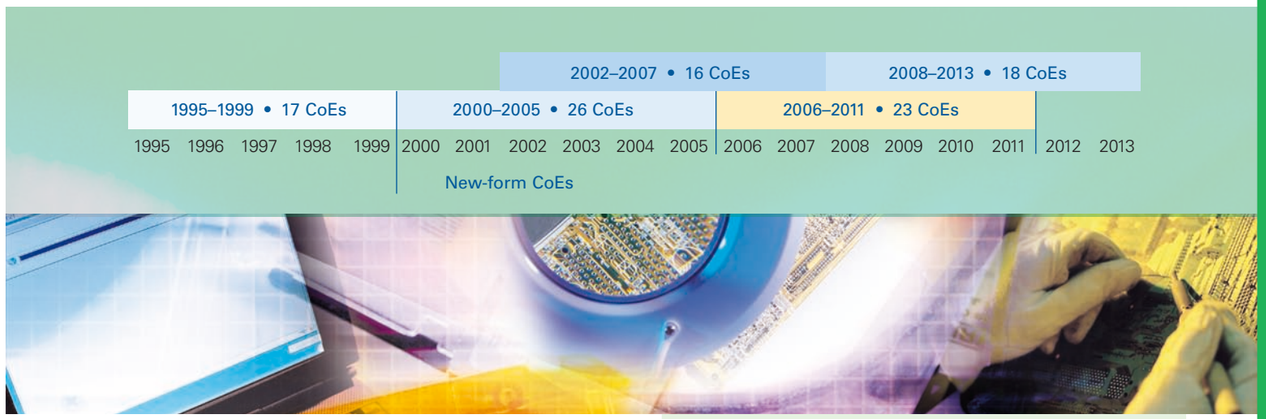
Appointed by the Ministry of Education on the Academy's recommendation, Finland's first twelve Centres of Excellence in Research were selected for the term 1995–1999. A further five units were later appointed by the Ministry for 1997–1999.

The National Strategy for Centres of Excellence in Research was developed and adopted in 1997. This strategy draws on the key principles of science and technology policy that are aimed at enhancing the quality and international competitiveness of Finnish science and research and at increasing its visibility. Overall responsibility for the development and implementation of the strategy rests with the Academy.

In the first Finnish Programme for Centres of Excellence in Research (2000–2005), funding was provided for 26 CoEs and seven core facilities organisations. The latter comprised at least one CoE and other high-level research teams for which the organisation provided various services. Academy funding for the programme amounted to 54.8 million euros, while Tekes granted 10.8 million euros to eleven units.

Under the second CoE programme (2002–2007), the Academy provided funding worth 33.1 million euros to 16 units. Tekes funding was 5.3 million euros, which was shared by six units.

The third CoE programme (2006–2011) involves 23 units. Seven of them are newcomers to the programme; 16 were also funded in the first programme but they have revised and updated their research plans. During 2006–2008, Academy funding for the third CoE programme will amount to 28.5 million euros. Tekes is contributing two million euros and Nokia 0.3 million euros. CoEs and their projects are also eligible to apply for other competitive funding from the Academy and Tekes.



Fourth Centre of Excellence programme

The fourth Finnish Programme for Centres of Excellence in Research will run from 2008 to 2013. The programme involves 18 units; eight of them are newcomers and ten are returning to the programme with new and revised research plans. For the first stage of the programme in 2008–2010, the Academy has allocated 26 million euros, KCL, a research company for the global forest cluster, 414,000 euros and Nokia 150,000 euros.

Applications to the fourth CoE programme were received from 113 units. Based on a rigorous international peer-review process and the Academy's science policy considerations, 44 were shortlisted for further evaluation. In this second round, international experts both reviewed the applications and visited the applicant units. Their main evaluation criteria were the scientific quality and innovativeness of the research plan, the proposed action plan, researcher training, the research environment as well as the researchers' scientific merits and publications.

It was a difficult task indeed to select the best Centres of Excellence from an impressive field of candidates. The substantial investments made in research over the past few years have certainly paid off: Finnish science and research is more multidisciplinary and competitive than before, it has greater international exposure than before, and it is nationally and internationally more networked than before.

The Academy of Finland's mission is to finance high-quality scientific research, act as a science and science policy expert, and strengthen the position of science and research. The Academy works to contribute to the renewal, diversification and increasing internationalisation of Finnish research. Its operation covers the full spectrum of scientific disciplines.

The Academy supports and facilitates researcher training and careers in research, internationalisation as well as the practical application of research results. The Academy is keen to emphasise the importance of the impact of research and breakthrough research by encouraging researchers to submit boundary-crossing funding plans that involve risks but that also offer promise and potential for scientifically significant breakthroughs.

The Academy funds research annually with around 260 million euros, which accounts for 16 per cent of government R&D spending. Each year the Academy receives funding applications worth 1.1 billion euros.

Funding is provided for research projects, research programmes, Centres of Excellence in Research, research posts, foreign visiting professors' work in Finland, researcher training, international networking and research collaboration between universities, research institutes and business companies. Each year Academy-funded projects account for some 3,000 researcher FTEs at universities and research institutes.

For further information on Finnish Centres of Excellence and the National Strategy for Centres of Excellence in Research, visit www.aka.fi/eng > Science in society.

Centres of Excellence (CoE) in Research 2008–2013

Integrative Photosynthesis and Bioactive Compound Research at Systems Biology Level

Eva-Mari Aro
University of Turku, University of Helsinki

The CoE aims to answer the question of how photosynthetic reactions are regulated and how they are integrated with the production of primary and secondary metabolites and biohydrogen.

Ultimately, the aim is to build a comprehensive systems biology picture of the function of assimilating cyanobacteria and how they respond to the environment.

The programme's biotechnological goals with respect to cyanobacteria are to identify commercially viable compounds and molecules that serve as medicinal substances, and to harness cyanobacteria for efficient biohydrogen production.

Dalton Carmel is interested to research the influence of as-yet-unidentified proteins on the vital functions of cyanobacteria.

Generic Intelligent Machines Research

Aarne Halme
Helsinki University of Technology, Tampere University of Technology

The CoE's main focus of research is on the methods and technologies needed to develop intelligent mobile machines, either modern working machines or future advanced robots.

Intelligent mobile machines are an area of strong growth in technology industry. They are set to profoundly change people's everyday life over the next few decades and to open up whole new vistas for industrial product development. Finland's technology industry in this field is highly advanced and exports will certainly benefit from its further development.

The CoE is a globally significant player that is engaged in a diverse range of activities.

Research on Mitochondrial Disease and Ageing

Howard Jacobs
University of Tampere, University of Helsinki

The CoE focuses on researching mitochondrial diseases: a diverse and surprisingly common group of diseases characterised by mitochondrial dysfunction. As yet there is no cure for these diseases.

Mitochondrial diseases typically occur in organs and tissues that are the most dependent on energy produced by oxygen; for instance, the heart, the brain, and muscles.

Scientists at the CoE are interested to study genes, proteins and mechanisms involved in the replication and repair of mitochondrial DNA as well as DNA replication into daughter cells. Another area of interest is in diseases involving dysfunctions in these mechanisms. The main objective is to gain a deeper understanding of the cellular mechanisms responsible for mitochondrial diseases and to develop treatments for these diseases.

Genetic defects accumulate in the mitochondrial genotype even in the process of normal ageing. Scientists believe that these defects are associated with many ageing-related characteristics. Therefore another major focus of research at the CoE is on the mechanisms of normal ageing.

Host Defence Research

Sirpa Jalkanen
University of Turku, University of Helsinki, National Public Health Institute

The CoE's main research interests include the function of viruses, bacteria and cancer cells as well the defence mechanisms of the human body.

Rami Kurimo from the CoE in Research on Mitochondrial Disease and Ageing.

The aim is to elucidate the mechanisms that regulate the movement of viruses, bacteria and cancer cells and the way in which a normally-functioning defence mechanism can render them harmless. New methods of treatment can alleviate patients' suffering and prevent premature deaths.

Bacteria and viruses have developed mechanisms that they use to confuse and escape the immune defence system. Cancer cells, then, are capable of making use of trafficking-molecules that are typical for leukocytes, allowing them to roam about the body and form deadly metastases. As yet, hardly anything is known about these mechanisms.

The team composition is internationally exceptional, involving experts of both immunology, cancer diseases, bacteriology and inflammation diseases. This will allow for the application of the results in basic research to clinical settings, disease diagnostics and patient care.

Molecular Imaging in Cardiovascular and Metabolic Research

Juhani Knuuti
University of Turku, Åbo Akademi University, Turku University Hospital

The CoE's research agenda focuses on resolving the underlying mechanisms of cardiovascular diseases, metabolic syndrome and diabetes and on developing tools for the prevention, diagnosis and treatment of these diseases.

In the field of cardiac research, the aim is to develop new imaging methods that will help to determine the risk and severity of coronary heart disease and heart failure and to guide the therapy of these diseases. In diabetes research, the aim is to elucidate the interactions between different organs, such as adipose tissue, the liver, central nervous system and heart in the pathogenesis and development of the diseases. This will pave the way to developing and testing new treatments.

Philosophical Psychology, Morality and Politics: Human Conduct in the History of Philosophy

Simo Knuuttila
University of Helsinki, University of Jyväskylä

The main concern of the CoE is to study the psychological assumptions that lie behind ethical and political theories in the history of philosophy from Antiquity to Enlightenment.

Research into the history of philosophy has recently made important breakthroughs and influenced the development of systematic philosophy. Studies in philosophical psychology, for their part, have extended to take in the psychological background of classical theories of ethics, social practices and politics.

As well as conducting a series of separate studies, the CoE will be working to compile an exhaustive handbook on the history of the psychological background of ethics and social philosophy.

Physics, Chemistry, Biology and Meteorology of Atmospheric Composition and Climate Change

Markku Kulmala
University of Helsinki, University of Kuopio, Finnish Meteorological Institute

Research at the CoE is aimed at reducing the scientific uncertainty that continues to surround climate change. One of the major uncertainties has to do with aerosol particles, and particularly with the interactions between aerosol particles, clouds and climate. To resolve these uncertainties an in-depth, multidisciplinary understanding is needed on the formation and dynamics of both aerosol particles and cloud droplets, as well as on the interactions between atmosphere and biosphere.

The CoE engages in both experimental and theoretical research. The former relies primarily on continuing measurements taken at field stations as well as measurement campaigns all over the world. An important aspect of the experimental work is to develop and produce new measurement instruments, which involves working closely with business companies. On the theoretical side, the main effort is devoted to creating new theories, developing new models and performing extensive simulations

The CoE is the world's leading research unit in its field. The continuity and diversity of its measurements have given it a clear headstart.

Analysis and Dynamics Research

Antti Kupiainen
University of Helsinki, University of Jyväskylä

The CoE's main area of research is mathematical analysis and its applications in mathematical physics and biology.

The red thread that ties together research at the CoE is dynamics. Key areas of research include dynamic models in physics, biology and practical applications. Another major area of interest is in the mathematical theory of phenomena occurring within these models, such as chaos, fractals and turbulence.

The aim is to create a stronger link between mathematics and applications. For instance, theoretical studies of turbulence have led to cooperation with the process industry; studies in statistical mechanics have found applications

Sanna Sevanto measuring changes in Scots pine stem diameter at the SMEAR II station.

in the field of wireless mobile networks, and theories of geometric analysis in medical tomography.

Public Choice Research

Hannu Nurmi
University of Turku, Turku School of Economics

The CoE's focus of research is to explore phenomena and institutions that have to do with the interaction between politics and economy.

The aim is to gain an overall view of the principles of democratic governance and institutional design. One area of special interest is the process of democratic selection as well as the operation and development of multi-member decision-making bodies. Furthermore, researchers at the CoE are interested in the principles of cost-benefit sharing in multi-member organisations such as the European Union.

Relations between the public and private sector are one of the most traditional areas of study in public choice research. Specific interests include factors impacting the size and structure of the public sector, relations between business and government as well as systems of income distribution in different countries. Answers will be sought to such questions as how changes brought about by globalisation affect the powers and functions of government.

Microbial Food Safety Research

Airi Palva
University of Helsinki

The CoE addresses some of the key microbiological challenges in the food production chain. Microbiological factors have a significant bearing on food safety and quality. Modern production processes and cold chains have changed the microbial ecological conditions of food production.

Food safety ultimately translates into consumers' well-being and intestinal health. Indeed, key areas of research at the CoE include the human intestinal microbiota, food-borne diseases, the characteristics of bacteria and the mechanisms governing the interaction between microbes and hosts.

The knowledge coming out of the research will have important practical application in preventing intestinal infections and in examining intestinal health. Furthermore, it will help to improve process hygiene; protect consumers against bacteria responsible for food spoilage; and reduce food industry losses due to premature product spoilage.

The diversity and multidisciplinarity of this research makes it a unique undertaking in the whole of Europe.

White Biotechnology – Green Chemistry Research

Merja Penttilä
VTT Technical Research Centre of Finland

The CoE is committed to developing new biotechnological and chemical methods for the efficient production of chemicals, materials and fuels from renewable natural resources.

The use of plant materials instead of oil can help reduce both industry dependence on fossil fuels and carbon dioxide emissions into the atmosphere.

White or industrial biotechnology combined with green chemistry has a vital role to play in developing sustainable production processes that help save energy and the environment.

The development of efficient production strains requires an understanding on the regulation of the physiology of production microbes as well as the use of systems biology methods.

The Centre's aim is to develop microbial cells that will produce useful new compounds out of plant biomass sugars. They have numerous industrial applications, for instance as precursor molecules for the production of new bioplastics.

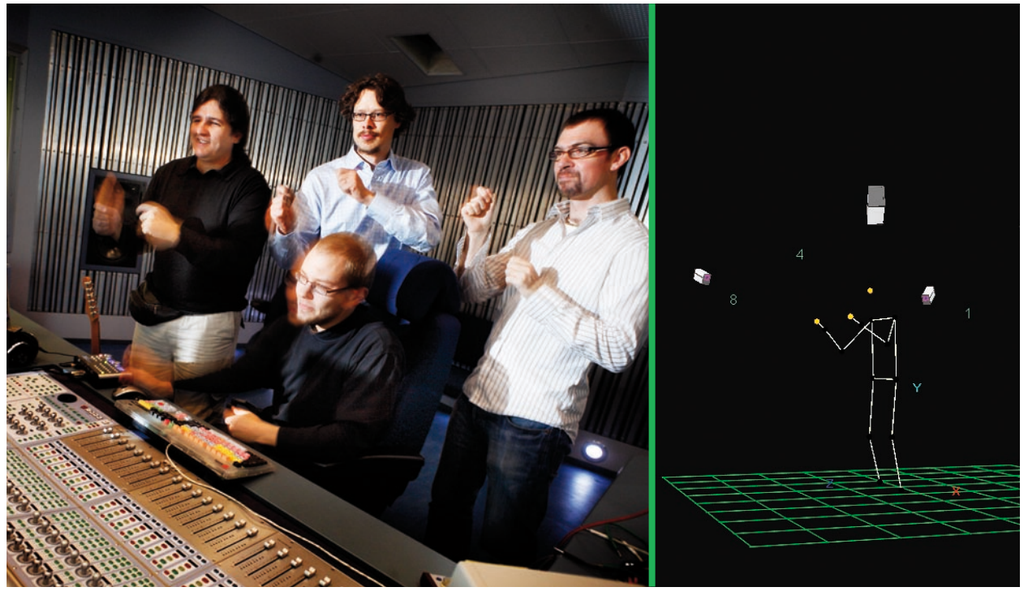
Functional Materials

Jarl B. Rosenholm
Åbo Akademi University, University of Helsinki

The CoE's research is focused on the manufacture of physiochemically interactive fibre-based materials used primarily in the paper and packaging industry as well as on the functionalisation of these materials by way of printing methods. 'Functional' refers here to a predicted, immediate or delayed response of the material to an external stimulus.

The purpose is to develop tailored intelligent products to take the place of mass products that are on the decline. Examples are hybrid media applications for the printing industry and ICT industry, integrated product applications for the healthcare industry and food and pharmaceutical packagings, including quality assurance for paper and packaging products, transport tracking and authenticity assurance.

The units involved in the CoE have unique interdisciplinary expertise.



Jose Fornari, Tuomas Eerola, Mikko Leimu and Geoff Luck from the CoE in Interdisciplinary Music Research in Jyväskylä getting to grips with the production of rhythm.

Smart Radios and Wireless Research

Antti Räisänen
Helsinki University of Technology

The CoE conducts high-level research and training in radio science and engineering and wireless data communications.

Key areas of research include high frequency, microwave and millimetre wave engineering, multi-antenna systems, multi-standard radios, the design of integrated circuits for data communications and signal processing in wireless data communications.

Intelligent multi-antenna systems and multi-standard radios allow for more efficient and flexible use of radio spectrum. Intelligent radio sensors and millimetre wave cameras are used among other things to improve the efficiency and safety of passenger and freight transport and the performance of industrial processes.

Molecular and Integrative Neuroscience Research

Mart Saarma
University of Helsinki

The research at the CoE focuses on the molecular and systems-level neurobiological mechanisms based on the effects of trophic factors in brain development, plasticity (learning and memory) and in the pathogenesis and treatment of diseases.

Scientists at the CoE are particularly interested in the complex and multifaceted interactions among trophic factors, intracellular messenger cascades and ion transport proteins that regulate electrical and chemical signalling in brain cells and in neuronal networks.

Neurotrophic factors play a decisive role in several diseases, such as Parkinson's and Alzheimer's, schizophrenia, depression and epilepsy as well as in the actions of medical substances used in the treatment of these diseases. The CoE aims to put its research results into practical use, especially in the prevention and treatment of neurogenerative brain diseases.

Interdisciplinary Music Research

Petri Toiviainen
University of Jyväskylä, University of Helsinki

The CoE's research agenda deals with the way in which people listen to music, experience music and present and perform music. Special areas of interest include the perception and learning of music, musical emotions and the connections between music and movement.

These research interests tie in closely with the role of music in promoting well-being: the cognitive, emotional and motor effects of music therapy rehabilitation, the use of technology for the advancement of musical expression, the occurrence and prevention of stage fright in musicians, the use of music in controlling emotions and the role of music in learning a foreign language.

The CoE is an exceptionally broad and interdisciplinary undertaking in the field of music research. Among the disciplines represented are musicology, music therapy, psychology, cognitive science, brain research, biomedicine, computer science and physics.

Foundations of European Law and Polity Research

Kaarlo Tuori
University of Helsinki, Åbo Akademi University, National Research and Development Centre for Welfare and Health (Stakes)

The CoE's aim is to study and interpret the changes ongoing in Europe in the field of law.

These changes have generated new kinds of problems. These problems can no longer be adequately addressed by traditional concepts of legal thinking that are anchored to the nation state.

The CoE will work to develop theoretical and conceptual tools that allow for an examination of an increasingly multilayered and multicentered European law.

The research is grounded on the tension between coherence and fragmentation in law. Each of the three research teams will analyse this basic tension from their own perspective. The first team will address the need for reform in legal terminology and thinking; the second focuses on Europe as a polity; and the third is interested in Europe as a coherent market and as fragmented national legal cultures.

Algorithmic Data Analysis Research

Esko Ukkonen
University of Helsinki, Helsinki University of Technology

The CoE works to develop new concepts, principles and algorithms for computational data analysis as well as practical applications.

Data analysis is gaining ever greater significance in science and industry: methods of measurement are constantly improving, the costs of measurement are decreasing and it is easier to store the data collected. In biology and environmental research, for instance, it is now possible to take measurements of phenomena that earlier could not even be perceived.

Major areas of research collaboration include molecular biology and medicine, environmental research, linguistics and data communications. Prospective applications of the methods developed at the CoE include genetic mapping, the investigation of mechanisms of genetic regulation, studies of the distribution of different species, the study of dialects and nomenclatures, the study of climate change as well as information retrieval and telecommunication networks. The unit's research results have inspired vigorous methods development and numerous applications in different parts of the world.

The CoE integrates basic research in computer science with applications cooperation in a globally unique way.

Cardiovascular Diseases and Type 2 Diabetes Research

Seppo Ylä-Herttuala
University of Kuopio, University of Oulu

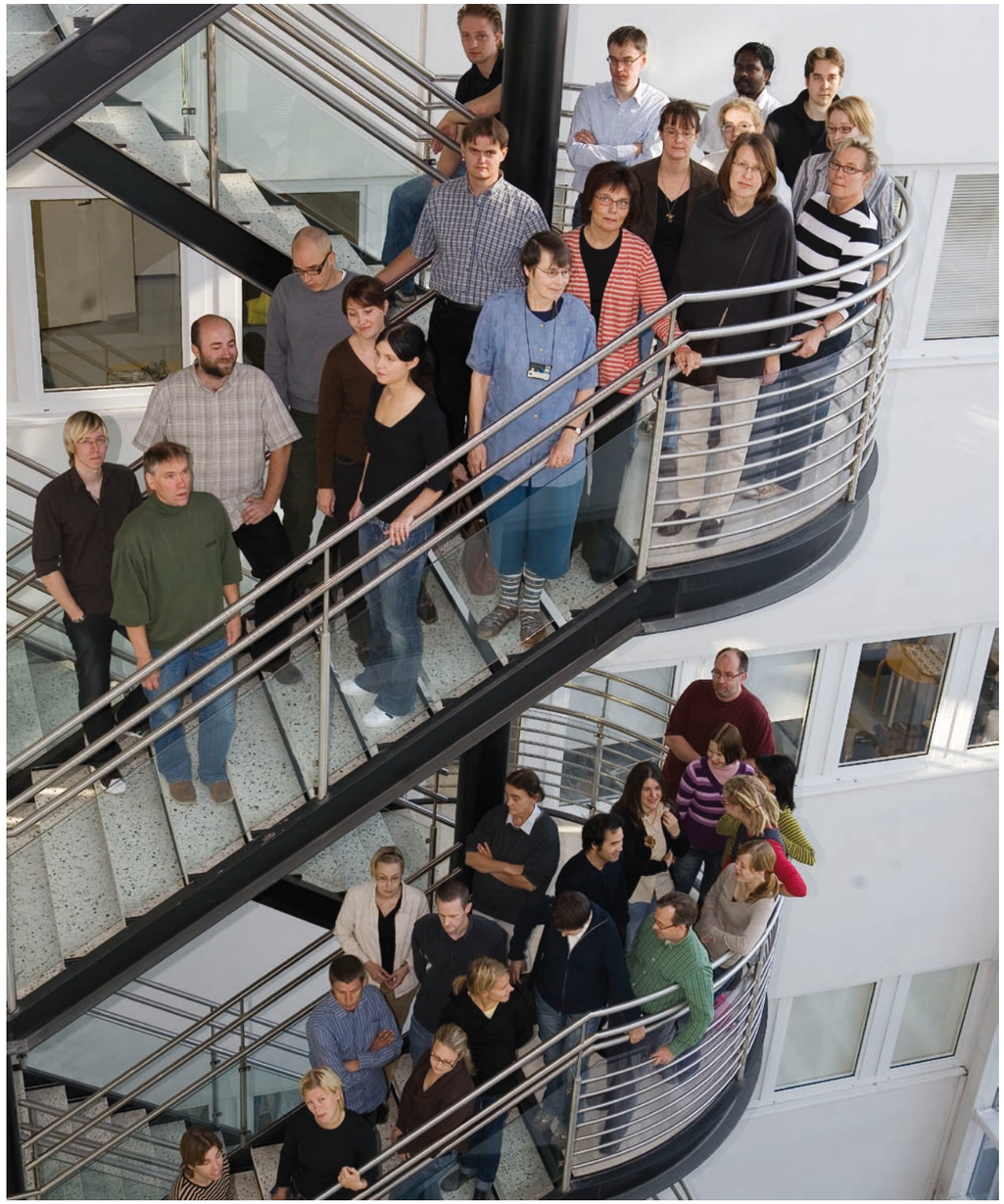
The CoE's main research interests are cardiovascular diseases and type 2 diabetes: their pathogenic mechanisms, genetic background, new clinical treatments and methods of prevention.

The aim is to elucidate the pathogenesis of type 2 diabetes, myocardial ischaemia, heart failure, obesity and atherosclerosis. Furthermore, scientists at the CoE will be working to develop new approaches to the diagnosis, treatment and prevention of these diseases. They will be applying state-of-the-art methods of gene technology, gene therapy and genome analysis, linked with data obtained from patient records.

The results will be used to improve existing methods of treatment and to develop entirely new treatments.

Eva-Mari Aro: ***Integrative Photosynthesis and Bioactive Compound Research at Systems Biology Level***

Blooms of cyanobacteria: a source of medicines and bioenergy!



CoE in Integrative Photosynthesis and Bioactive Compound Research.

Yagut Allahverdieva measuring the fluorescence of chlorophyll in thale cress.

Cosmin Sicora preparing a sample to study gene function in a cyanobacterium using the real-time PCR method.

For many people, cyanobacteria (blue-green algae) mean just one thing: that late in the summer, they can no longer go swimming off their favourite beach. For scientists, however, the blooms of cyanobacteria are a complex phenomenon full of opportunities, from the production of medicines to the generation of bioenergy.

"Cyanobacteria have received surprisingly little research attention," says Academy Professor Eva-Mari Aro, who is in charge of the CoE in Integrative Photosynthesis and Bioactive Compound Research at Systems Biology Level at the University of Turku. "There are thousands of cyanobacterial strains, and they differ from one another quite substantially."

Scientists at the CoE are working to explore the metabolism of cyanobacteria, from the event of photosynthesis through to the formation of metabolic products. The results of their studies have practical application in the production of energy, bioactive substances and other compounds useful for research purposes. At the same time, the work will help to shed light on the ecology of cyanobacteria and on methods of controlling blooms.

Photosynthetic mechanism, biohydrogen energy and medicines

Ultimately, the aim and purpose is to put the life-sustaining mechanism of photosynthesis to use in the production of clean energy.

"The photosynthetic mechanisms where oxygen is released are the same in plants and cyanobacteria," Aro explains. "The creation of artificial photosynthesis requires an understanding of the basic mechanisms involved, and our research will contribute to that understanding."

Through photosynthesis, cyanobacteria can produce hydrogen out of water and sunlight – a clean fuel using an inexhaustible source of raw material. "We urgently need CO2-neutral ways of generating energy," Aro points out. The capacity of natural hydrogen production in cyanobacteria is quite limited, but scientists at the CoE are now searching for more efficient strains in the natural environment and applying the tools of biotechnology to boost their production capacity.

"Apart from hydrogen, cyanobacteria produce a whole range of bioactive compounds," Aro says. Knowledge about these compounds remains limited, but photosynthetic mechanisms are closely involved in the production process. "We're trying to find out what kinds of compounds are produced by these bacteria, what these compounds are capable of doing, and how we could use them."

CoE well-placed to undertake broadly-based research

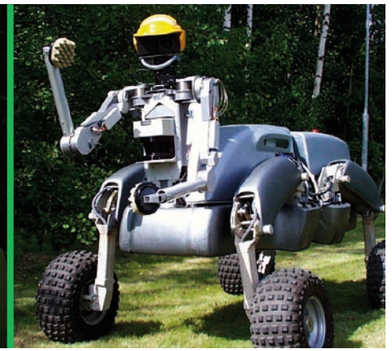
The CoE is composed of research teams from the University of Turku Department of Biology and the University of Helsinki Department of Applied Chemistry and Microbiology. The main focus of work for the unit in Turku under Professor Aro is on the mechanisms of photosynthesis, while the Helsinki unit under Academy Professor Kaarina Sivonen is chiefly interested in the production of toxins and bioactive compounds, genomics and ecology. Professor Mirja Salkinoja-Salonen is investigating the metabolism of different kinds of micro-organisms.

"We'll be combining the use of many different methods in order to gain a system-level understanding," Aro says. "No cellular events happen in isolation of one another, instead they're all controlled under one comprehensive regulatory network."

Aro says that the granting of CoE status has a surprisingly large impact: "You gain more respect and esteem, more publicity, and the whole research team gets resources needed for a longer-term, concerted research effort."

Aarne Halme: *Generic Intelligent Machines Research*

From tough and mean to intelligent machines



CoE in Generic Intelligent Machines Research.

"Machines are in competition now to become intelligent," says head of the CoE in Generic Intelligent Machines Research, Professor Aarne Halme from Helsinki University of Technology (HUT). "The competitive edge is no longer gained by the iron construction of machines, but instead by automation."

When mechanics is enhanced with intelligence and the ability to move, a whole range of systems are needed to control the machine's functions, such as power generation, environmental sensing and communication. Scientists at the CoE are interested to study the basic problems that occur in these subsystems by validating practical solutions with prototypes rather than by means of simulation.

"In engineering sciences, research isn't over until validation has been done with real machines," Halme says and continues: "Engineering sciences create the world, they don't explain it."

Much room for development

Halme is keen to point out there is still much room for development in machines: "An example is to improve power and energy transmission systems in mobile machines by improving their control functions."

The productivity of robot-like intelligent machines is significantly boosted by learning. The development of learning skills, then, requires an effort to develop sensing methods such as vision, hearing and touch, as well as the machine's capacity for cognition. "As the baby boom generation continues to age, these topics are attracting growing attention, for instance, when designing mobile service robots assisting the elderly. These robots need to be designed for maximum utility. A machine is badly designed, if using it loads the user."

Apart from individual robots, another focus of research is dedicated to robot communities and their control and communication structures.

Revised research agenda will yield international results

The CoE in Generic Intelligent Machines Research has been re-appointed to the Centre of Excellence programme with a sharply revised research agenda. The unit has two research teams: the team working under Professor Halme at the HUT Automation Technology Laboratory and the team under Professor Matti Vilenius at Tampere University of Technology's Institute of Hydraulics and Automation, which also had CoE status during the 2000–2005 term. The newly revised research agenda and the unit's close integration with the current CoE organisation have given it a whole new direction.

Effective networking is important to every Centre of Excellence. The CoE in Generic Intelligent Machines Research has launched its own infrastructure programme to develop a hardware environment suitable for the verification and validation of results that is accessible to the two units that are physically separated from each other. "The online laboratory allows researchers to use the machinery and hardware from both Helsinki and Tampere. Creating a workable environment is a tough challenge, even by international standards."

The WorkPartner robot offers a useful platform for R&D in new-generation service robotics.

Information moves from one level to the next

"The core teams will include members from both Tampere and Helsinki. Under each work programme we'll appoint senior researchers who'll be involved in different teams and convey information between these teams," Halme explains.

External partners include the Forum for Intelligent Machines (FIMA) as well as international research teams. Globally, there is very active and lively research especially in the field of new advanced robotics.

On a national level, the CoE has excellent cooperation with industry – for good reason. "Industrial machinery manufacturers are an important cornerstone for Finnish technology industry," Halme emphasises. "We're working to help this industry thrive in an environment of intense international competition."

"The involvement of industry doesn't mean we'll be compromising our scientific objectives – quite the contrary," Halme underlines. "Our business partners will often be able to pick up on an idea and continue to process it, so our valuable research results will certainly not remain unused."

"Commercial work always brings an extra element of pressure," Halme points out. "Our CoE status brings some relief from this pressure and what we wanted – the freedom to focus on our research."

Howard Jacobs: *Research on Mitochondrial Disease and Ageing*

Mitochondrial research starts second term

"Diseases caused by malfunction of the mitochondria, the power stations of our cells, are very common," says Academy Professor Howy Jacobs from the University of Tampere Institute of Medical Technology (IMT).

"Mitochondrial disorders are possibly associated with degenerative diseases that increase with advancing age, such as Parkinson's disease, old age diabetes, cardiovascular disease, eye and muscle diseases, hearing defects, infertility and certain types of cancer. It's a vast area of research," Jacobs explains.

Jacobs is in charge of the CoE in Research on Mitochondrial Disease and Ageing. During the 2002–2007 term, the Finnish Research Unit on Mitochondrial Biogenesis and Disease (FinMIT) focused on basic disease mechanisms. Now, the main challenge is to develop treatments for as-yet-incurable mitochondrial diseases, or at least to find ways to arrest their progression.

Developing new methods of treatment

Using model systems developed earlier, scientists at the CoE are now studying degenerative diseases of the nervous system, trying to find new treatments and to understand the normal and ageing-related function of mitochondria. "We're looking to find out how mitochondrial DNA is copied from one cell generation to the next, and how it's influenced by disease mutations and environmental factors," Jacobs explains.

"Diet, new drugs and gene technology all offer potential new solutions," Jacobs says. In their search for new treatments, the teams are making use of both libraries of pharmaceutical compounds and model organisms such as fruit flies and zebra fish. A promising new gene therapy technique is known as metabolic by-pass, going round blockages in biochemical reaction pathways.

"By the end of our term, we hope to be in the position to sign commercial partnerships," Jacobs adds.

Howy Jacobs, Director of the CoE in Research on Mitochondrial Disease and Ageing.

Jaakko Pohjoismäki and Howy Jacobs discussing analysis of mitochondrial DNA from the human heart.

Shweta Manjiry and Rami Kurimo sorting fruit flies according to specific mutations they carry.

An exercise in international cooperation

The CoE in Research on Mitochondrial Disease and Ageing is made up of four research teams from IMT and the Research Programme of Molecular Neurology at the University of Helsinki. Offering a unique combination of clinical, genetic, physiological, biochemical and pharmacological approaches, the teams are led by Howy Jacobs, Professor Anu Wartiovaara, Academy Research Fellow Hans Spelbrink and Academy Research Fellow Brendan Battersby.

The CoE represents a broad cross-section of international expertise at the highest level. Jacobs describes the Centre's strong interdisciplinary and international representation as a valuable asset in their attempts to unravel this complex phenomenon.

Indeed, this is very much an exercise in international cooperation. The research involves 50 scientists from almost 20 different countries, and the leaders of the research teams represent four different nationalities. The CoE also has active research collaborations with cognate research teams in the UK, France, the US, Canada, Japan and other countries.

"Top-quality science is inherently international. We present our results to an international audience, and national frontiers are irrelevant," Jacobs points out.

"We have an international organisation and that helps us to recruit the best people from whatever country. This is also an investment in the future, because it's easier for our students and postdocs to make the move from this international environment to the best institutions worldwide. In due course, the skills and expertise picked up by these people are returned to Finland. Finally, it helps to strengthen the international standing of Finnish science."

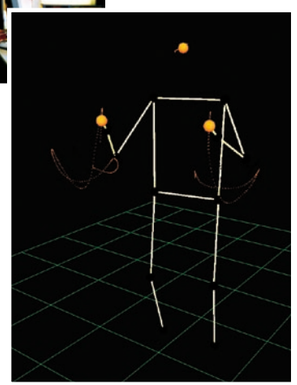
"Our CoE status makes it so much easier to persuade and convince international bodies to fund our research effort," Jacobs says. "It means a great deal to us to have been recognised by the Academy, and we'll be doing our utmost to repay their confidence. We hope our efforts will provide a solid platform for the future growth and development of mitochondrial research and medical technology."

Petri Toiviainen: *Interdisciplinary Music Research*

Music – an integral part of our life from cradle to grave

From left to right: Jose Fornari, Olivier Lartillot, Suvi Saarikallio, Geoff Luck, Rafael Ferrer Flores, Marko Punkanen, Tuomas Eerola, Hannes Juutilainen, Elvira Brattico and Tommi Himberg. Behind the drums Marc Thompson. In the middle Jaakko Erkkilä.

Geoff Luck conducting the orchestra, with motion-detection equipment providing visualisation.



Tuomas Eerola (left) and Petri Toiviainen discussing the results of computer analysis of Finnish folk melodies.

Newborn babies have many musical skills and talents. Tarja Ilkka measuring the automatic reactions triggered by music in the baby's brain during sleep.

Children who play an instrument show strong brain development. Taimi, 5, is participating in a study to explore how the brain is affected and shaped by music.

"The emotions invoked by music are probably one of the main reasons why many of us listen to or play music," says Petri Toiviainen, Professor of Music at the University of Jyväskylä.

"Music is an integral part of human culture. Tunes are present in our life from cradle to grave – in fact from womb to grave because even unborn foetuses respond to music."

Although humans have cried, laughed and moved to the beat of rhythm since time immemorial, we continue to have a rather limited understanding of how music is processed in the brain and of the nervous mechanisms of emotions invoked by music. The same goes for how music is interwoven with the movement of the player and the listener.

Headed by Toiviainen, researchers at the CoE in Interdisciplinary Music Research in Jyväskylä are mainly interested to study how people listen to music, experience music and how they play and perform music. Applications of the new knowledge produced in this research, such as music therapy, the promotion of language learning and the reduction of stage fright, have both social, pedagogic, artistic and commercial significance.

More than one key is needed to unlock the secrets of the staff

"Our main areas of interest include the perception and learning of music, the origin of musical emotions and the connections between music and movement," Toiviainen says.

Musicology, music therapy, psychology, cognitive science, brain research, biomedicine, computer modelling and physics – the researchers are applying an unusually large number of keys in their quest to unlock the secrets of notes.

"Music and the cognitive processes of the human mind are just too complex to be captured by a single method."

The CoE consists of the Music Cognition Team based at the University of Jyväskylä Department of Music, and the Brain and Music Team under Adjunct Professor Mari Tervaniemi based at the University of Helsinki Department of Psychology.

Toiviainen is keen to stress the value of the unit's CoE status: "It provides a solid basis for our work as one of the world's biggest interdisciplinary music research teams and allows for systematic longitudinal studies, for instance, on children's musical development and the impact of music therapy."

Studies of movement and other hot topics

There is considerable interest in such areas as how musical skills develop and how the choice of teaching method affects the learning of an instrument; how music therapy rehabilitation works; and how music can be used to set and create mood.

The CoE will take on many topical issues: the application of brain research methods, the computational analysis of music, the role of movement in the production and reception of music. The aim is to gain an accurate scientific and computational image of musical emotions, the meanings of music and musical development.

This research effort will also have direct practical usefulness, as Toiviainen explains: "One of the possible applications for the computer algorithms we're developing is in the automatic analysis and classification of music on the internet. We also expect to gain a closer understanding of the potential impact of music on language learning."

Applications of movement studies will pave the way to new musical interfaces that will let people with limited movement engage in musical expression. "We also want to learn how to assess the impact and effectiveness of music therapy and in this way to develop more effective tools of diagnosis and rehabilitation," Toiviainen concludes.

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