CENTRES OF EXCELLENCE
IN RESEARCH

2014–2019

LEADING THE WAY IN SCIENCE

Centres of Excellence – the flagships of Finnish research

Centres of Excellence are the flagships of Finnish research. They are at the very cutting edge of science in their fields, carving out new avenues for research, developing creative research environments and training new talented researchers for Finnish society and business and industry.

A Centre of Excellence (CoE) is a research and training network that has a clearly defined set of research objectives and is run under a joint management. Funding is provided for six years, in two three-year terms, which means that CoEs can work to long-term plans and even take risks. CoEs are jointly funded by the Academy of Finland, universities, research institutes and the private business sector.

The Academy of Finland has funded Centres of Excellence since 1995. The sixth CoE programme is scheduled to run from 2014 to 2019, and it involves 14 centres.

CENTRES OF EXCELLENCE
IN RESEARCH

2014–2019

Leading the way in science

Aims

The Centre of Excellence programme is designed to strengthen the international competitiveness of Finnish research and to increase its visibility and appreciation. In addition, the programme aims at developing creative and productive research and training environments that generate excellence and contribute to the overall progress of science and society.

The CoE programme facilitates the establishing of research consortia between different fields of science and research. It promotes the efficient use of research infrastructures and opens up new opportunities for increased national and international cooperation. Furthermore, the CoE programme creates favourable conditions for scientific breakthroughs and in this way stimulates the regeneration of science and research.

As a whole, the CoE programme supports the development of the Finnish research system.

Impact

The Centre of Excellence programmes are the most notable success stories of Finnish research. They have successfully laid the foundation for the development of creative and productive research and training environments that advance internationally pioneering research. The programmes have brought increased international visibility to Finnish research, showcasing the best that Finnish science and research have to offer.

CoE programmes have broad-ranging impact on Finnish research as well as on the research, development and innovation field. They are also extremely important environments for training and education.

The added value gained from CoE programmes is reflected in the improvement of research environments and research cooperation. An ambitious and high-quality research environment is best placed to produce new top researchers, new ideas, new methods and new approaches.

Selection

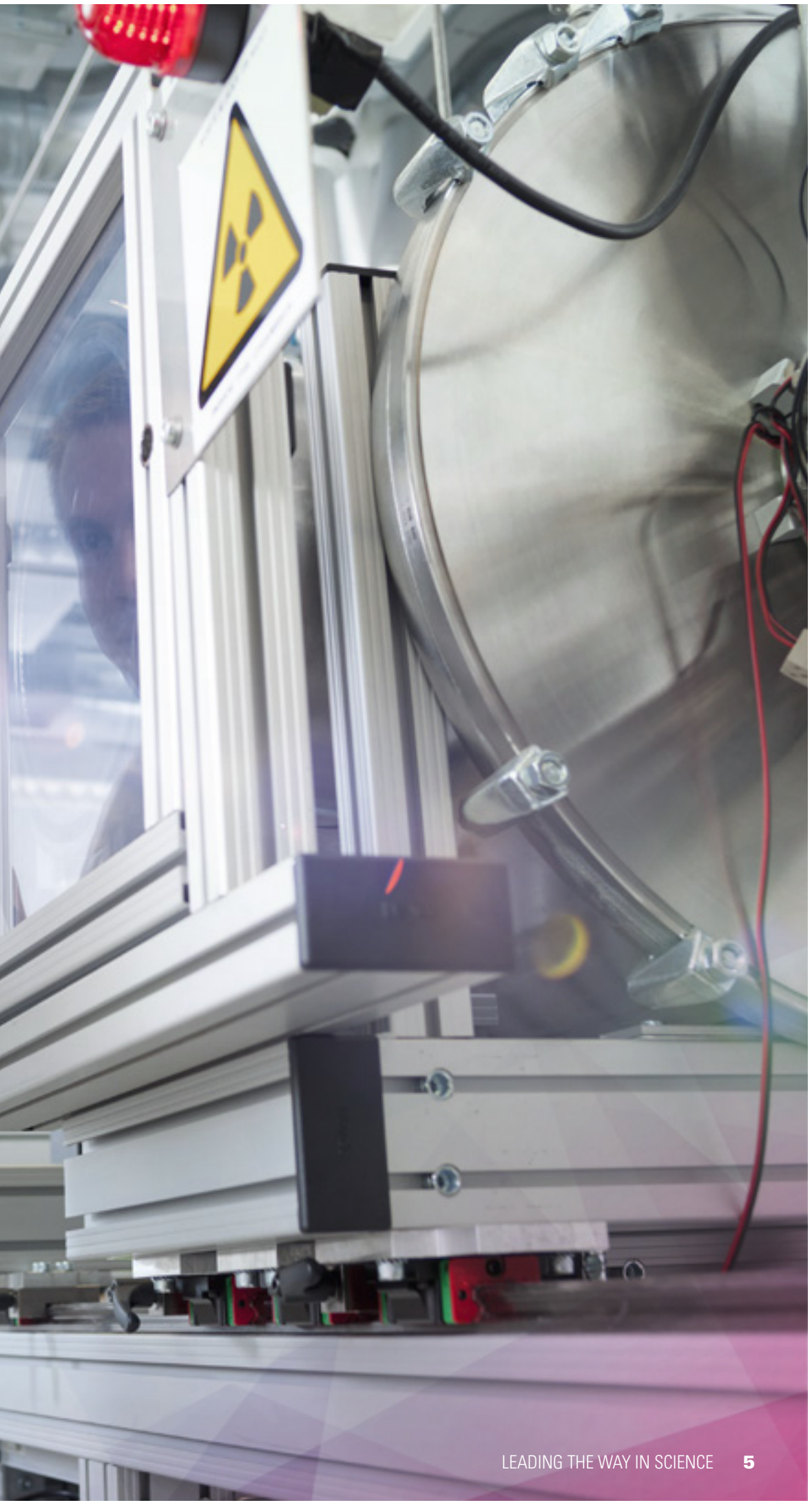
The key criteria on which Centres of Excellence are selected are the scientific quality and innovativeness of their research. Other factors that are considered include the feasibility of the research plan, the qualifications of team members, networking contacts and the contribution to the promotion of professional research careers and researcher training.

CoE applicants are also assessed in terms of how they compare with the standards of the international forefront. Furthermore, the added value from the CoE and the significance of its research are weighed, together with the impact of its research on society and business and industry.

CoE programme calls are divided into two stages. The whole selection process takes about 18 months. The selection is based on thorough international peer review.

Biological tailors

Nature itself teaches the materials scientist how the principles of self-assembly can be used to create nanocomposites and multifunctional materials with excellent mechanical properties. The integration of biological tailoring and production methods with materials science provides a solid foundation for the development of new materials for the bioeconomy. ▶



Future materials and biological production processes

There is both a scientific and a societal dimension to our Centre of Excellence. More and more often today, the goal is to move towards a "bioeconomy" that makes use of renewable and bio-based materials and biological processes. At the same time, there is an ever greater need in technology for better, more functional and reasonably priced materials. This, however, must not draw our attention away from material qualities. Reconciling all these elements will require a whole new approach.

Our vision is that over the coming decades, the dividing line between materials and biological sciences will fade away and that biological production mechanisms will become cost-effective. This would have a profound societal impact in Finland, too, if it leads to the development of new branches of hi-tech industry.

Following nature's example

The aim of our CoE is to gain a deeper scientific understanding of how biological raw materials, the biological tailoring and production of materials, self-assembly and genetic engineering can be harnessed for the future needs of materials science.

Ultimately, our goal is to produce biosynthetic hybrid materials by emulating natural processes. We are working to develop strong self-assembled

Academy Professor Olli Ikkala

nanocomposites by combining colloidal structures and especially nanocellulose with engineered macromolecules. The aim is to achieve high tensile strength by using genetically engineered proteins modelled on silk and its tensile strength. In our work, we combine supracolloidal chemistry with supramolecular chemistry in order to control self-assembled structures from nano to macro level. A major research focus is to study dynamic self-assembled systems whose structure is formed by feeding energy with a view to creating emergent qualities.

For the time being, the applicability of biosynthetic materials is limited by the fact that their production is not scalable. This is something we are keen to change. Indeed, it is likely that in the next few years the production of polymers using bio-organisms will become cheaper and move to an industrial scale. The Trichoderma mould is a promising mechanism for the production of genetically engineered materials. It is used to modularly connect natural materials and their best properties together. Already the range of materials is extraordinarily diverse.

From materials science to biology

Our CoE integrates four areas of competence and expertise: the self-assembly of molecules and colloids, the genetic engineering of proteins, the production and tailoring of cellulose and wood-based nanomaterials, and the biological production of engineered biomolecules. All this comprises a chain of competence that allows us to design, engineer, investigate and understand materials from the molecular to the nano level, and further to explore their behaviour at the level of practical applications. At the same time, we learn how they can be produced and what their opportunities and limitations are.

> We are breaking down boundaries between disciplines.

The future of materials science is headed towards multicomponent and multifunctional materials whose different length-scale structures and functions and their combined effects need to be properly understood and controlled. Our diverse biological expertise means we have all of the tools and methods that are needed to manage this complexity. We are breaking down boundaries between disciplines. All our laboratories are located in close proximity to one another, which is perhaps why people find this such an inspiring community to work in and where they can learn from others. So broad is the scope of our subject matter that it would be impossible for any one person to know it all alone.

Professor Merja Penttilä

FACTS:

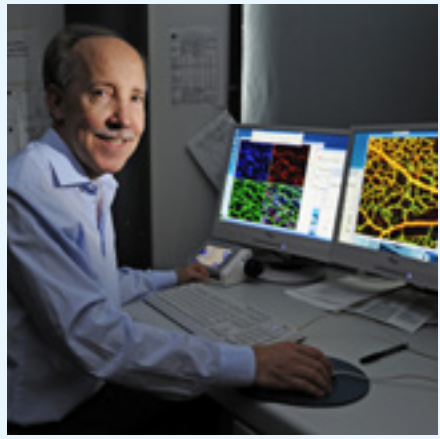
Number of staff: About 60.
Sites of research: Aalto University and VTT Technical Research Centre of Finland.
Number of research staff recruited from abroad: About 20.
Average age of research staff: Very wide range, average around 35 years.

From test tube to patient

There is a pressing need for better and more individually tailored cancer therapies. Targeted therapies are highly effective, but it is crucial that combinations are carefully selected so as to avoid the development of tumour drug resistance.

The Centre of Excellence in Translational Cancer Biology is committed to identifying new targets for therapy among the body's own cells that are necessary for the growth and spread of cancer. The search is focused on blood and lymphatic vessels and stroma that are known to be important to cancer. In addition, we are interested in exploring other cellular structures that have proved significant in the immediate vicinity of cancer cells. Blockers targeting these cells can open up huge new opportunities to develop targeted combination therapies.

During our CoE term, we will be using preclinical models to identify new treatment strategies designed to prevent the growth and spread of cancer. The expertise of our world-leading researchers ranges from the basic biology of cancer to treatment trials, providing an optimal setting for the translation of research results into practice for the patient's best. The CoE is ideally placed to conduct basic research that can pave the way to effective methods for the diagnosis and targeted therapy of cancer. ■



Academy Professor Kari Alitalo

> Our basic research can pave the way to effective methods for the diagnosis and targeted therapy of cancer.

FACTS:

Number of staff: 61.

Sites of research: University of Helsinki and University of Turku. VTT Technical Research Centre of Finland, Hospital District of Helsinki and Uusimaa, National Institute for Health and Welfare and Turku University Hospital are also involved in the research.

Number of research staff recruited from abroad: 21.

Average age of research staff: 37 years.

More efficient primary production

The Centre of Excellence in Molecular Biology of Primary Producers is interested in exploring the growth, development and stress and energy metabolism of plants and photosynthesising microorganisms. We apply the most up-to-date research methods in the field of systems and synthetic biology. Basic research in this field – and therefore related applied research that promotes bioeconomy – is highly fragmented throughout the world.

The consumption of fossil fuels has caused the climate to change, and the continuing growth of the world population requires that food production is stepped up. The European Union has proposed new strategies for the transition to bioeconomy, but the key lies in the limits of primary energy production. It is imperative to increase the ability of plants, algae and cyanobacteria to capture solar energy in a form that is useful to humans as food, fuel and animal fodder.

Our aim is to find out how photosynthesising organisms integrate the absorption of solar light energy and the consequent carbon metabolism pathways, and to explore opportunities to improve the efficiency of primary production.

Our photosynthesis researchers and our plant development and stress biology researchers are internationally respected experts in their fields. To date, they have had only limited contact with one another, but the CoE offers a unique opportunity for them to join forces.

Academy Professor Eva-Mari Aro

> How do photosynthesising organisms integrate the absorption of solar light energy and the consequent carbon metabolism for efficient productivity?

FACTS:

Number of staff: Around 80.
Sites of research: University of Helsinki and University of Turku.
Number of research staff recruited from abroad: Around 40.
Average age of research staff: About 38 years.

CENTRE OF EXCELLENCE IN BIOMEMBRANE RESEARCH: FROM LIPID-PROTEIN INTERACTIONS TO FUNCTIONS

Communication at cell level

How do lipids and proteins interact in the cell membrane? Biomedicine does not have an answer to this question. At least not yet. ▶


BIOMEDICI
HELSINK

The laws of interaction

Researchers at our Centre of Excellence are working to establish the laws that govern the interplay between proteins and fats or lipids, the main components of cells. Cell research today is focused on proteins, for the simple reason that lipids are more challenging to study.

Yet, cells are full of membrane structures composed of lipids. For cells to function, membranes need to be actively engaged in intracellular trafficking that is mediated by proteins. While the mechanism of membrane traffic has been successfully studied, very little is known about lipid-protein interactions.

Lipid membranes both help and hinder interactions between proteins. In fact, the membrane environment may determine what function a protein is capable of performing, and which other proteins it communicates with. But why? This is the mystery that we are now going to investigate.

From basic research to practice

Researchers at our CoE are developing and using new techniques that will help shed light on these interactions. The tools we use include imaging, biophysical and biochemical methods and mathematical modelling. Our simplest models are computer simulations of the interactions between membranes and proteins. The next step is to study simple model membranes in test tubes and then to tackle real living cells.

The focus of our research is at the level of basic cellular mechanisms, and we will not limit our studies to the treatment of any specific cell tissue, cell part or disease. The results of our work have implications in a wide range of fields. Indirectly, they can contribute to the development of new medical drugs because most receptors targeted by drugs are located in cell membranes, and multiple receptor signalling requires the reorganisation of membranes. Furthermore, as many drugs are soluble in fats, an understanding of molecular interactions will help us predict the effects of a drug molecule in a more precise manner.

In addition, our research will help understand the mechanisms of, for instance, cardiovascular and Alzheimer's diseases, because fats play a major role in the development of these conditions. We

Academy Professor Elina Ikonen

▶ Our research focuses on how lipids and proteins interact while directing cellular functions. ◀

can take cells from a person suffering from such a disease and find out why a certain protein is not functioning properly in its membrane environment.

A fascinating journey

The research conducted at our CoE is not a popular science around the world and it involves a lot of risks. That is why we have built up an extensive international network with researchers in this field.

Given our CoE status, we are now in the position to formulate broad research questions that no individual research team could tackle alone. Our aim is not to study all possible protein-lipid interactions. Instead, we want to understand the laws governing those interactions.

Our CoE has a simple structure. One team is studying cholesterol, the most common lipid in cellular membranes. Another team is studying actin, the most abundant protein in cells and responsible for forming support structures in cells. Actin is what keeps us from falling apart. It affects the shape of cells and how the intracellular membrane structures are formed. Furthermore, our theoretical physics and FiDiPro groups simulate nanoscale phenomena, such as interactions between molecule parts and atoms. It would be virtually impossible to reach this level of accuracy by experimental means alone.

Our CoE team is highly committed and motivated and has access to state-of-the-art tools. We also now have a long enough time perspective so that we can be ambitious in the formulation of our research questions and in our choice of research methods. If you want to be a forerunner, it is clear that you cannot wait for others to establish novel research methods. We are keen to lead the way rather than follow in someone else's footsteps. Besides, our team spirit makes this a fascinating journey.

FACTS:

Number of staff: 64.
Sites of research: University of Helsinki and Tampere University of Technology.
Number of research staff recruited from abroad: 26.
Average age of research staff: 34 years.

A new dimension of mapping

The basic idea behind the laser scanner is simple and straightforward: the distance between the object and scanner is measured based on the time travelled by the laser pulse. When the laser scanner's exact position and orientation are known, the distance measurement can be converted into location information of the object. The laser scanner produces a cloud of points of the object that can be used for highly accurate and detailed 3D mapping.

The Centre of Excellence in Laser Scanning Research covers the development of hardware electronics, system integration and positioning technologies and in-depth research into new innovations, information extraction methods, visualisation techniques and applications based on these technologies. Laser scanning has important applications, for instance, in the estimation of standing tree stocks and in 3D modelling of the built environment.

We take a cross-disciplinary approach to our research. Our unit is privileged to have a number of world-leading researchers on its staff, most of whom are exceptionally young. Laser scanning itself is a young field of research, going back no more than some 15 years. In the modern information society of the early 2020s, we expect that laser scanning is an omnipresent technology that has a positive impact on the lives of every citizen. ■

Professor Juha Hyyppä

▶ In the early 2020s, laser scanning is omnipresent and has a positive impact on the lives of every citizen. ◀

FACTS:

Number of staff: More than 30 PhDs plus postgraduate students.

Sites of research: Finnish Geodetic Institute, University of Oulu, University of Helsinki and Aalto University.

Number of research staff recruited from abroad: More than 10.

Average age of research staff: 36 years.

New impetus for research on energy metabolism

The Centre of Excellence in Research on Mitochondria, Metabolism and Disease (FinMIT) is focused on the molecular mechanisms that regulate mitochondrial homeostasis. We apply disease models aimed at understanding pathological processes and testing treatment strategies.

A major area of focus is the pathophysiology of direct and indirect mitochondrial dysfunctions. We are also interested in the associations and mechanisms between metabolic obesity and mitochondria. We combine basic research with solid practical medical expertise.

Mitochondrial dysfunction is known to be a major factor in many diseases, including nervous system degeneration, heart disease and general metabolic diseases. As yet there is no cure for mitochondrial diseases, and there are few effective treatments. Therefore, the therapies developed based on our research represent significant new advances.

During our CoE term, we will continue our studies into how the mitochondria residing in our cells remain healthy and how they communicate

Academy Professor Howard T. Jacobs

with other parts of the cell in order to maintain metabolic balance. We couple this knowledge with genetic analyses in families with mitochondrial diseases in order to develop disease models that can help test the efficacy of treatments.

> Mitochondria are at the core of cell metabolism and human health.

FACTS:

Number of staff: 56 researchers and 6 technicians.
Sites of research: University of Tampere and University of Helsinki.
Number of research staff recruited from abroad: 28.
Average age of research staff: 30 years.

Going beyond the surface

Cardiovascular and metabolic diseases are a major public health concern in Finland. Researchers are now delving deep into the human body in an attempt to unravel the causes of these diseases.


B BRAUN

Public health in the balance

The main themes of our research are cardiovascular and metabolic diseases. Our aim is to develop new diagnostic methods for the early detection and prevention of these diseases and for their effective treatment and rehabilitation.

Heart disease is the single leading cause of death in Finland. One of our major goals, therefore, is to understand how heart disease begins and develops. A major focus of our work is on the build-up of fragile plaques in the heart and arteries. The rupture of these plaques causes stroke or myocardial infarction.

Cardiovascular and metabolic diseases are interwoven and interconnected in many ways. Obesity-related diabetes is a major risk factor for atherosclerosis, or hardening of the arteries, a key research focus at our Centre of Excellence. We are interested in exploring the molecular, genetic and environmental factors in the pathogenesis of atherosclerosis. Obesity and metabolic diseases place a considerable economic burden on the healthcare system.

Two cities

Our CoE works from two locations, that is, the Turku PET Centre and the University of Eastern Finland Kuopio campus. The work done by our research teams at these locations is seamlessly woven together. There is a long-standing synergy between our units, so there has been no need for us to learn how to work together. Furthermore, our expertise in cardiovascular and metabolic diseases goes back more than 20 years. Our unit is probably unique in the whole world.

Professor Juhani Knuuti

> Our CoE has at its disposal an exceptionally diverse toolkit that combines both basic research and clinical research.

Our CoE has at its disposal an exceptionally diverse toolkit that combines both basic research and clinical research. It follows that among our ranks we have a wide range of professionals, including medical doctors, biochemists and radiochemists, physicists, sports physiologists and researchers in the field of health biosciences.

In our work we use the latest genetic engineering techniques as well as animal models. Furthermore, we have access to one of the world's largest cohort datasets in diabetes research. All this means we are well placed to develop new diagnostic methods and gene therapies.

Another technology in our toolkit is advanced molecular imaging, which we use to test treatments and therapies and to monitor the behaviour of medicines in the patient's body. We use positron emission tomography or PET scanning, a method in which a radioactive marker is put into the patient's bloodstream, but also magnetic, x-ray and ultrasound imaging. Special cameras provide us with highly accurate images of the metabolic processes occurring in the body as the marker diffuses into tissue.

A grand passion

Our CoE has set itself ambitious goals. One of them is to identify the ultimate cause of type 2 diabetes and to be able to influence its development. Changes to insulin sensitivity at tissue level and insulin resistance are integrally related to these ambitions.

Our aim is not directly to find a cure for a specific cardiac or metabolic disease, although our research will certainly lead to new treatments. Our work will facilitate admission to treatment, the making of accurate diagnoses as well as rehabilitation. In the future, it might be possible to develop targeted medications for specific types of diabetes and to stabilise fragile arterial plaques with a course of medical treatment.

Some of our goals are so tough and ambitious that they can only be reached if every area performs to the absolute maximum of its potential and if new methods are developed as work progresses. However, without ambitious goals we would often fail to make progress even towards smaller intermediate ones. We are prepared to take innovative risks because ours is a field that often sees new and surprising findings.

Research in our blood

There is a good balance at our CoE between senior and junior researchers. It is particularly important for us that we have a good mix of researchers at different levels of their careers. We want to provide a stepping stone to a future career in science and research. Most importantly, we want to ensure that recent doctoral graduates always can move forward by providing them the opportunity to build up their senior profile.

It is impossible to overstate the immaterial value that comes with Centre of Excellence status. It has huge local significance to our host organisations, especially as there are just a few Finnish CoEs in the field of health research.

FACTS:

Number of staff: 97.

Sites of research: Turku PET Centre (University of Turku, Åbo Akademi University and Hospital District of Southwest Finland) and University of Eastern Finland Kuopio campus.

Number of research staff recruited from abroad: 23.

Average age of research staff: 35 years.

How organs are formed

Our Centre of Excellence conducts research in experimental and computational developmental biology. We have diverse expertise in the development of different organs as well as in computer modelling of development and evolution.

Our main areas of focus are the development of teeth, hair, mammary glands and fly wings. All these organs develop from the outer layer of the embryo, and furthermore their development is regulated by similar mechanisms.

We are interested in understanding the logic governing the shape and regeneration of organs. What is it in the gene regulatory networks that directs the formation of different organs? What kinds of developmental changes are seen during evolution? And how are new organs constructed from stem cells?

Our aim is to gain an understanding of the general principles governing the formation of different organs and to understand how gene mutations cause disturbances in organ development. In addition, we are working to develop different kinds of tools for the modelling of organs as well as imaging and culture methods for the experimental analysis of organ development and regeneration. The results obtained and tools developed in this work have application in basic research, teaching and in the future in building organs from stem cells.

Academy Professor Jukka Jernvall

> We are interested in understanding the logic governing the shape and regeneration of organs.

FACTS:

Number of staff: 37.
Site of research: University of Helsinki.
Number of research staff recruited from abroad: 17.
Average age of research staff: 35 years.

The atmosphere in change

Our main research focus is on the atmosphere and its interactions with different ecosystems. This work is based on an extensive network of field stations that produce detailed measurement data on energy and mass fluxes between the atmosphere and terrestrial biosphere. At these field stations, we take measurements of particles formed in forests, for instance, in order to determine their role in the formation of clouds in the atmosphere and thereby their impact on the climate. Our interests also extend to air quality and the relationships between the changing climate and airborne pollutants. We conduct a broad spectrum of research that extends from the molecular and cell level to the global climate.

Our observations of changes happening in the atmosphere and biosphere, not only in Finland but around the world, produce unique time series data. We use focused experiments and models to try to unravel the processes underlying the phenomena observed.

Our research is aimed at reducing the scientific uncertainties related to climate change. This will help deepen our understanding and produce more applicable results on the feedback mechanisms between atmospheric processes and natural ecosystems. Our results will help curb climate change and also facilitate adapting to climate change.

Academy Professor Markku Kulmala

Our research team includes scientists working in the fields of physics, chemistry, meteorology and forest sciences. Each member of our international and multidisciplinary team brings their own expertise to the table to help resolve the bigger picture.

> Our observations produce unique time series data.

FACTS:

Number of staff: 235.

Sites of research: University of Helsinki, University of Eastern Finland and the Finnish Meteorological Institute.

Number of research staff recruited from abroad: 59.

Average age of research staff: 35 years.

In search of the lost interpretation

People talk a great deal about the Bible, but do not read it enough. Or if they do, they don't question the text. However, a literal reading of the Bible is not possible. But does there exist a single "correct" interpretation or version of the Bible? ▶

A historical jigsaw

Our Centre of Excellence is interested in studying how cultural upheavals in the Middle East have influenced the creation and evolution of canonical sacred texts – and vice versa. The text in the main focus of our research is the Hebrew Bible, or the Old Testament.

We have a very thorough grounding in research methodology and a wide selection of source materials. Our four research teams, consisting of scholars of the Old and New Testaments, Assyriologists and archaeologists, all approach the subject in hand from different angles. Our aim now is to bring together these diverse perspectives and to achieve completely novel results. We want to construct a historically accurate overview using sources dug out – both literally and figuratively – from the ground, archives and museums.

The changing Word

Our research examines the processes and mechanisms of historical change at both the micro and macro levels. The changes concerned range from minute discrepancies between texts, manuscripts and translations to profound social, political, religious and demographic changes that have shaken nations.

The impetus for the writing of the Old Testament came from the destruction of Jerusalem and the religious, social and intellectual crisis that followed from the forced exile of its upper class. But what exactly was is it in the siege of this relatively anonymous city that prompted this text? What was its original purpose? And how do sacred texts become sacred and permanent? These are the kinds of questions that make our research so fascinating. Ours is a job of an historical sleuth digging deep into the texts of the Old Testament.

Professor Martti Nissinen

We are also interested in comparing different historical versions and translations of the Old Testament. Even the smallest changes made over the years may have led to major disparities in interpretations. The same is true for history of research, and this is why we hope that the conclusions drawn in our ongoing projects will provide fertile soil for future young scholars, who in turn can prove that we got it all wrong!

Our everyday knowledge

Current translations of the Old Testament are based on one medieval Hebrew manuscript that is about one thousand years old. However, during its time the text of the Old Testament has seen innumerable changes and it has been

translated several times into various languages. That is why the belief that the Bible is invariable simply isn't true. In our job it is necessary to be prepared constantly to question and challenge old notions and to go back all the way to the very foundation stone of religion.

The word of the Bible is often mentioned in public discussion today, and this is why we are convinced we can contribute to raising public awareness and knowledge. Decision-makers and ordinary citizens will no doubt be interested in knowing about the background to contemporary events in the Middle East and North Africa, for instance. Many of these answers are found in ancient cultural changes and in interpretations of the Bible and other sacred texts. We want to add an expert but at once a critical perspective to this debate.

> The belief that the Bible is invariable simply isn't true.

Strength in togetherness

Our research community is characterised first and foremost by collaboration. All information is systematically shared, and we work closely together on an equal basis. This we learned a long time ago: the more we pull together, the better the results. When one succeeds, all succeed.

Furthermore, we put a premium on creating a good atmosphere and maintaining good administrative practice. The idea is that it is possible to work in top gear within normal working hours – there's no need to do more. We also stress the value of togetherness and well-being in the workplace.

Many of the research staff at our CoE have a long history of collaboration. We have succeeded in creating a comprehensive and active international network of partners including leading universities and research communities in the fields of both theology and ancient history. ■

FACTS:

Number of staff: 40.

Site of research: University of Helsinki. A few CoE members are based elsewhere.

Number of research staff recruited from abroad: 9.

Average age of research staff: 34 years.

High culture of mathematics

The Centre of Excellence in Analysis and Dynamics Research consists of nine multidisciplinary research groups devoted to researching pure mathematics and its applications especially in the fields of physics and biology. Our aim is to create a new culture of mathematics in Finland that will encourage mathematicians to work more closely with application developers and to rethink the researcher training system.

Research at our CoE covers a broad spectrum of mathematical analysis and its applications. Specific fields of research include dynamical systems, geometric analysis, fractals, random geometry, partial differential equations and applications in turbulence, statistical mechanisms and mathematical models of biological evolution.

Our CoE brings together respected and internationally recognised mathematical analysis research teams whose synergy offers the potential to break open new territory. International cooperation is an integral part of our culture. Our partners include researchers from the best universities in the world, including Fields medallists, the equivalent of Nobel laureates in mathematics.

We aim at new breakthroughs by combining the latest ideas and approaches of analysis, probability theory and mathematical physics. ■

Academy Professor Antti Kupiainen

▶ The new culture of mathematics will encourage mathematicians to work more closely with application developers and to renew the researcher training system. ◀

FACTS:

Number of staff: About 85.

Sites of research: University of Helsinki, University of Jyväskylä and University of Oulu.

Number of research staff recruited from abroad: 29.

Average age of research staff: 35 years.

Leading the way in space climate research

The Centre of Excellence in Research on Solar Long-term Variability and Effects (ReSoLVE) specialises in research on space climate, that is, the long-term variability in the Sun's magnetic field and magnetic activity and its effects especially in near-Earth space.

The Sun's magnetic activity has varied dramatically in recent decades. Researchers at our CoE are working to find out what has happened in the Sun over the past 100–150 years and how this has impacted the occurrence of magnetic storms in the Earth's magnetosphere.

Solar wind disturbances may cause significant disruption to technological systems, such as satellites, data communications and electric power lines. The behaviour of the Sun also impacts the Earth's atmosphere and climate in many ways, but as yet we have only limited knowledge about these effects.

Our CoE consists of five research teams that work very closely together, for instance, in numerically modelling solar magnetic fields and the atmospheric effects of particles and in the comparison, analysis and interpretation of long time series of satellite and terrestrial measurements.

Professor Kalevi Mursula

We are widely regarded as an international pioneer in this field. We probably cover the field of space climate research from the Sun to near-Earth space and the Earth's atmosphere more thoroughly than any other research team in the world. ■

▶ The recent, dramatic changes have surprised even the most experienced solar researchers. ◀

FACTS:

Number of staff: About 35.

Sites of research: University of Oulu, Aalto University and Finnish Meteorological Institute.

Number of research staff recruited from abroad: About 18.

Average age of research staff: 35 years.

A new dimension to borders

A border is not just a line that separates, but also one that unites. Border crossing has become a focal point for research. ▶

CENTRE OF EXCELLENCE IN THE RELATIONAL AND TERRITORIAL POLITICS OF BORDERING, IDENTITIES, AND TRANSNATIONALISATION

Living borders

Border research has proliferated in recent decades and attracted growing interest especially in connection with world-shaking events. First, following the collapse of Eastern Europe, the meaning of borders and the concept of border attracted many, even contradictory interpretations. Border research received a further boost from the US terror attacks of 2001, after which border-related security issues moved sharply onto the research agenda.

The research interests of our Centre of Excellence are in the areas of state spatial transformation, spatial socialisation and identities, border crossings and the management of global flows. These areas are further divided into a few general themes.

Border research is traditionally focused on a few iconic borders, such as that between the United States and Mexico. Here in Finland, research efforts are designed and geared to open new perspectives on borders and on the identities of nations and individuals. Our work has high current relevance and interest both in research and society generally.

Our research is often conducted in the form of case studies into the European border system or certain specific borders in southern Africa and Asia, for instance. We also incorporate the perspective of tourism into border research.

Thinking without borders

Various global flows and ethnic processes in today's world are putting a whole new face on the old-fashioned, state-centric world view. Nations' identities are no longer permanent and invariable, but there is a commitment and willingness to cherish them. Borders appear as both social and technological landscapes of power and control.

Professor Anssi Paasi

With the increasing use of biometric identifiers, even people's bodies have transformed into borders of sorts that they carry wherever they go. At the same time, the role of the state is elevated to a new scale. The European Union, for example, regulates at various levels what can and may be done in Finland. Finland, for its part, contributes to various EU systems. Closed states have evolved into networks.

One area that holds special interest to us in our research on transnationalisation or cross-border processes is the Finnish regional planning system. Processes of policy transfer involve the integration of international practices and strategies and their terminology as part of the national system. Our research interests also extend to the

> Our work has high current relevance and interest both in research and society generally.

construction of socialisation, national identity and citizenship.

The core of our research lies in human geography, but much of our work cuts across disciplinary boundaries, both in theoretical and empirical research. Boundaries are explored not only from the vantage point of geographical, but also political and cultural research.

Always on the map

The members of our CoE have been involved in shaping the development of border research since the 1990s. We continue to set ourselves high standards both with respect to our publishing profile and our results, which at best will help change the concepts and key approaches of our research tradition. Our ambition is to be a net exporter rather than importer of new theory and results. One of the biggest challenges for our project is to bring international exposure to Finnish social and cultural research.

Our research also involves the nitty-gritty of fieldwork at different sites around the world. This includes document analysis, interviews, basic social sciences methods and overviewing statistics in order to identify the general trend of major flows. In addition, we will be holding numerous international seminars.

The senior researchers at our CoE go back several decades. Their research interests are mutually complementary, which indeed was the crown of our successful research plan. Ours is an equal opportunities research community where younger people learn from more experienced colleagues and vice versa.

We anticipate that our CoE will give added prominence to the role of geography in the field of sciences. At the same time, we hope that this opportunity will motivate our young and talented researchers to break glass ceilings in the academic world. ■

FACTS:

Number of staff: At the outset 22, new recruitments will bring in 8–9 more research staff.

Sites of research: University of Oulu and University of Tampere School of Management.

Number of research staff recruited from abroad: Only a few, but number is set to increase with new recruitments.

Average age of research staff: 35 years.

Understanding and lack of prejudice

Our research focuses on the question of how religious groups in the past as well as today have accepted or recognised other groups in society and vice versa, how religions have been accepted in different societies.

Researchers at our Centre of Excellence are interested in studying the era of Antiquity and Early Christianity as well as encounters between Christianity, Islam and Judaism. Another area of interest is the discourse on tolerance from the Middle Ages to Enlightenment. Indeed, the treatment of minorities, a recurring theme in public debate today, is one of the CoE's areas of focus. In addition, one of our research teams is working to develop philosophical models to help understand contemporary religious discourse.

Our research methods are historical and philosophical: the aim is to gain a better understanding of our subject and to develop as universal models as possible for religious thinking and behaviour. Even though ours is a sympathetic understanding approach grounded in the humanities, we also put our results to practical use.

Professor Risto Saarinen

Our first major report is concerned with religious recognition in the history of ideas. We will be putting forward models of religious recognition that can help increase tolerance in multicultural society. We present an academic case for the view that despite their differences, religions could in fact share a common understanding of the opportunities and limits of rational discussion.

> Multicultural society needs a rational understanding of religions.

FACTS:

Number of staff: 35.
Site of research: University of Helsinki.
Number of research staff recruited from abroad: Two.
Average age of research staff: 42 years.

ISBN 978-951-715-872-5

Academy of Finland: leading the way in science

The Academy of Finland provides funding for cutting-edge and innovative research aimed at significant scientific breakthroughs. The Academy is Finland's leading expert organisation in science and science policy and in that role is committed to strengthening the position of science and research. Our overriding aim is to support the renewal, diversification and internationalisation of Finnish research.

The Academy offers many funding opportunities to support individual researchers at different stages of their career. We facilitate researcher training and research careers, promote internationalisation and further the practical application of research results. We also encourage researchers to submit boundary-breaking, high-risk but high-quality research plans that offer potential for breakthroughs.

Previous Centre of Excellence programmes:

1995–1999	17 CoEs
2000–2005	26 CoEs
2002–2007	16 CoEs
2006–2011	23 CoEs
2008–2013	18 CoEs
2012–2017	15 CoEs

For more information, go to www.aka.fi/coe

ACADEMY OF FINLAND

Hakaniemenranta 6 • POB 131, FI-00531 Helsinki
Tel. +358 295 335 000 • Fax +358 295 335 299

www.aka.fi/eng