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Centres of Excellence in Research 2018–2025

The Centre of Excellence Programme 2018–2025 involves 12 Centres of Excellence (CoE) in Research, composed of research teams from a total of twelve universities and research institutes.

Law, Identity and the European Narratives

The dilemma of many current European crises is that popular support for the ideals behind the EU – human rights, equality and shared prosperity – has dropped inside the Union. At the same time, the massive wave of migrants making their way into Europe are seeking precisely that: security, rule of law and economic opportunity.

Much of the earlier scholarship on European integration and the law has been constitutional, examining the issues of European constitutionalism within its framework. In contrast, the Centre of Excellence in Law, Identity and the European Narratives seeks to critically investigate the foundations of the European narrative about a shared heritage of law, values and ideals. The purpose is to examine crises through the development of conflicting narratives of Europe in 20th-century thinking and its impact on contemporary policies and popular perceptions.

Furhter information: Kaius Tuori (University of Helsinki, UH), Pamela Slotte (UH) and Reetta Toivanen (UH); The Centre of Excellence in Law, Identity and the European Narratives website

Ageing and Care

The Centre of Excellence in Research on Ageing and Care studies the transformation of ageing and care for older people using new conceptual and interdisciplinary perspectives. The research of the CoE combines an analysis of the diversification of everyday life with an analysis of ongoing profound societal and policy changes. In particular, the CoE will explore the implications of transnationalisation and digitalisation for ageing and care.

The CoE combines scholarship from social policy, sociology and gerontology, analysing older people's care needs, agency and equality as well as the changing character of care work. Its research is a concerted effort of four different research groups from the Universities of Jyväskylä, Tampere and Helsinki and involves close collaboration with a broad network of leading international scholars. The CoE also acts as an international training platform for early-career researchers.

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Further information: Teppo Kröger (University of Jyväskylä, UJ), Marja Jylhä (Tampere University), Sakari Taipale (UJ) and Sirpa Wrede (University of Helsinki); Centre of Excellence in Research on Ageing and Care website

Inverse Modelling and Imaging

Inverse modelling is an interdisciplinary field of science that concentrates on the mathematical theory and practical interpretation of indirect measurements. In addition to purely mathematical problems, the research in the Centre of Excellence of Inverse Modelling and Imaging focuses on problems encountered in medical imaging, geophysical prospecting and nondestructive testing. The methods of inverse problems bring the advances of modern mathematics to a vast number of applied areas.

Also, inverse modelling applications inspire new and deep mathematical questions closely connected to other sciences. Inverse problems research is one of the most important and topical fields of contemporary applied mathematics.

Further information: Matti Lassas (University of Helsinki, UH), Heikki Haario (LUT University), Antti Hannukainen (Aalto University, AU), Nuutti Hyvönen (AU), Mikko Kaasalainen (Tampere University, TAU), Jari Kaipio (University of Eastern Finland, UEF), Ville Kolehmainen (UEF), Sampsa Pursiainen (TAU), Mikko Salo (University of Jyväskylä), Aku Seppänen (UEF), Andreas Hauptmann (University of Oulu), Samuli Siltanen (UH), Johanna Tamminen (Finnish Meteorological Institute), Tanja Tarvainen (UEF) and Marko Vauhkonen (UEF); Centre of Excellence of Inverse Modelling and Imaging website

Stem Cell Metabolism

Stem cell research holds great promise for treatment strategies spanning from organ replacements to treatments that slow the ageing process and reduce ageing-related diseases such as cancer, cardiovascular disease and neurodegenerative diseases. To fully realise the potential of stem-cell-based strategies, we must better understand the cellular processes that are critical to stem cell function. Stem cells have a unique metabolism, but its role is not yet fully understood.

The Centre of Excellence in Stem Cell Metabolism focuses on investigating what role the distinctive metabolism of stem cells may play in stem cell biology. The CoE also addresses how stem cell function can be modified by regulating their metabolism, and aims to develop approaches utilising metabolic control in stem-cell-based therapies.

Further information: Pekka Katajisto (University of Helsinki, UH), Ville Hietakangas (UH), Timo Otonkoski (UH) and Henna Tyynismaa (UH); Centre of Excellence in Stem Cell Metabolism website

Tumour Genetics Research

Neoplasms, commonly known as tumours, are a challenging disease group as every single case is unique. Environmental factors, genomes, epigenetic modifications and

combinations of these all play a significant role in the disease process. Researchers in the Centre of Excellence in Tumour Genetics Research have previously made important discoveries in identifying major human tumour genes, thus increasing understanding of the basic concepts of neoplastic growth. This creates a solid foundation for the CoE's research.

Technological advances have facilitated the genome-wide characterisation of individuals and cancers. Research has produced an enormous amount of new data, and the rapid advances in technologies continue to open up opportunities towards novel scientific breakthroughs.

The CoE can advance beyond the state-of-the-art in improving the understanding of genome function by using large datasets and by creating and analysing new datasets from patient populations identified via unique Finnish registries. The CoE will bring genomic medicine into practice. A key goal is also to produce new expertise that will support the launch and development of Finland's National Genome and Cancer Centre.

Further information: Lauri Aaltonen (University of Helsinki, UH), Matti Nykter (Tampere University), Janne Pitkäniemi (Finnish Cancer Registry) and Jussi Taipale (UH); Centre of Excellence in Tumour Genetics Research website

Research of Sustainable Space

Space is an emerging megatrend. The increasing number of satellites threatens the sustainable use of space, as without removal, space debris will make critical orbits unusable. A central factor affecting spacecraft lifetime is the radiation environment, which is unpredictable due to an incomplete understanding of plasma dynamics.

The Centre of Excellence in Research of Sustainable Space combines top Finnish assets in space physics and debris to bring about an international paradigm change in the sustainable utilisation of space. The researchers will build a next-generation radiation-tolerant nanosatellite fleet to advance the understanding of the radiation environment to an unprecedented level. They will also demonstrate sustainability by bringing the spacecraft back to the atmosphere.

The CoE performs cutting-edge experimental analysis utilising international space missions and the world's best supercomputer modelling tools. It will exploit top-tier science to secure safe orbits for the future, and revolutionise experimental space physics based on nanosatellites.

Further information: Minna Palmroth (University of Helsinki, UH), Pekka Janhunen (Finnish Meteorological Institute), Emilia Kilpua (UH), Jaan Praks (Aalto University) and Rami Vainio (University of Turku); Centre of Excellence in Research of Sustainable Space website

The History of Experiences

The Centre of Excellence in the History of Experiences studies the role and place of experiences in society and in explaining history. It presents a new approach, history of experiences, as a way to establish how people's experiences are formed, how they are interpreted and how they influence individuals' relationships to their community and to society at large. The CoE's research will focus on the role of experiences by studying three major social constructions: (lived) religion, (lived) nation and (lived) welfare state. The prefix 'lived' refers to how societal reality is always reflected and made through experiences. Much research has been done on experiences, but they have not been systematically studied as part of the individual-society relationship or when explaining the history of institutions and ways of thinking through a combination of micro and macro analysis. The research data include Finland's and Europe's history, offering an example of how to understand, explain and solve key questions of the present and the future human society.

Further information: Pirjo Markkola (University of Tampere, TAU), Ville Kivimäki (TAU), Raisa Toivo (TAU) and Pertti Haapala (TAU, former director of the Center of Excellence); Centre of Excellence in the History of Experiences website

Complex Disease Genetics

Revealing the molecular mechanisms underlying common complex diseases holds the promise of improved and targeted prediction, prevention, diagnosis and treatment. Building on unique resources and an extensive track record in disease genetic studies in Finland, the Centre of Excellence in Complex Disease Genetics aims to develop and apply a powerful, reliable and general strategy for comprehensive identification of risk and protective variants. The CoE will also develop and pilot strategies and lead national efforts to implement genomic findings into prevention and personalised treatment of common complex diseases.

Further information: Samuli Ripatti (University of Helsinki, UH), Mark Daly (UH), Leif Groop (UH), Jaakko Kaprio (UH), Aarno Palotie (UH), Matti Pirinen (UH) and Tiinamaija Tuomi (UH); Centre of Excellence in Complex Disease Genetics website

Quantum Technology

In the near future, quantum technologies will have a profound impact on our society. As a pioneer in the field, the Centre of Excellence in Quantum Technology brings together scientific and technological excellence and cutting-edge research infrastructures to harness quantum phenomena in solid-state-based quantum devices and applications.

The CoE aims to introduce novel approaches for control of quantum coherence and dissipation and to develop new and improved quantum circuits and hybrid

architectures. Its research combines experimental, theoretical and applied expertise in all-superconducting and silicon-based devices, superconducting-metal interfaces, graphene and other 2D materials, nanowires and carbon nanotubes. New technological applications are foreseen in quantum sensors, simulators, communication and computing, with unprecedented scientific, economic and societal benefits.

Further information: Jukka Pekola (Aalto University, AU), Tapio Ala-Nissilä (AU), Christian Flindt (AU), Pertti Hakonen (AU), Sabrina Maniscalco (University of Helsinki), Mikko Möttönen (AU), Gheorghe-Sorin Paraoanu (AU), Mika Prunnila (VTT Technical Research Centre of Finland Ltd), Mika Sillanpää (AU), Zhipei Sun (AU) and Visa Vesterinen (VTT); Centre of Excellence in Quantum Technology website

Body-on-Chip Research

The Centre of Excellence in Body-on Chip Research is based on strong, existing collaboration between the participating research groups and on joint research results produced in the Human Spare Parts project. The CoE combines know-how in biological and engineering sciences to develop a new "body-on-chip" platform.

The platform will consist of several cultured tissue blocks connected with cultured vasculature and nervous systems. The way it works is that the computer-integrated nervous system stimulates, analyses and even controls different biological processes in vitro. To achieve this goal, the researchers will combine multidisciplinary expertise on human stem cells, biomaterials, sensors, microfluidics, biomodelling and bioimaging.

The CoE will produce comprehensive knowledge, for example, on understanding tissue interactions, constructing complex in vitro tissue co-cultures and controlling their functionalities. The resulting expertise and technologies will improve, for instance, the development of new personalised treatments and drugs.

Further information: Minna Kellomäki (Tampere University, TAU), Katriina Aalto-Setälä (TAU), Jari Hyttinen (TAU), Pasi Kallio (TAU), Susanna Miettinen (TAU) and Susanna Narkilahti (TAU); Centre of Excellence in Body-on-Chip Research website

Ancient Near Eastern Empires

The Centre of Excellence in Ancient Near Eastern Empires studies the changing imperial dynamics of social group identities in the first millennium BCE Near East. The CoE is a multidisciplinary project, applying methods from digital humanities, sociology, archaeology and cultural heritage studies.

The CoE contributes to a thorough understanding of the imperial impact on social groups, focusing on local and minority social group identities in a time of dramatic political change in the cradle of civilisation – the ancient Near East in the first millennium BCE. The CoE uses cross-disciplinary methods, studying the periods of Neo-Assyrian,

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Neo-Babylonian, Persian, Hellenistic and early Roman control to increase dialogue between ancient historians, archaeologists and social scientists.

Further information: Saana Svärd (University of Helsinki, UH), Antti Lahelma (UH) and Jason Silverman (UH); Centre of Excellence in Ancient Near Eastern Empires website

Game Culture Studies

The Centre of Excellence in Game Culture Studies brings together leading expertise in game culture studies to develop original theoretical and empirical approaches that are crucial for understanding, anticipating and influencing the impact games have on culture and society.

The CoE's work is focused on four interconnected themes: the meaning and form of games; the creation and production of games; players and player communities; and the societal framing of games.

Further information: Frans Mäyrä (Tampere University, TAU), Raine Koskimaa (University of Jyväskylä), Olli Sotamaa (Tau) and Jaakko Suominen (University of Turku); Centre of Excellence in Game Culture Studies website