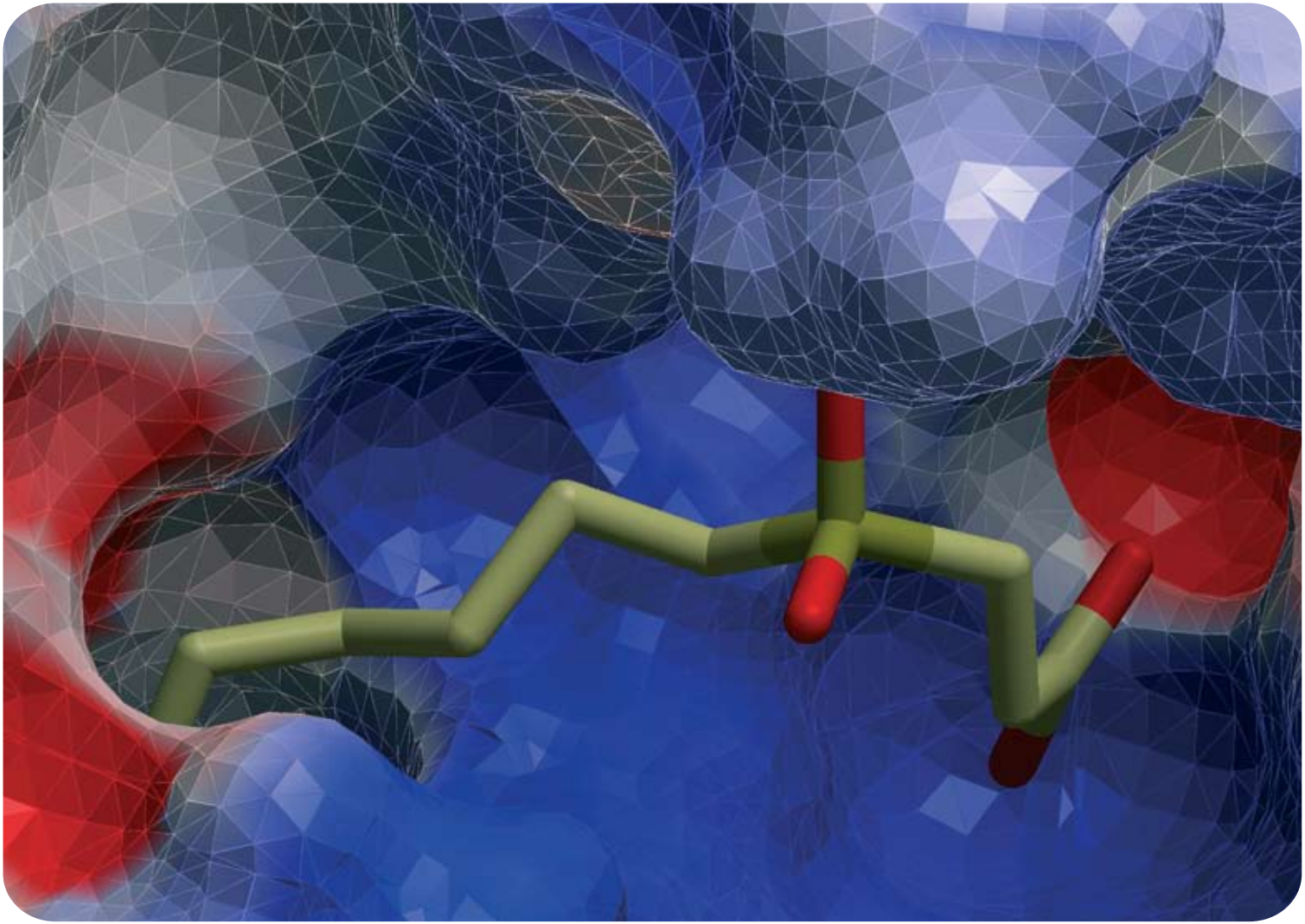
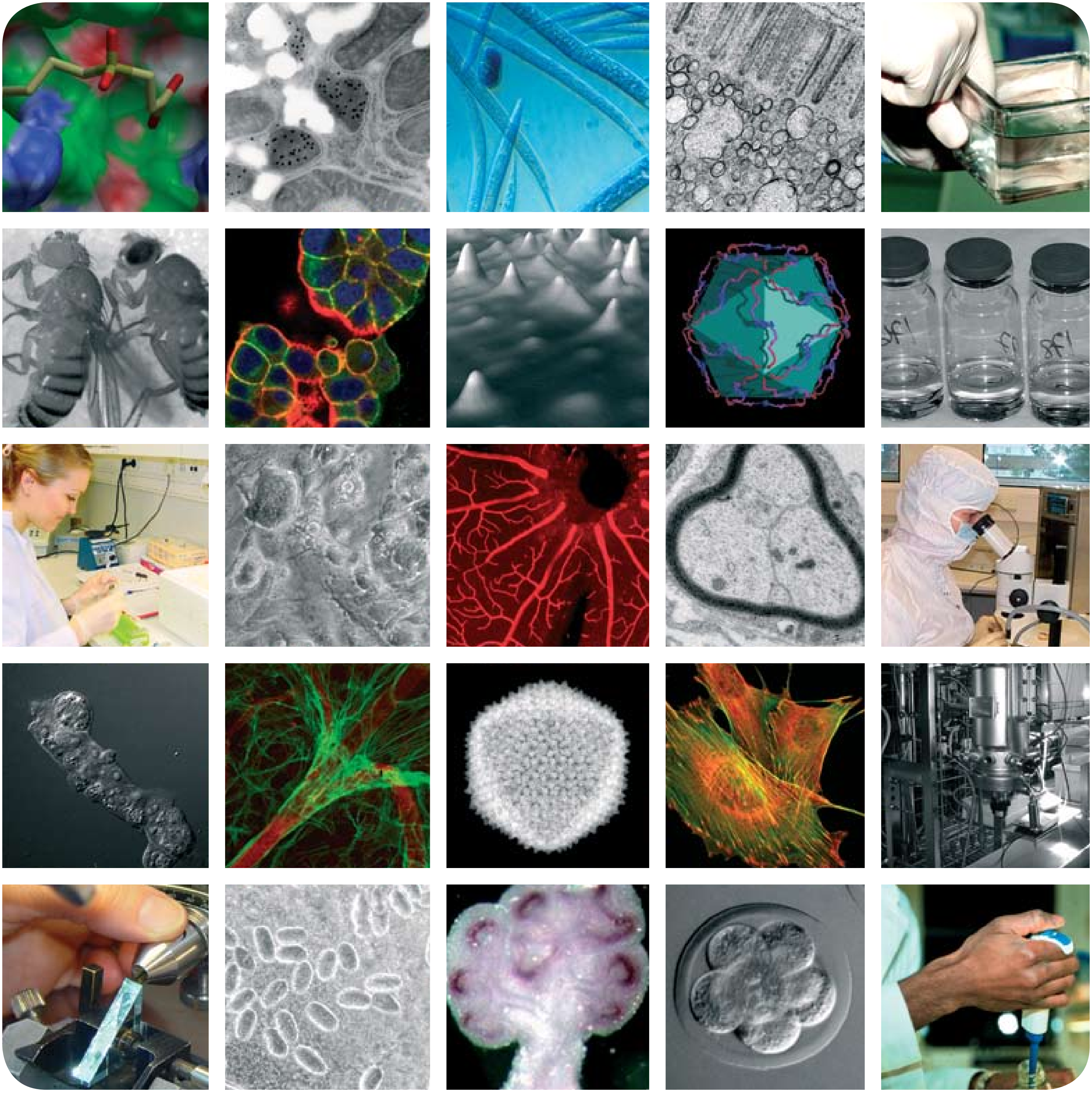
Biocenter Finland





Biocenter Finland

National Network of Biocentres

Biocenter Finland is an umbrella organisation of biocenters in six Finnish Universities (Helsinki, Kuopio, Oulu, Tampere and Turku, and the Åbo Akademi University). When established in the 1980's and 1990's, Finnish biocenters represented new types of multidisciplinary research organizations bringing together life scientists and biomedical researchers working in universities, research institutions, hospitals and industry. Establishment of Biocenters marked the first stage in the restructuring of basic research; multidisciplinary research programs were initiated, research infrastructure was strengthened through joint core facilities, and researcher training and technology transfer were reorganized.

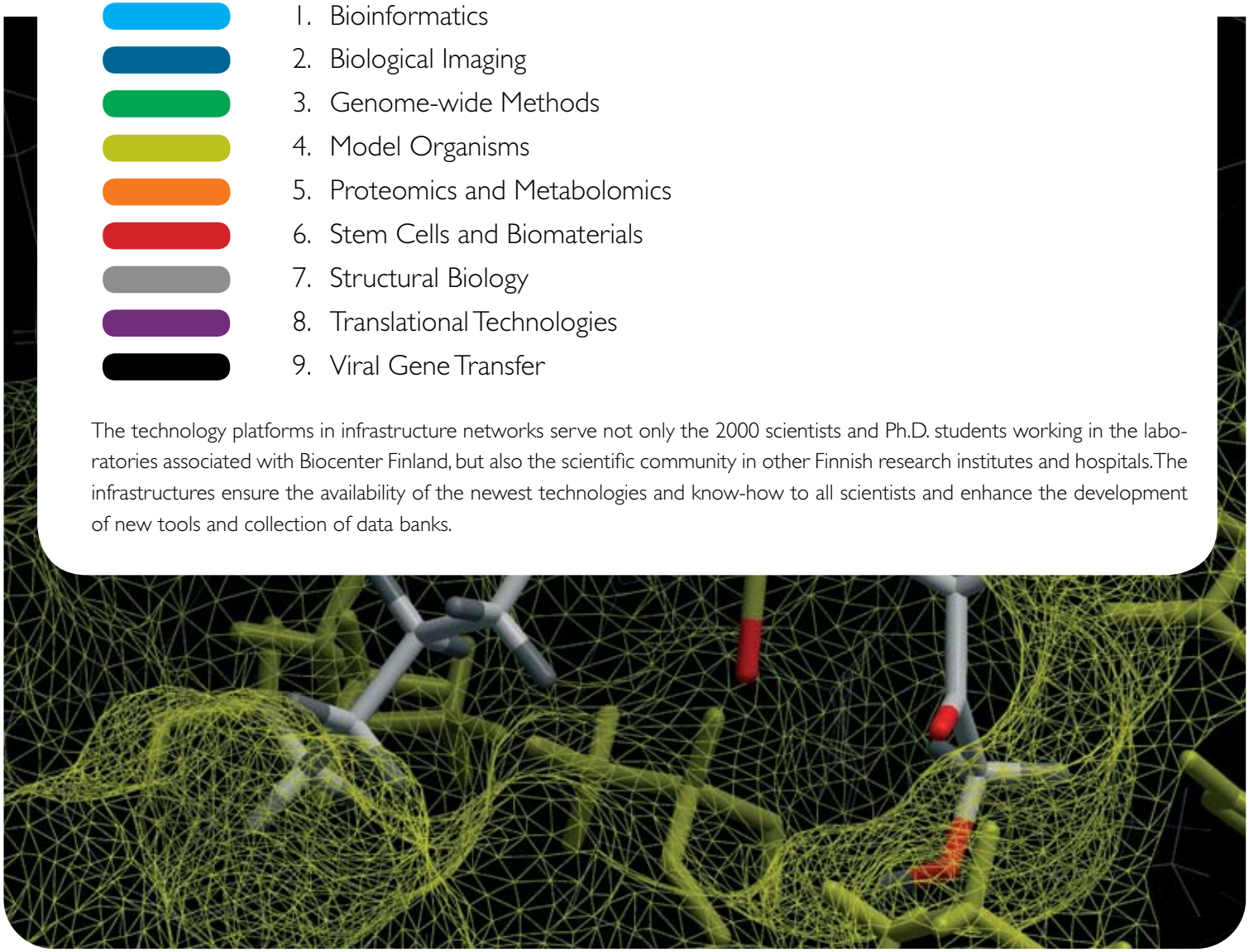
Establishment of Biocenter Finland in 2006 marked the second stage in the restructuring of biological and medical research infrastructure at the national level. Today the most visible activity of Biocenter Finland is provision of funding for nationwide technology services in the partner biocenters for the benefit of the entire scientific community. The aim is to avoid unnecessary overlaps and invest into the newest technologies and equipment. Technology services are provided by Biocenter Finland infrastructure networks in bioinformatics; biological imaging; genome-wide methods; model organisms; proteomics and metabolomics; stem cells and biomaterials; structural biology and biophysics; translational research technologies; and viral gene transfer and cell therapy.

Biocenter Finland also supports emerging technologies, and promotes international researcher training and recruitment, research career development, and commercial exploitation of research results. Through its infrastructure networks Biocenter Finland is actively involved in the development pan-European infrastructures on the ESFRI Roadmap.

Biocenter Finland – Infrastructure Networks

1. Bioinformatics
2. Biological Imaging
3. Genome-wide Methods
4. Model Organisms
5. Proteomics and Metabolomics
6. Stem Cells and Biomaterials
7. Structural Biology
8. Translational Technologies
9. Viral Gene Transfer

The technology platforms in infrastructure networks serve not only the 2000 scientists and Ph.D. students working in the laboratories associated with Biocenter Finland, but also the scientific community in other Finnish research institutes and hospitals. The infrastructures ensure the availability of the newest technologies and know-how to all scientists and enhance the development of new tools and collection of data banks.



1. Bioinformatics

Coordinator: Sampsa Hautaniemi, Biomedicum Helsinki, University of Helsinki

Due to advances in measurement technologies, such as microarrays, mass spectrometry, deep sequencing and large-scale screening, bioinformatics has become an integral part of biological and biomedical research. These technologies produce huge amounts of data on gene sequences, mutations, protein structures, human diseases and mouse phenotypes, and are typically collected into data banks.

Bioinformatics provides tools, such as in silico modeling and simulation, to translate multidimensional biological data into knowledge and medical benefits. Thus, the productivity of biomedical sciences and related industries is increasingly dependent on computational methodologies and software. Lack of such software or methodologies is seen as a bottleneck for cutting-edge research exploiting the high-quality Finnish biodata and novel measurement technologies. Therefore, the major objective of Bioinformatics Infrastructure network is to provide services for both bioscientists (e.g., data analysis, experimental design and software) and bioinformaticians (e.g., APIs to databases, technology transfer and technology platforms).

$$\nabla^2\varphi_{\mathrm{A}}(\mathbf{r}) = -\sum_i \frac{q_i^{\mathrm{A}}}{\epsilon_0\epsilon_{\mathrm{A}}}\delta(\mathbf{r}-\mathbf{r}_i),$$

$$\int_{\Sigma_{\mathrm{A}}}\left(F(\mathbf{r},\mathbf{r}_0^{\mathrm{A}})\frac{\partial\varphi_{\mathrm{S}}(\mathbf{r},\mathbf{r}_0^{\mathrm{A}})}{\partial n}-\varphi_{\mathrm{S}}(\mathbf{r})\frac{\partial F(\mathbf{r},\mathbf{r}_0^{\mathrm{A}})}{\partial n}\right)\mathrm{d}\sigma+\int_{\Sigma_{\mathrm{B}}}\left(F(\mathbf{r},\mathbf{r}_0^{\mathrm{A}})\frac{\partial\varphi_{\mathrm{S}}(\mathbf{r},\mathbf{r}_0^{\mathrm{A}})}{\partial n}-\varphi_{\mathrm{S}}(\mathbf{r})\frac{\partial F(\mathbf{r},\mathbf{r}_0^{\mathrm{A}})}{\partial n}\right)\mathrm{d}\sigma$$
$$-\sum_k\frac{q_k^{\mathrm{S}}}{\epsilon_0\epsilon_{\mathrm{S}}}F(\mathbf{r}_k,\mathbf{r}_0^{\mathrm{A}})=0.$$

$$\frac{1}{2}\left(1+\frac{\epsilon_{\mathrm{S}}}{\epsilon_{\mathrm{B}}}\right)\varphi_{\mathrm{B}}(\mathbf{r}_0)=\left(\frac{\epsilon_{\mathrm{S}}}{\epsilon_{\mathrm{B}}}-1\right)\int_{\Sigma_{\mathrm{B}}}\frac{\partial F(\mathbf{r},\mathbf{r}_0)}{\partial n}\varphi_{\mathrm{B}}(\mathbf{r})\mathrm{d}\sigma+\left(\frac{\epsilon_{\mathrm{S}}}{\epsilon_{\mathrm{B}}}-\frac{\epsilon_{\mathrm{A}}}{\epsilon_{\mathrm{B}}}\right)\int_{\Sigma_{\mathrm{A}}}\frac{\partial F(\mathbf{r},\mathbf{r}_0)}{\partial n}\varphi_{\mathrm{A}}(\mathbf{r})\mathrm{d}\sigma$$
$$+\frac{\epsilon_{\mathrm{A}}\epsilon_{\mathrm{S}}}{\epsilon_{\mathrm{S}}\epsilon_{\mathrm{B}}}\sum_i\frac{q_i^{\mathrm{A}}}{\epsilon_0\epsilon_{\mathrm{A}}}F(\mathbf{r}_i,\mathbf{r}_0)+\sum_j\frac{q_j^{\mathrm{B}}}{\epsilon_0\epsilon_{\mathrm{B}}}F(\mathbf{r}_j,\mathbf{r}_0)+\frac{\epsilon_{\mathrm{S}}}{\epsilon_{\mathrm{B}}}\sum_k\frac{q_k^{\mathrm{S}}}{\epsilon_0\epsilon_{\mathrm{S}}}F(\mathbf{r}_k,\mathbf{r}_0).$$

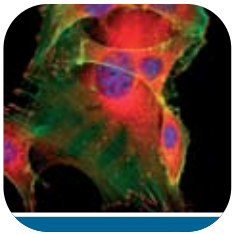
2. Biological Imaging

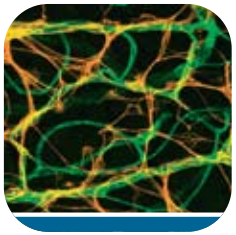
Coordinator: John Eriksson, BioCity Turku, Åbo Akademi

Biological imaging ranges from the visualization of ions, molecules, cells and tissues to the non-invasive imaging of full size animals. The importance of imaging has grown tremendously since the development of methods and markers for live cell imaging, such as green fluorescent proteins for confocal microscopy, as well as novel microscopic principles. Different in vivo imaging modalities such as computer tomography (CT), single photon emission computer tomography (SPECT) and magnetic resonance imaging (MRI) has given us tools to visualize structure, metabolism and function in a living body.

Modern imaging requires sophisticated instrumentation for data acquisition and methods of bioinformatics and data handling for their storage and analysis. The prerequisite for live cell imaging is that the equipment is near to the laboratories and animal centres. Therefore, each biocenter has confocal microscopes, video microscopes, and transmission electron microscopes for imaging of cells and tissues. However, in the National Imaging Infrastructure Network of Biocenter Finland, different biocenters have been granted specific spearheaded tasks. Helsinki and Turku are focused on the recent developments of new imaging technologies including high-resolution STED, PALM and STORM microscopy as well as high content screening at cellular and molecular level. Turku Bioimaging hosts some of these most recent technologies and has a high-resolution optical imaging core service at the BF level.

High resolution electron cryo-microscopy, electron tomography and three-dimensional image reconstruction for nanoscale structures are available at the Institute of Biotechnology in the University of Helsinki. In vivo imaging facilities include instrumentation in PET in Turku, MRI in Kuopio and Helsinki, as well as optical methods in Helsinki and Turku.





3. Genome-wide Methods

Coordinator: Tomi Mäkelä, Institute of Biotechnology, University of Helsinki

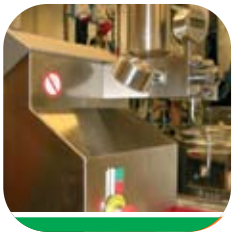
High throughput genetic methods and the development of novel technologies such as RNA interference (RNAi) are rapidly transforming both basic biological science and biomedicine requiring restructuring of conventional research units. Because of the highly specialized and capital-intensive nature of genomics instrumentation and reagent sets these should be developed as core infrastructures providing services to researchers nationally. Integration and focusing of local services was initiated within this network in BF in 2007 and led to national recognition on the Roadmap of National Research Insfrastructures (2008).

In addition to ongoing support for genetics, genomics, and gene expression and regulation, recent investments into systems biology and high-throughput technologies have already provided critical support for world-leading scientific research. Cost-effective access to reagents and libraries enabling knockdowns or overexpression as well as high-throughput facilities is provided nationwide as a collaborative effort of Helsinki units. High-content screening services are customized to local research strengths and integrated with imaging and translational technologies. The genome-wide BF network will continue as an expert body to coordinate training efforts, to evaluate the services, to facilitate the use of these services in biocenters throughout Finland, and to integrate these activities internationally.

4. Model Organisms

Coordinator: Raija Soininen, Biocenter Oulu, University of Oulu

Genetically modified organisms are widely used in studies of development and genetic diseases, and also in studies of complex diseases like cancer and diabetes. Simple organisms such as the nematode C.elegans and fruit fly Drosophila are well characterized and used in large-scale genetic analyses of biological regulatory pathways and mechanisms. The zebrafish Danio rerio is an emerging vertebrate model used in development and genetic studies. Genetically modified (GM) mice have become the most important model organisms to understand the molecular basis of health and disease in man and to serve as suitable animal models for human disease. They thus have an important role in the development of new therapeutic approaches to human diseases. Work with GM mice requires high level of expertise, and specific ethical and regulatory issues have to be followed. Core facilities with experienced personnel provide high quality service in generation, analysis, and archiving of GM mice. Large international projects to systemically produce mutations in all genes in the mouse genome will facilitate work with GM mice. Local infrastructure is essential for providing services in customized mutagenesis and expertise in all aspects of mouse related issues, such as generation and archiving of mutant mouse lines, as well as in training. Highly specialized personnel and modern facilities are also required in systematic phenotyping of GM mice.



5. Proteomics and Metabolomics

Coordinator: Garry Corthals, BioCity Turku, Åbo Akademi University and Turku University

ProtMet.net - The Finnish Proteomics and Metabolomics technology platform - covers the technology platforms in (1) proteomics & protein characterisation and (2) metabolomics, thereby representing a network diverse in applications and methodologies. In establishing the network we have embarked on an ambitious plan to link independently operating national service laboratories, combining experience and resources to offer a coordinated national technology platform.

The broad field of proteomics is an essential technology in biosciences that underpins strategically important areas in academia and biotechnology, enabling characterisation and temporal and spatial quantitation of proteins at various locations in practically all biological systems. It also affords measurement and discovery of post-translational protein modifications, protein-protein interactions and protein properties, which are amongst the most sought after applications. Metabolomics is a rapidly emerging discipline dedicated to the global study of metabolites in biological systems, their dynamics, composition, interactions, and responses to interventions. The metabolome can be studied as an intermediate phenotype linking the genotype and the environment.

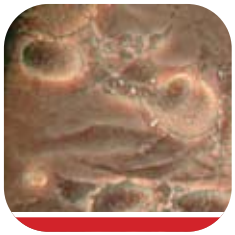
6. Stem Cells and Biomaterials

Coordinator: Olli Silvennoinen, Institute of Medical Technology, University of Tampere

Stem cell research is one of the most rapidly developing areas of biomedicine. Recent stem cell technologies have opened up several novel avenues for biomedical research, such as developing disease models, drug development, tissue regeneration and development of functional organoids.

In this BF network efforts are directed to obtain knowledge and protocols to generate stem cells from different sources. The network aims also at development of adult stem cell-based tissue engineered biomaterial implants and organoids. A special emphasis is put to develop techniques to generate and use the so called induced pluripotent cells (iPS) from committed permanently differentiated cells. The discovery that somatic cells can be reprogrammed into pluripotency via only three developmental control genes has opened new horizons for stem cells in e.g. derivation of patient specific cellular models for basic and applied research. Propagation of pluripotent cells from patients permit for the first time detailed studies on the molecular biology of human disease mechanisms and the use of such cells for development of novel therapeutics. In the long term the iPS cells should provide a unique way to develop technologies for obtaining immunologically tolerated cells for cell and tissue transplantation.

The main challenges of the network are: 1) how to channel and validate stem cells to specific cell lineages and functional cell types, 2) how to use these in tissue engineering and regeneration, and 3) how to use these as models for drug screening and organoid development.



7. Structural Biology

Coordinators: Adrian Goldman, Institute of Biotechnology, University of Helsinki & Rik Wierenga
Biocenter Oulu, University of Oulu

Structural biology and biophysics covers a wide range of topics, from protein production via structure determinations to biocomputational analysis. The Finnish national network comprises four major disciplines, all focused on experimental determination of macromolecular structures and elucidation of mechanisms by various time-resolved techniques. They are X-ray crystallography, nuclear magnetic resonance (NMR) spectroscopy, other time-resolved biophysical techniques, and electron microscopy. This network also benefits from central resources, such as CSC – IT Center for Science Ltd. and from the Bioinformatics network. Four of the biocentres have macromolecular x-ray crystallography facilities (Institute of Biotechnology, BioCity Turku, Biocenter Oulu, Biocenter Kuopio), while the Institute of Biotechnology has a significant investment in nuclear magnetic resonance (NMR) spectroscopy, cryo-electron microscopy and novel three-dimensional methods and time-resolved optical spectroscopy (TROS). The National Biological NMR Centre at the Institute of Biotechnology provides state-of-the-art NMR instrumentation, methodology and expertise.

8. Translational Technologies

Coordinator: Olli Kallioniemi, Institute for Molecular Medicine Finland FIMM

The network coordinates two technology platforms: 1) biobanking and biomarker research, and 2) discovery and proof-of-concept validation of therapeutic molecules.

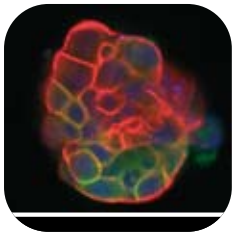
Finland is well-positioned to play a major role globally in the development of biobanks and biomarker capabilities. Systematic large-scale biobanking activities are ongoing at a few sites, such as at the University of Tampere (with Tampere University Hospital) and in Helsinki (Institute for Health and Welfare (THL), University of Helsinki/FIMM and HUS). This biobanking platform is linked to the role of FIMM and THL in coordinating Finnish participation in the European-level biobanking infrastructure (Biobanking and Biomolecular Resources Research Infrastructure, BBMRI). In addition to these large-scale efforts, numerous investigator-initiated sample collections and clinical data sources exist. Automation of sample acquisition and fractionation technologies, as well as generation of arrayed tissue and molecular resources will be developed and demographic and clinical annotation of the samples enhanced. The application and availability of biobanking resources should be improved by groups developing diagnostics, including clinical researchers and companies in Finland.

The second translational research platform will focus on drug discovery and development. This platform is linked to the European EATRIS infrastructure, coordinated in Finland by FIMM. This platform will further develop several existing strong capabilities in Finland, such as chemoinformatics/structural biology, high-throughput screening, as well as in vivo testing. The aim is to facilitate the capabilities for discovering inhibitors to interesting targets, and to carry out proof-of-concept testing in vivo. This platform should optimally bridge the gap between academic research and industrial interests to drug discovery.

9. Viral Gene Transfer

Coordinator: Seppo Ylä-Herttuala, Biocenter Kuopio, University of Eastern Finland

Gene transfer techniques are an important tool in studies of gene function as well as in the clinical evaluation of new treatments. In research the most important impact of efficient transient and stable gene transfer methods is the generation of new cell lines or animal models for the basic research of protein functions. Many of these methods are based on utilization of viruses as means to target and deliver genes into appropriate cells. Alternatively, recent advances in the RNAi-methodology enable the same delivery method to be used to efficiently silence specific genes in cells. Successful work with these sophisticated viral methods requires special expertise and strict safety considerations both of which are found in all biocentres in Finland. In particular, the AIV Institute, specializing in gene transfer methods for drug development, has a long-standing experience with strict regulations and requirements essential for gene therapy based approaches for human patients. Some of their products are already in clinical trials. The AIV Institute is responsible for co-ordinating the development and production of gene transfer vectors at national level in Finland.

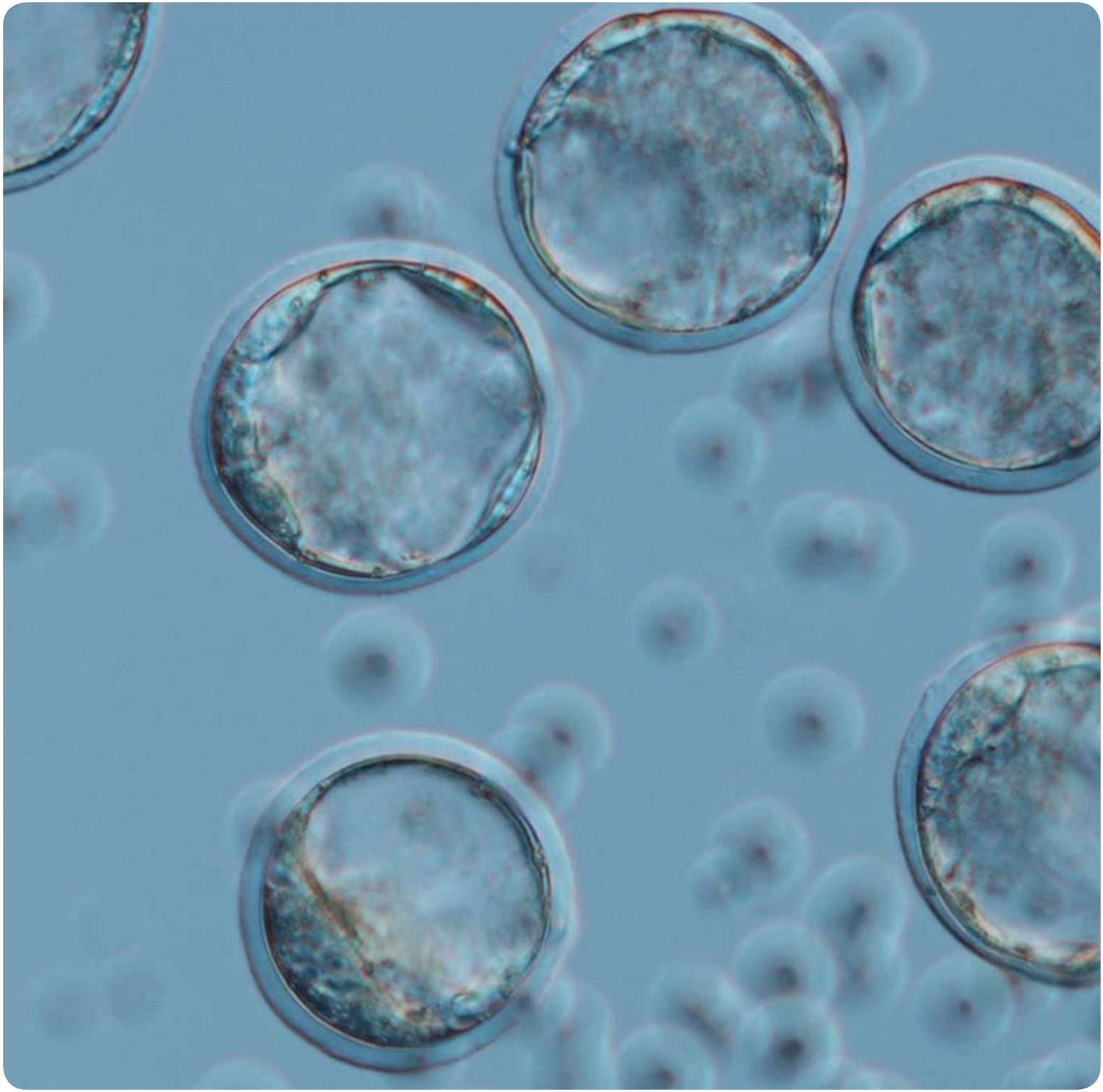


Emerging technologies

An additional way for Biocenter Finland to support technology development in life sciences is funding to new and emerging technologies. The first emerging technology platform to pass the international peer review and to receive funding is Lentiviral Platform for creating somatic Genetically Engineered Mouse Models (LentiGEMM).

LentiGEMM
Juha Klefström, University of Helsinki

Lentiviral transduction of tissues and somatic stem cells to generate genetically engineered mosaic animals constitutes a new technology circumventing the lengthy time and labor required to establish germline transgenic or knockout mouse colonies. It enables tissue-specific engineering of wildtype animals, with broad applications in life sciences and pharmaceutical research. LentiGEMM technology platform aims to develop a Finnish infrastructure for efficient lentiviral delivery of cDNAs and shRNA vectors to mouse tissues providing distributable resources and validation tools. Eight research groups from biocenters in Helsinki, Turku and Kuopio participate in the LentiGEMM platform.



Biocenter Finland – Member Institutes

Biocenter Kuopio

Director: Professor Seppo Ylä-Herttuala
www.uku.fi/bck/

Biocenter Kuopio (BCK) was founded in February 2007 as an umbrella organization for research groups active in molecular medicine, biotechnology and pharmaceutical research. Today BCK comprises the A.I.Virtanen Institute and 15 research groups from other departments of the University of Eastern Finland. The research profile of BCK is on molecular medicine of major diseases of high importance for health care, including cardiovascular diseases, neurodegenerative diseases and metabolism-related diseases. The strong areas are molecular and cellular mechanisms of the diseases, disease modeling, prevention and therapy of the diseases, gene and cell-based therapy, and pharmaceutical intervention as well as *in vitro* and *in vivo* imaging.

Biocenter Oulu

Director: Professor Johanna Myllyharju
www.biocenter.oulu.fi/

The mission of Biocenter Oulu (BCO) is to enhance international, high-level basic research in the focus area of biosciences and medicine of the University of Oulu, Finland. The tasks include running a graduate school and participating in a regional collaboration aiming at commercialization of new ideas and products. The research areas of BCO relate to molecular medicine, biocatalysis and genomics, with strong international profiles in matrix biology, cardiovascular and metabolic disorders, lipid metabolism, control of hypoxia, development of kidney and reproductive organs, and evolutionary genomics of both plant and insect species. The research projects supported by BCO are selected for 4-year periods based on international external evaluation of their scientific merit. The evaluations ensure a dynamic mode of operation whereby projects may continue or end within BCO and new ones may begin depending on the success of their research. BCO also provides long-term support for young scientists, who, following a successful post-doctoral period, are planning to set up their own group.

The research is supported by 10 core facilities providing a continuum for studying the structure and function of proteins, the function of normal and diseased cells, and control of genes and physiological processes. All core facilities operate on an open access principle and the contact persons, services and their prices are explained in www.biocenter.oulu.fi (see core facilities). The BCO profile in BF technology platforms focuses on mouse models and structural biology. Oulu has strong expertise in ultrastructural pathology of tissues, and these services will be expanded at national level.

BioCity Turku

Director: Professor Jyrki Heino
www.biocity.turku.fi/

BioCity Turku is an umbrella organization supporting and coordinating life science and molecular medicine related research in the University of Turku and in the Åbo Akademi. The two universities share one campus area in a historical location of the city of Turku. The existence of one compact, multidisciplinary campus area is the major strength of science in Turku and, in this magnitude, also unique in Finland. The same campus additionally houses the Turku University Central Hospital, the VTT (Technical Research Centre of Finland) Medical Biotechnology Unit and the THL (National Institute for Health and Welfare) Turku unit. The research groups working in these organizations are also active members in the six BioCity Turku research programs: Systems biology, Receptor research, Immunology, Reproductive and developmental medicine, Diagnostics and Biomaterials. BioCity Turku core laboratories and research services are organized into three centers, namely Turku Centre for Biotechnology (www.btk.fi), Turku Center for Disease Modeling (www.tcdm.fi) and Turku Positron Emission Tomography Centre (www.turkupetcentre.fi) that provide top-of-line technology services in biological imaging (www.bioimaging.fi), genomics, proteomics and disease models.

Biocentrum Helsinki

Director: Professor Irma Thesleff
www.helsinki.fi/biocentrum/

Biocentrum Helsinki (BCH) is an umbrella organization coordinating the multidisciplinary research in molecular biology and biomedicine at the University of Helsinki (UH). The mission of BCH is to foster high quality research and collaboration between UH campuses as well as to support the development and operation of research core facilites. Altogether there are about 1500 scientists on Meilahti campus and 1500 on Viikki campus (altogether about 250 research groups) involved in research in these fields.

BCH provides funding for research groups selected as BCH members by the Rector through an international evaluation based on scientific excellence. In the term 2007-2010, 14 of the 28 groups are located on the Meilahti Campus (Faculty of Medicine, FIMM), and 14 on the Viikki campus (Faculties of Biological Sciences, Veterinary Medicine, and Agriculture and Forestry, Institute of Biotechnology, Neuroscience Center). BCH also supports the repatriation of Finnish scientists as well as the recruitment of young foreign scientists by allocating two-year start-up grants. The scientific focus of BCH is based on the groups selected. The main emphasis of the work performed in the current groups is devoted to cell and molecular biology, cancer biology, molecular neurobiology, developmental biology, human molecular genetics, plant biotechnology and structural biology and biophysics.

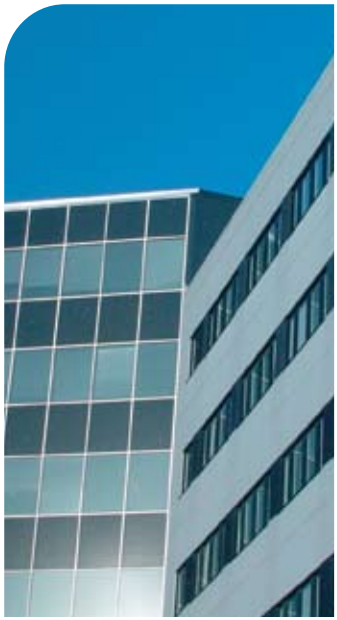
BCH coordinates and supports 17 core facilities on the Meilahti and Viikki Campuses typically through a salary of one person. The Aalto University has joined BCH March, 2010.

Institute of Biotechnology

Director: Professor Tomi Mäkelä
www.biocenter.helsinki.fi/bi/

The Institute of Biotechnology (BI) at the University of Helsinki is an independent research institute with a mission to increase knowledge in biotechnology and integrative biology and use this for the benefit of society. BI has research programs in Molecular Cell Biology, Developmental Biology, Genome Biology, and Structural Biology & Biophysics, and integrative programs in Quantitative Biology and Patterning Dynamics. Ongoing Academy of Finland Centers of Excellence at BI are in areas of virology, molecular neuroscience, cancer biology, plant signaling, and metapopulations. BI is an international, competitive and rewarding workplace, where the staff within the 29 research groups and 7 core facilities exceeds 300 and comes from 30 different countries.

BI has state-of-the-art facilities in imaging, model organisms, proteomics, genomics, bioinformatics, crystallography, and NMR. These are shared both locally as well as nationally as part of Biocenter Finland and are also popular among enterprises in the life sciences area. A high-level international Scientific Advisory Board has an important function in providing advice on scientific directions, and also regularly evaluates BI groups and other activities. The Institute of Biotechnology is located on the Viikki Campus where it forms part of the largest life science campus in Finland. The vision of the Institute is to strengthen its position as an international outstanding research institute in biosciences profiled through high impact research and renowned scientists



Institute of Medical Technology

Director: Professor Olli Silvennoinen
www.uta.fi/imt/

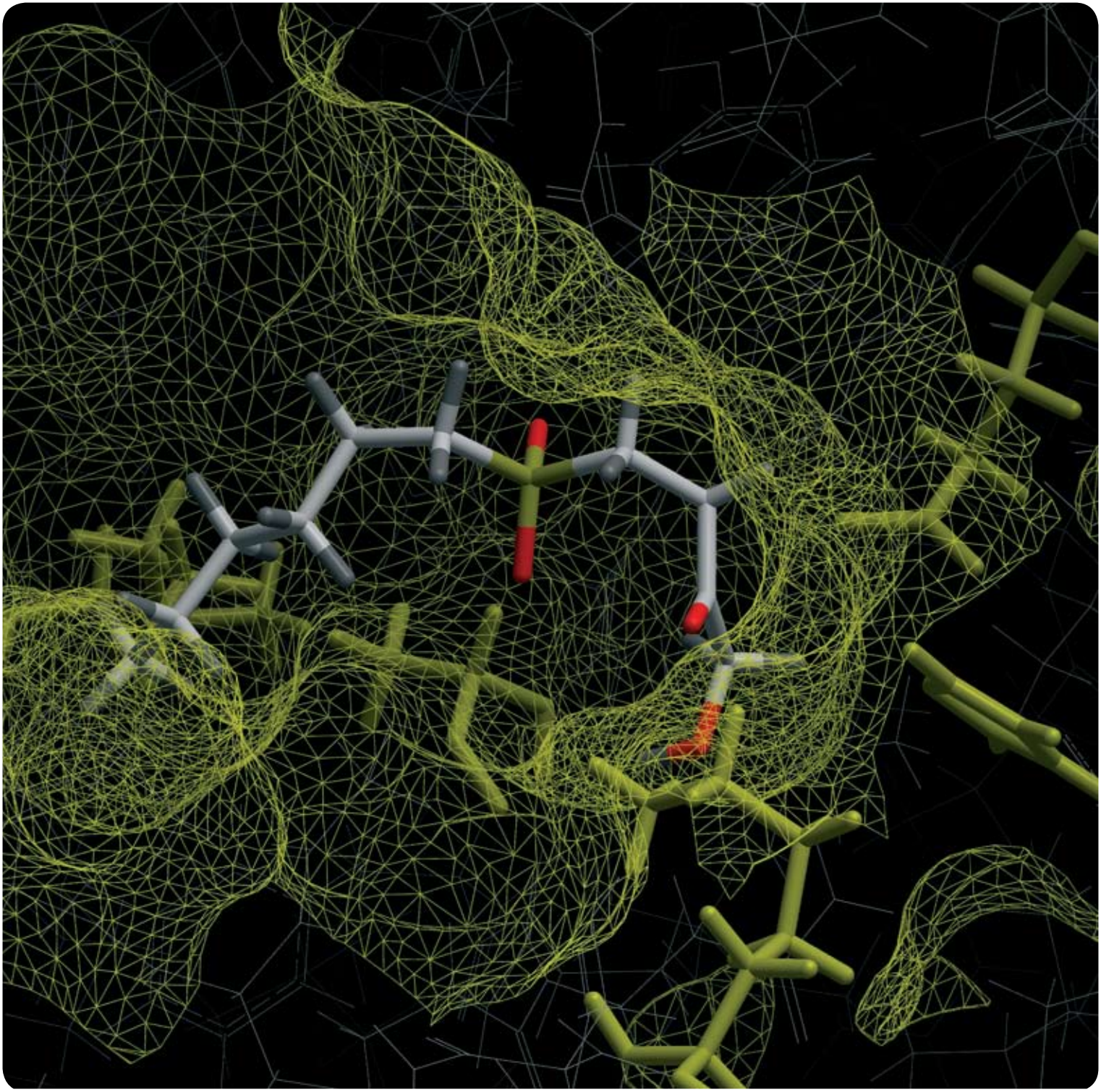
Institute of Medical Technology (IMT) is an independent institute of University of Tampere, founded in 1995. IMT is dedicated to modern biomedical research, and to the provision of high quality education at undergraduate, graduate and postdoctoral levels in natural sciences related to biotechnology and molecular biology. Our current 16 research groups with a personnel of over 160, are located in modern research facilities in Finn-Medi I and Finn-Medi II buildings directly connected to Tampere University Hospital on Kauppi Medical Campus. We are also actively collaborating with Regea Institute for Regenerative Medicine and Tampere Technical University, and developing with them a joint interdisciplinary School for Biomedical Technology.

Our strong research areas are mitochondrial genetics and diseases, immune responses and disorders, cancer research from genetics to patient diagnostics, protein production and interactions, and bioinformatics. Our special expertise include tissue technologies, virtual microscopy, stem cell technologies, and non-mammalian models *Drosophila* and Zebra fish *Danio rerio*.

The Institute for Molecular Medicine Finland

Director: Professor Olli Kallioniemi
www.fimm.fi

The Institute for Molecular Medicine Finland (FIMM) is an international research institute focusing on building a bridge from discovery to medical applications. FIMM investigates molecular mechanisms of disease using genomics and medical systems biology in order to promote human health. The three research focus areas of FIMM are i) human genomics, ii) medical systems biology and iii) translational research and personalized medicine. FIMM is a multi-disciplinary institute combining high-quality science with unique patient materials, and state-of-the-art technologies. The FIMM Technology Centre is focusing on genomics, sequencing, bioinformatics, high-throughput RNAi screening, and translational technologies. FIMM is part of the Nordic EMBL Partnership for Molecular Medicine.



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Biocenter Finland

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