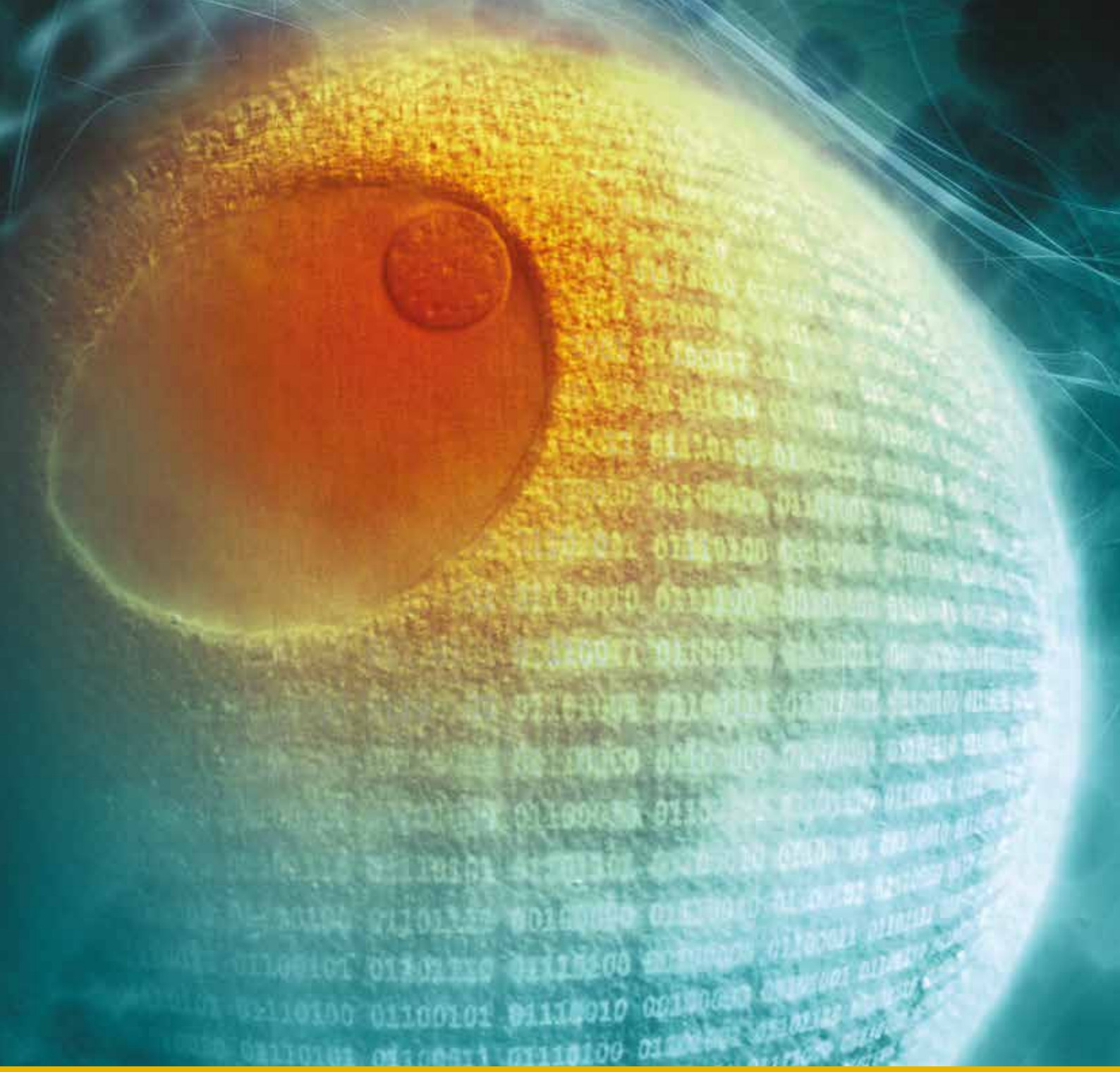


EMBL Programme 2017 – 2021

Digital Biology

EMBL

Europe's flagship laboratory for the life sciences

EMBL - the European Molecular Biology Laboratory - is Europe's centre of excellence in life science research, services and training. It was founded in 1974 by its member states as an intergovernmental organisation to promote the molecular life sciences in Europe and beyond.

EMBL is...

In the past 40 years, EMBL has grown into an international venture with 1600 staff from over 80 countries across five sites in Europe. Its founding principles, however, have constantly remained at the core of the EMBL model.

From the original 10 founding countries, our membership has increased to 22 member states and two non-European associate members at the end of 2016. The continued support of its member states is a testimony to the unique value of EMBL, which today is Europe's leading institution in the molecular life sciences, and one of the highest-ranked research institutes in the world.

4 EMBL publications
rank among the 100 highest cited papers ever

30% of EMBL research
group leaders hold ERC awards

45% of EMBL publications
are in the top 5% of journals in biochemistry, genetics and molecular biology

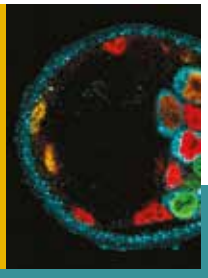
EMBL's core principles

- Scientific excellence
- Interdisciplinarity and collaboration
- Opportunities for young creative thinkers
- Early independence
- Continuous staff turnover
- Internationality and diversity
- Cutting-edge infrastructure

EMBL's five missions and the Programme 2017–2021

EMBL pursues five synergistic missions that complement and foster national scientific activities in its member states.

- Forefront research: uncovering the molecular basis of life



- Providing world-class research infrastructure and services

- Training and inspiring the next generation of leading scientists

- Driving research, innovation and progress through technology development, interactions with industry and technology transfer

- Playing a leading role in the integration of life science research in Europe

Every five years EMBL develops a strategic plan that outlines its future activities in each of these mission areas. For the EMBL Programme 2017–2021, EMBL has selected strategic priorities that build on its strengths to respond to the changing landscape of life science research, and offer new and improved services to the international scientific community.

Strategic Priorities 2017—2021

Focusing on EMBL's scientific strengths in Digital Biology

Strengthening and expanding EMBL's service portfolio

Digital Biology

We are entering a new and exciting chapter of life science research – the era of Digital Biology.

- Molecular biology is becoming **quantitative** from genotype to phenotype.
- **Modelling** of complex systems is becoming possible at all scales.
- **Human systems** are becoming accessible to molecular approaches, and bioinformatics bridges between basic, translational and clinical research.

Digital Biology holds unprecedented scientific opportunities and will have a far-reaching impact on medicine, industry and society.

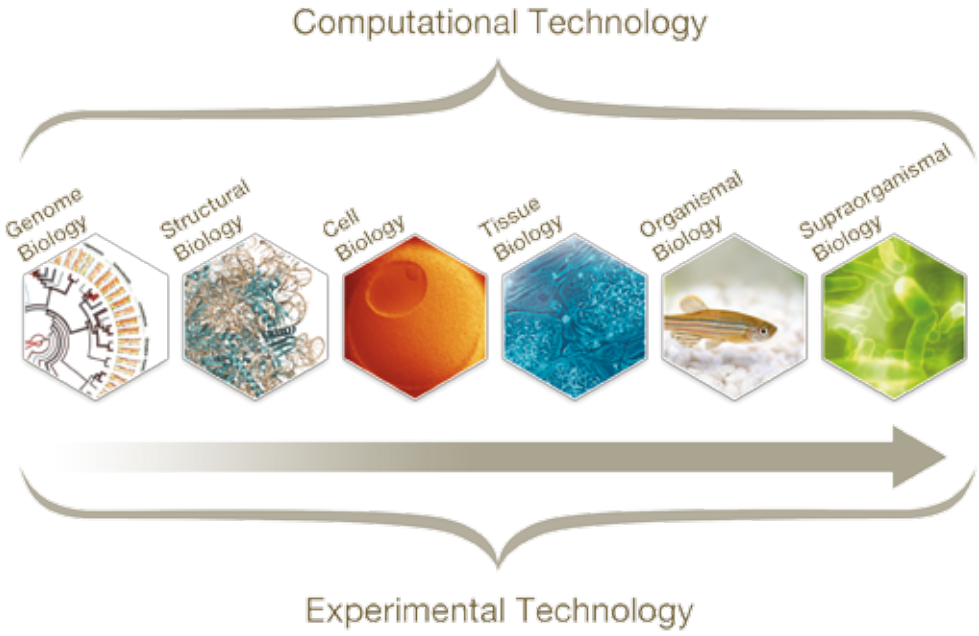
With the help of cutting-edge experimental technologies that visualise and quantify molecular processes, and computational technologies that integrate data across scales of biological organisation, we will be able to understand and make predictions about life's processes at all levels. These advances will ultimately lead to new ways to understand, model and predict human health and intervene in disease.

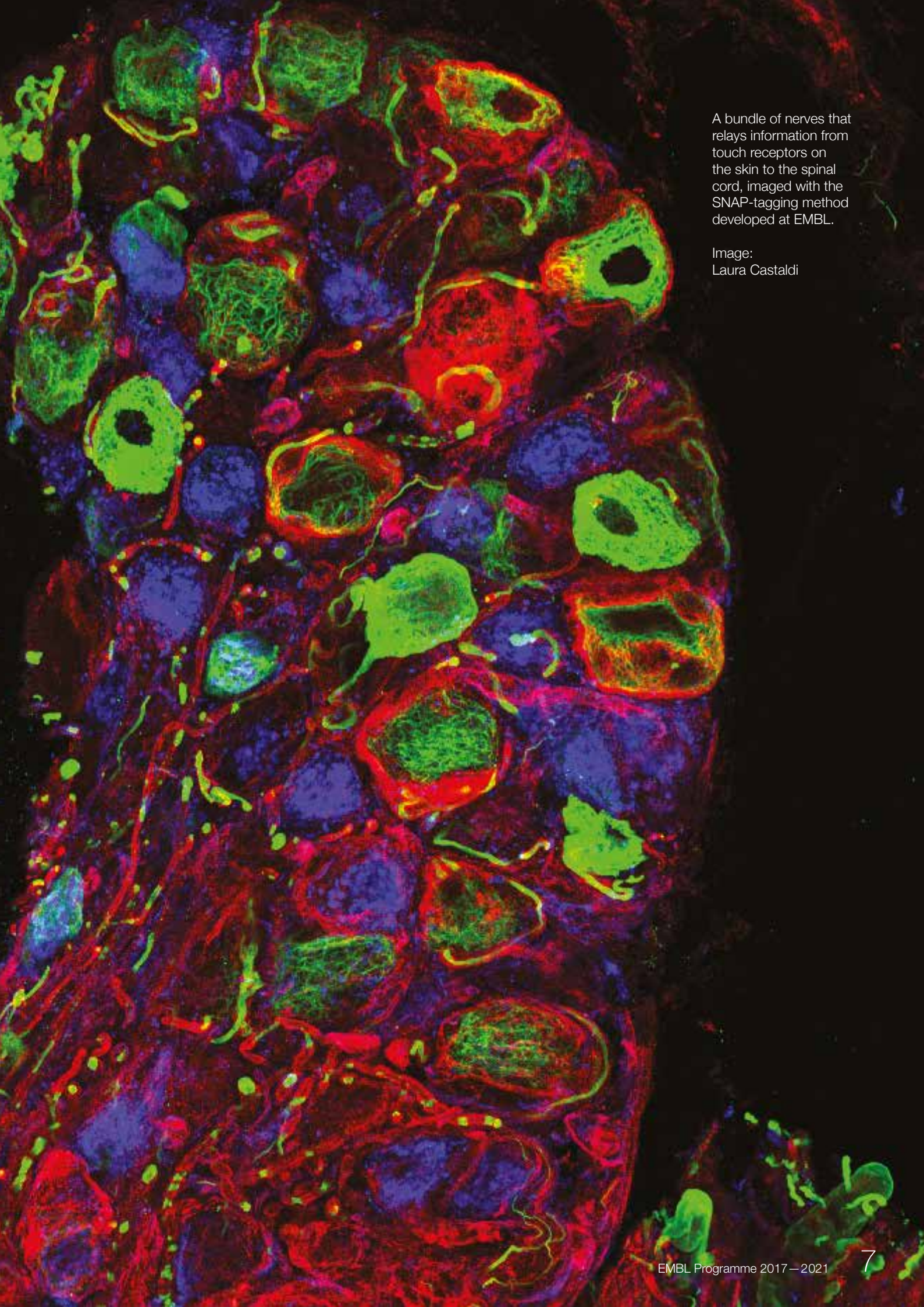
To drive progress in Digital Biology, in 2017—2021 EMBL will focus on its strengths in:

Interdisciplinarity
Collaboration at EMBL is highly interdisciplinary, drawing on the strengths of our diverse staff and external collaborators with expertise in biology, physics, chemistry, mathematics, bioinformatics and medicine.

Integration
Understanding life on many different scales requires innovative, multi-scale approaches. Digital Biology research at EMBL focuses on quantitative biology, integrative molecular data analysis, multi-scale imaging, computational modelling and bioinformatics.

Innovation
Innovative experimental and computational technology development form the cornerstone of EMBL's Digital Biology research programme in 2017—2021.





A bundle of nerves that relays information from touch receptors on the skin to the spinal cord, imaged with the SNAP-tagging method developed at EMBL.

Image:
Laura Castaldi

Forefront research: uncovering the molecular basis of life

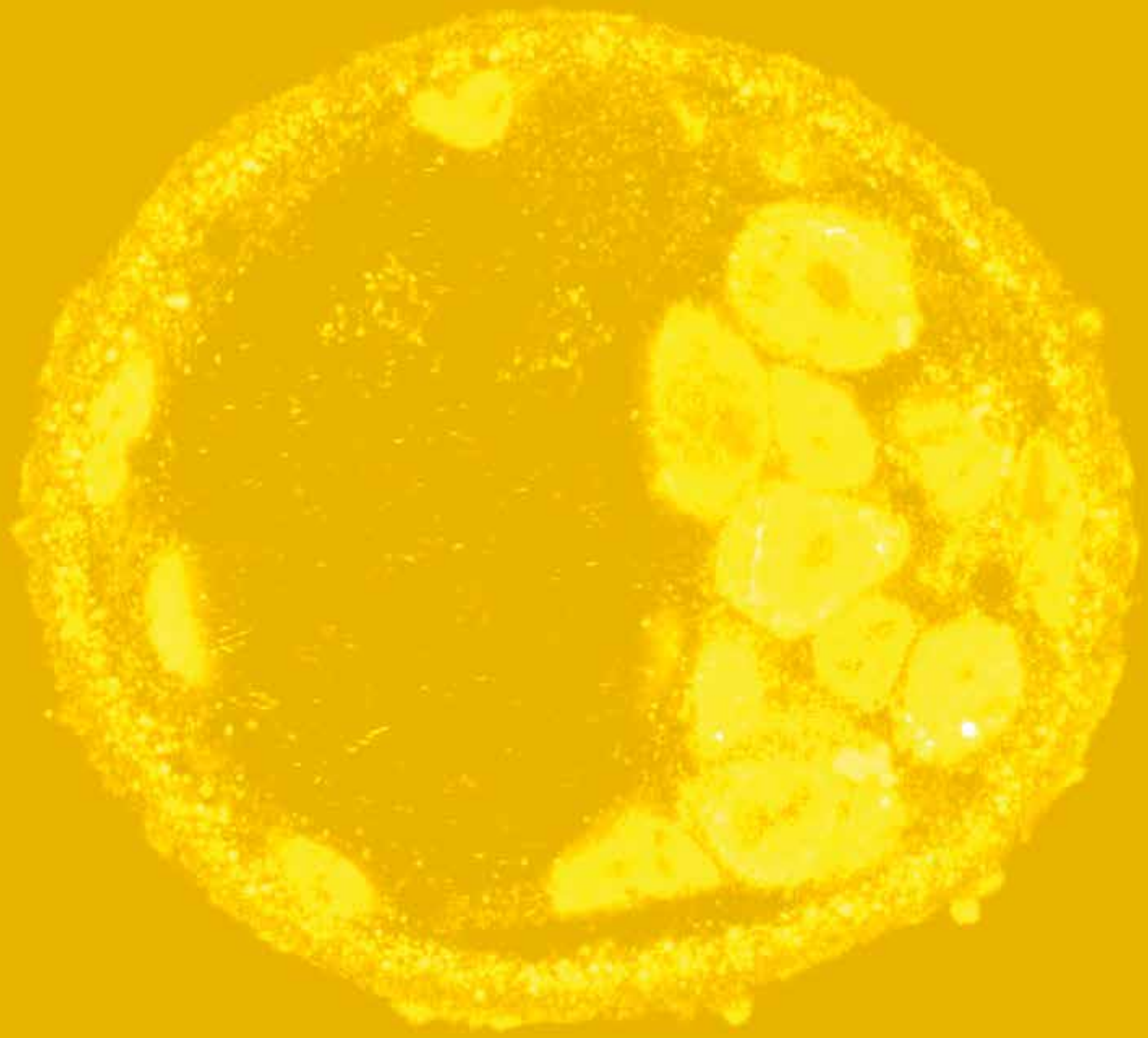


Image: Yusuke Ohnishi

Visualising molecular processes in space and time

3 EMBL Centres
support data analysis, visualisation & modelling across scales

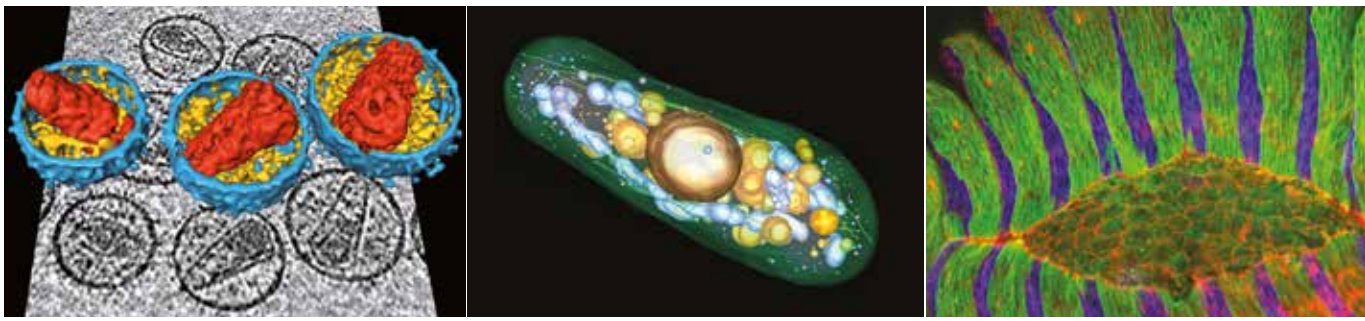
We are witnessing a revolution in imaging technologies, which now allow scientists to observe molecular machines directly in living organisms and see the processes of life and disease unfold in real time. Very few places in the world have the capacity to analyse, visualise and quantify the dynamic inner workings of life across the whole range of biological organisation. Thanks to its breadth of expertise, its collaborative culture and its comprehensive technology portfolio – ranging from structural biology methods over light microscopy at the cellular scale to live imaging of entire organisms – EMBL is one of these places.

Aims

1. **Bridging scales and resolutions**
   Building on our interdisciplinary expertise, we aim to pioneer new imaging approaches by pushing the limits of resolution and integrating different imaging techniques at the atomic, molecular, cellular and organismal levels to achieve a comprehensive understanding of molecular processes and their dynamics in space and time.

2. **Introducing tissue biology and disease modelling**
   Creating a new EMBL site for tissue biology and disease modelling in Barcelona, Spain, we aim to understand phenotypic variability at the level of tissues and organs. We will add expertise to EMBL's portfolio in the areas of multicellular tissue and organ-level imaging and image-driven modelling allowing experimental studies on the organ and tissue level in model species and manipulatable human systems.

3. **Strengthening neurobiology and epigenetics**
   By strategically refocussing research at EMBL Monterotondo on the interface of neurobiology and epigenetics, we aim to advance our understanding of the development of neural cell types and the role of genomic plasticity and genetic variation in neurological and neurodegenerative disorders.



EMBL scientists visualise biological processes from molecules over cells to tissues and organisms.
Images: John Briggs, Johanna Höög, Damian Brunner

The Big Data challenge

120 Petabytes
of scientific data managed by EMBL, Exabytes expected by 2021

With the advent of high-throughput technologies biology has entered the era of Big Data. Although genomics and other large-scale data offer tremendous opportunities to extract novel insights from large and complex datasets, they also present huge challenges with respect to analysing, integrating and storing data. As one of the world's largest biological data repositories and a leader in bioinformatics research, EMBL is at the forefront when it comes to tackling these challenges and reaping the benefits that Big Data holds for biology and medicine.

Aims

1. **Integrating data and modelling biological processes across scales**
   We will use bioinformatics to bridge between research in molecular, structural, cellular and organismal biology by integrating diverse data types at all spatial scales and creating multi-scale models of biological processes.

2. **Understanding variation**
   Exploiting genomics data and computational approaches, we will drive forward our understanding of how genetic and environmental variations between populations, individuals or single cells determine phenotypes associated with health and disease.

3. **Creating IT resources to enable biomedical research**
   Building on EMBL's track record in establishing bioinformatics standards, tools and resources, we will continue to enable the biomedical research community by developing innovative approaches to data collection, analysis, visualisation, archiving and sharing in the era of Big Data.

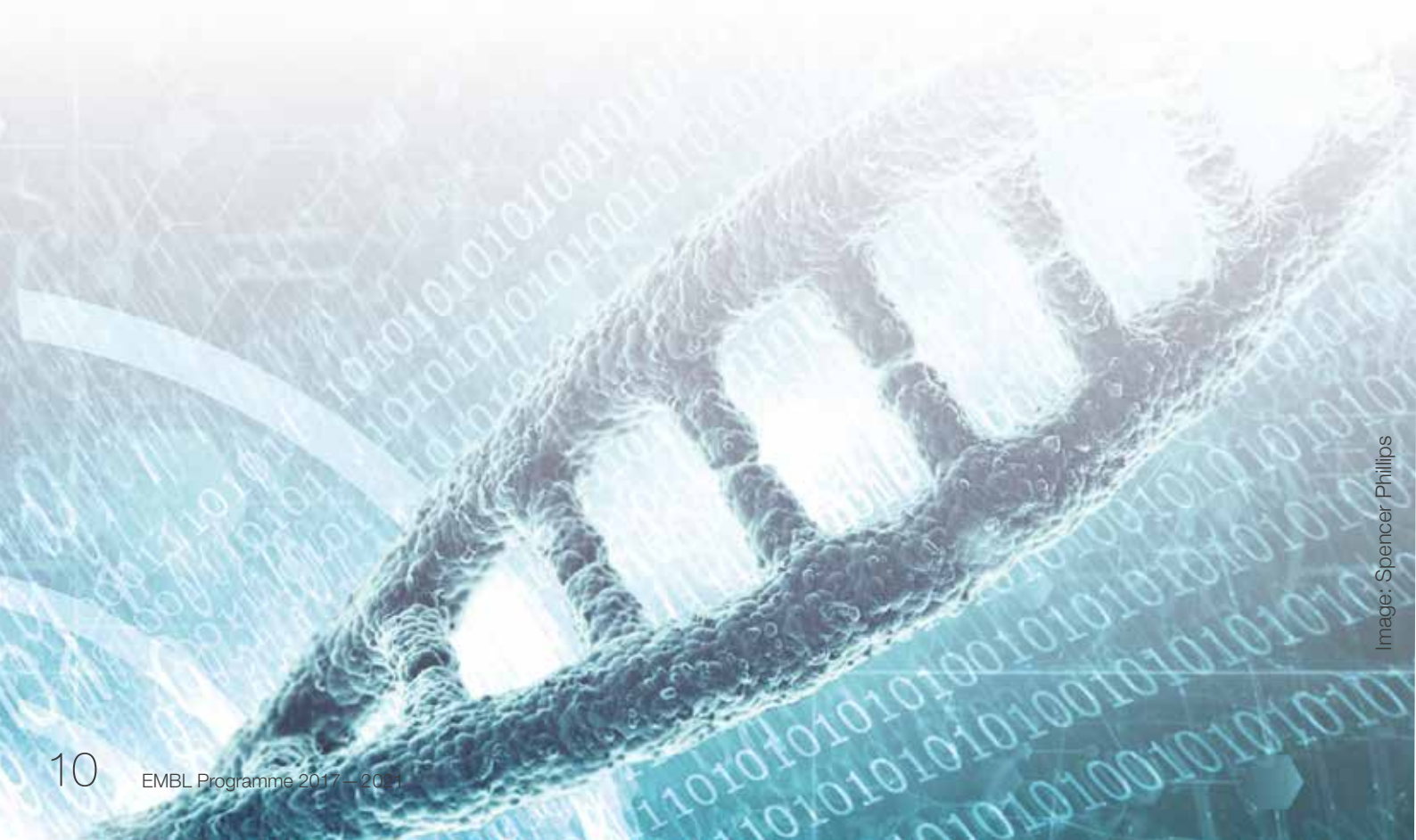


Image: Spencer Phillips

Towards human biology

8 EMBL partner institutes
in the area of molecular medicine
in Europe

Recent advances in molecular measurement and computational technologies are making human biology increasingly accessible to research at the molecular scale. Medicine and molecular biology are converging with the diagnostic process increasingly moving from the phenotypic description of symptoms towards the molecular characterisation of patients and disease states.

EMBL's focus on molecular and cellular technology, in both human and experimental systems, coupled with its experience in data management and innovative integrative analysis, make it a key player in bridging the world of basic science and translational and clinical research.

Aims

1. **Developing new tools and approaches to unravel human systems**
   Harnessing our strengths in developing new tools, methods and technologies and applying them to complex biological systems, we will work towards making human systems more systematically tractable in molecular terms in the future.

2. **Enabling translation by interpreting and making available human data**
   Applying our leading bioinformatics expertise, we will analyse and integrate data collected from human systems, support medical practitioners in interpreting these data to inform diagnosis and therapy and champion open data, data standards and security and ethics.

3. **Tackling human health and disease through collaboration**
   Intensifying partnerships with national research institutions in the area of molecular medicine, and participating in international consortia researching various aspects of human health and disease, we aim to decipher the underlying molecular mechanisms to inform new strategies for the treatment or prevention of diseases.

Surface mapping of metabolites on the skin of male and female individuals.

Image: Theodore Alexandrov

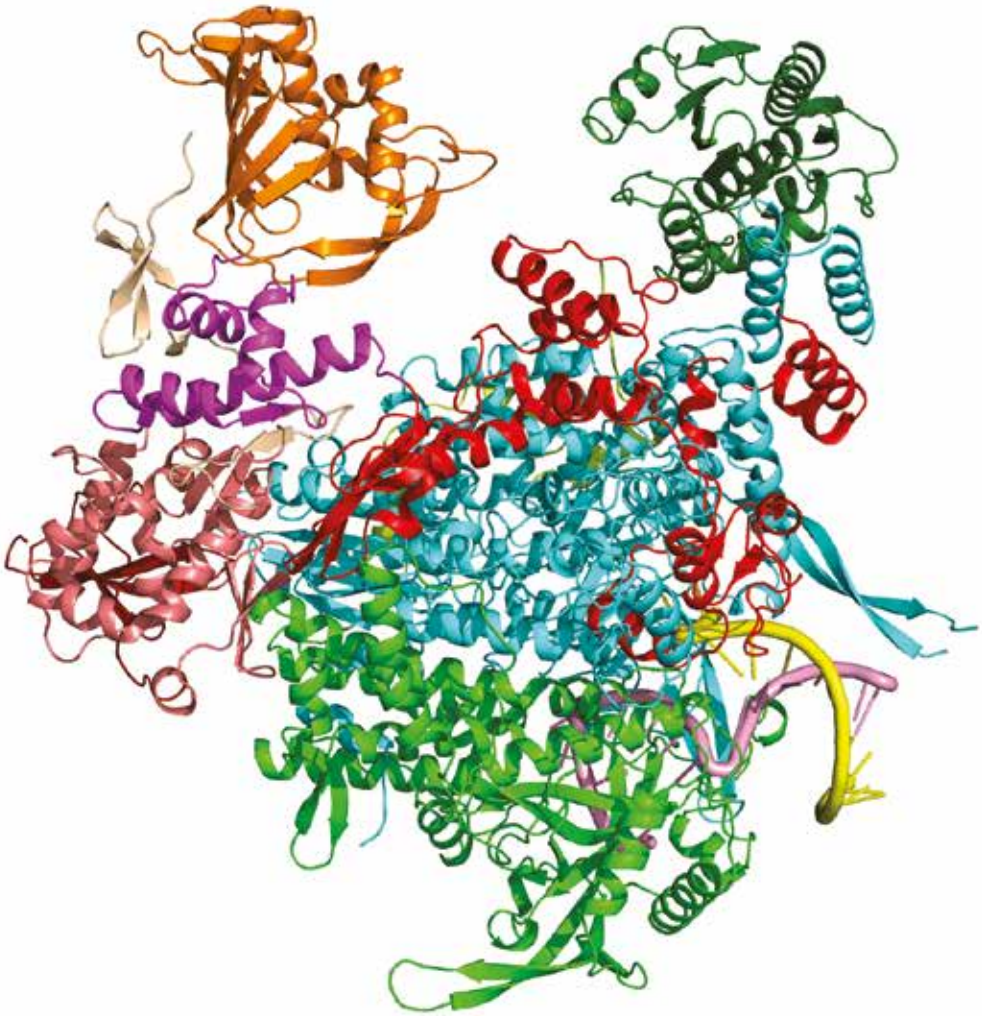
Providing world-class research infrastructure and services

Image: EMBL Photolab

EMBL operates unique world-leading research infrastructure that enables European researchers to achieve breakthroughs across many scientific disciplines. Each year, several thousand scientists gain access to cutting-edge technologies and expertise. To transfer this knowledge we also train and enable users to install similar facilities at national institutions.

EMBL's main priority for the period 2017–2021 is to strengthen our service portfolio for the benefit of the wider scientific user community.

We plan to address the increasing demand for novel research technologies to which many European researchers currently do not have access. Examples include new high-resolution electron microscopy methods, novel imaging technologies, and biological applications of the European X-ray Free Electron Laser that will be available in Hamburg from 2017.



EMBL services enable European researches to achieve breakthroughs such as solving the molecular structure of the influenza virus polymerase.
Image: Stephen Cusack

Bioinformatics services and IT infrastructure

Through EMBL's European Bioinformatics Institute (EMBL-EBI), the world's most comprehensive source of biomolecular data, we provide a broad community of commercial and academic researchers around the world with access to crucial data. Trends towards Big Data, new technologies and new data types translate into challenges regarding data processing, storage, and analysis for EMBL's research and service activities. To stay ahead of these challenges and ensure continuation of excellent user service, EMBL will invest in IT infrastructure, high-bandwidth connectivity and trained service staff across all its sites.

25 million web requests
received every day by EMBL-EBI's data resources

Aims

1. **Tackling data growth and integration**
   Finding sustainable solutions to handle exponentially growing data quantities – both at EMBL and in the context of the pan-European infrastructure ELIXIR – and developing innovative ways to integrate heterogeneous data and link different data resources for maximum user benefit will remain priorities for 2017–2021.

2. **Enabling translation to medicine**
   By providing reference human datasets for clinical practitioners and, particularly in the context of ELIXIR, by working internationally to harmonise storage and analysis of medically relevant data across Europe, EMBL's bioinformatics services aim to improve translation from basic biology research to medicine.

3. **Developing repositories and standards for imaging data**
   Combining expertise in developing data resources with understanding of imaging technologies and the needs of imaging communities, EMBL aims to lead the development of image data repositories and standards that allow data sharing and the integration of images with other data types.

Image: Carl Bergman

Structural biology services

3000 user visits
hosted each year at EMBL Hamburg and Grenoble

Together with the German Electron Synchrotron (DESY) in Hamburg and the European Synchrotron Radiation Facility (ESRF) in Grenoble, EMBL provides access to crucial enabling infrastructure for structural biology users from all over Europe. In 2017–2021, EMBL plans to expand its service portfolio and make a new generation of unique infrastructures and integrated structural biology approaches available to the life science community.

Aims

1. **Capitalising on next-generation synchrotrons**
   Through the implementation of next-generation light source PETRA III in Hamburg and the ongoing upgrade of the ESRF in Grenoble, world-leading synchrotron and beamline resources – and thus new scientific opportunities – are available at both sites. EMBL aims to help open up these opportunities to life scientists through the development of new technologies, methods and scientific services for biological users.

2. **Making the world's most powerful laser available for biologists**
   The European X-ray Free Electron Laser will start operation in Hamburg in 2017. To exploit its tremendous potential for structural biology applications, EMBL, as part of an international consortium, will develop and operate an on-site dedicated sample preparation and characterisation facility for life science users.

3. **Moving towards more integrated services**
   To support increasingly complex projects that rely on a combination of complementary methods, EMBL's structural biology services, together with local partners in Hamburg and Grenoble, are aiming to gradually integrate X-ray-based structural biology methods with electron and light microscopy, chemical biology, genomics methods and computational biology.

Image: ESRF

Core and user facilities

1200 users
of core facilities each year

EMBL's Core Facilities provide cutting-edge equipment and expert support in a range of scientific fields for internal and external users (roughly 25% of total users are external). Responding to demand for new technologies from the European scientific community, EMBL is planning to create new user facilities in the areas of imaging and metabolomics. To create a multiplier effect that goes beyond providing access to technology, all our facilities will train users in the operation of the equipment and help them create similar facilities in their home countries.

Aims

1. **Providing external users with access to high-resolution electron and light microscopy**
   Building on its leading expertise in electron and light microscopy development and use and its experience in providing scientific services, EMBL – contingent on funding raised – proposes to address the enormous demand in the European life science community for access to these new technologies with a dedicated facility for external users.

2. **Offering support for integrative structural modelling**
   To support EMBL researchers using integrated structural biology methods for research at the interface between molecular and cellular scales, to advise the staff operating the proposed new user facilities for imaging and to participate in user training, EMBL plans to establish a new EMBL Centre for Integrative Structural Modelling.

3. **Establishing a Metabolomics Core Facility**
   To cater for the growing need to integrate studies of metabolism and metabolites with other molecular datasets, EMBL will establish a Metabolomics Core Facility to provide services in quantitative analyses of small molecules based on mass spectrometry, imaging mass spectrometry and nuclear magnetic resonance methods.

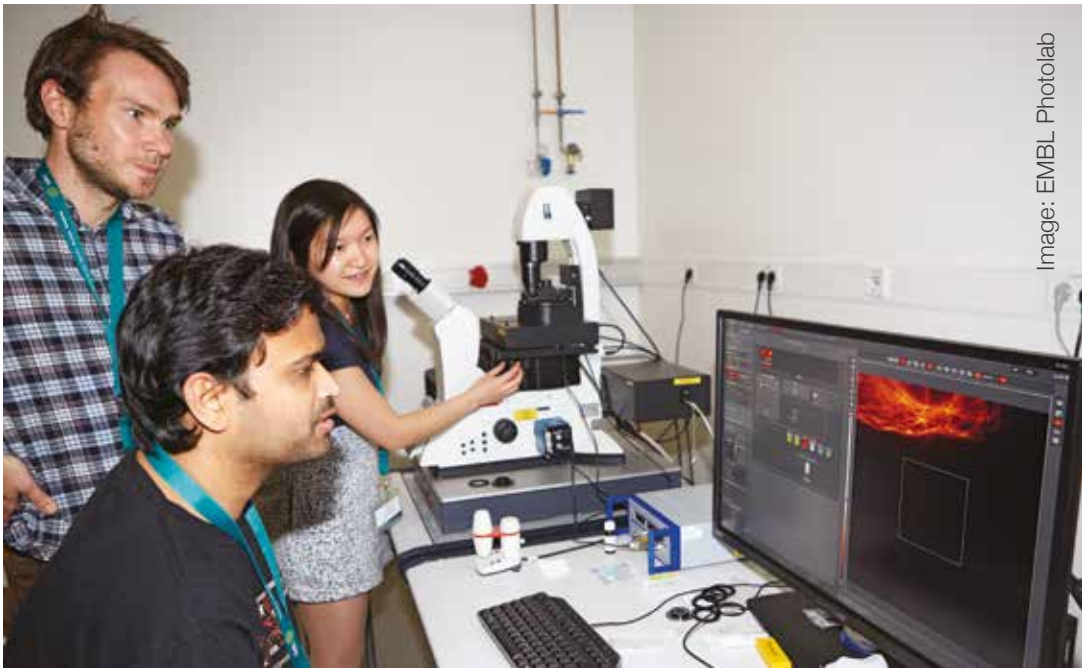


Image: EMBL Photolab

Scientific publications

EMBL's research and service groups collaborate intensely with scientists in our member states and beyond.

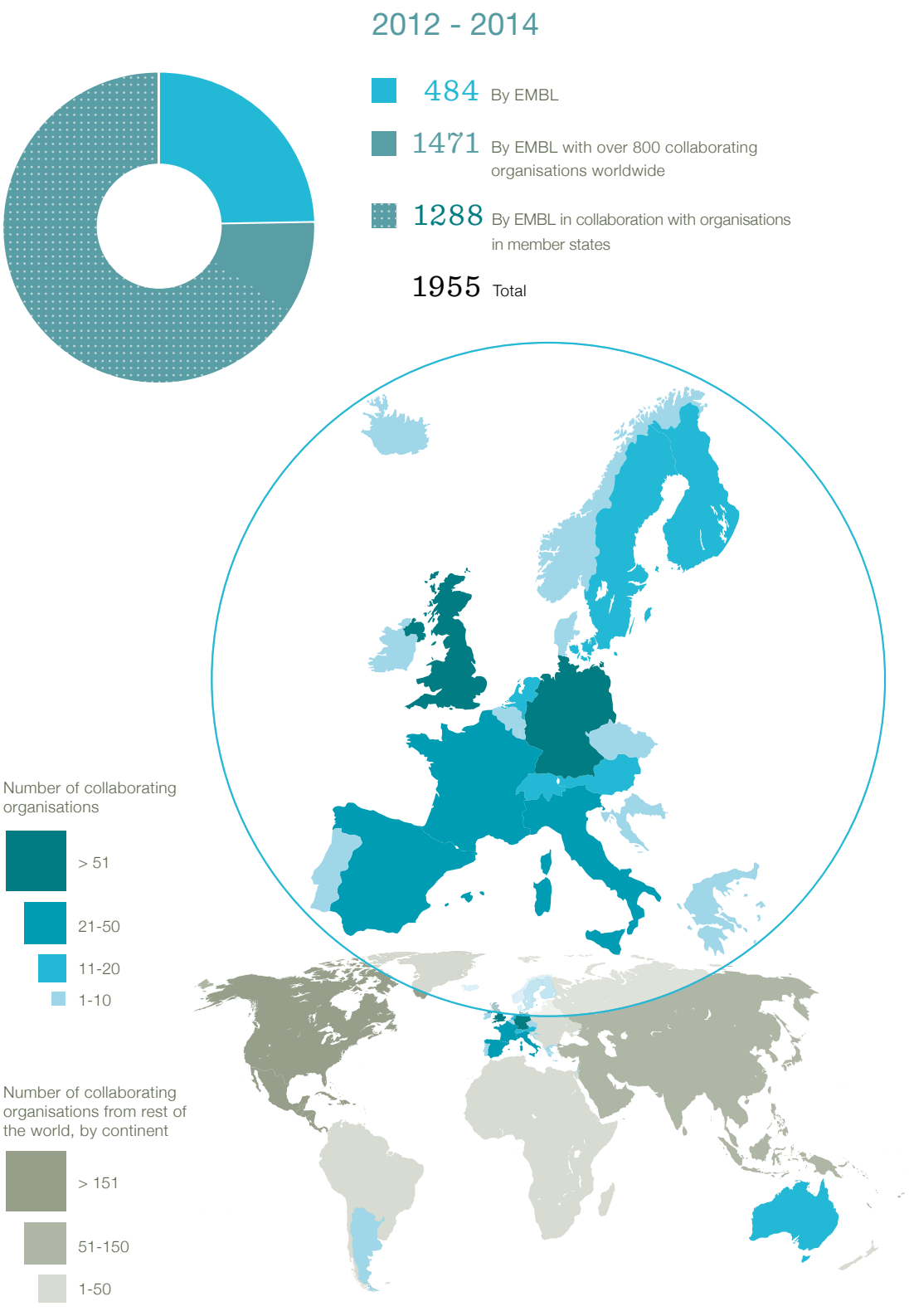


Image: Manuela Beck

Training and inspiring the next generation of leading scientists

Image: EMBL Photolab

EMBL is a centre of excellence for advanced training and has over its 40 years of history helped launch the careers of several thousand life scientists. Our renowned internal training programmes for predoctoral and postdoctoral fellows serve as best practice examples for similar programmes in member state institutions. EMBL's courses, conferences and e-learning platforms deliver continuing professional development for external scientists and user training in scientific methodology. To continue to provide our member states with highly skilled scientists, EMBL constantly strives to improve its internal and external training programmes.

220 PhD students & 290 postdocs
at steady state trained at EMBL

Aims

1. **Providing career development support and vocational training for fellows**
   To prepare and support our fellows on their path to scientific leadership positions, EMBL will offer enhanced career development support, strengthen the networking opportunities with industrial and academic partners and offer training in areas such as entrepreneurship and enhanced research ethics.

2. **Broadening the coverage of EMBL's external training activities**
   We aim to expand EMBL's Course and Conference Programme in terms of attendee numbers and its scientific coverage to include a broader range of topics. We will pay particular attention to engaging with medical and industrial researchers and other communities interfacing with molecular life sciences.

3. **Strengthening scientific dissemination through e-learning and off-site training**
   We plan to establish an EMBL-wide e-portal for training that will facilitate access to training materials for conferences and courses and make scientific content available to a broader public. In addition, we will continue to serve European scientists with more off-site training courses, particularly in the area of bioinformatics.

Image: EMBL Photolab

7000 scientists
attend 80 courses & conferences held at EMBL each year

Driving research, innovation and progress through technology development, interactions with industry and technology transfer

Image: EMBL Photolab

EMBL is a pioneer in the development of technology and instrumentation that drives progress in life science research at EMBL and beyond. To make our discoveries and inventions broadly available and to benefit scientists, industry and society at large, EMBL and its knowledge-transfer arm EMBLEM interact closely with industry in multiple ways, including actively engaging in technology transfer.

18 EMBL spin-off
companies launched since 1999

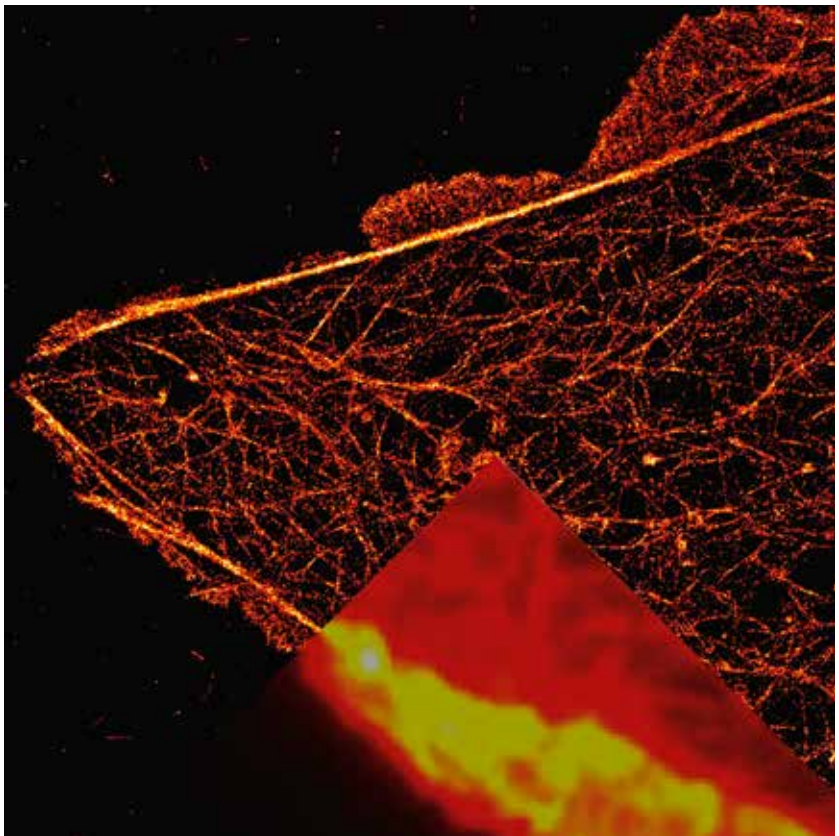
Aims

1. **Driving progress through innovative technology development**
   Building on its 40-year track record in technology development, EMBL aims to achieve major advances in the three focal areas of innovative synchrotron beamline technology and automation, advanced imaging technology and pioneering software for data processing and analysis.

2. **Accelerating access to novel imaging technologies**
   To address the high demand for EMBL's innovative imaging technologies, we propose to establish a platform that will provide access to novel technologies developed at EMBL for a wider community of users prior to commercialisation. These plans will depend on our ability to secure dedicated funding.

3. **Intensifying strategic cooperation with industry**
   To promote the translation of our skills and resources into innovative products that benefit society, EMBL will continue to offer its scientific, technology and data management expertise to companies in pre-competitive research areas and strive to forge new, mutually beneficial, strategic partnerships with industry.

32 industry partners
participate in EMBL's institutional industry programmes



Comparative imaging of an actin meshwork by confocal and super-resolution microscopy, one of the technologies EMBL scientists are advancing.

Image:
Jonas Ries

Playing a leading role in the integration of life science research in Europe

7500 EMBL alumni
worldwide, 80% working in EMBL member states

As Europe's only intergovernmental laboratory in the life sciences, EMBL plays a leading role in the integration of science initiatives and helps shape science policy and strategy in Europe. We proactively engage with our member states and with the broader European and international scientific communities, European policy-making and decision-taking bodies including the EIROforum organisations, the European Strategy Forum for Research Infrastructures (ESFRI) and the European Commission as well as with the general public.

Aims

1. **Integrating Europe's scientific landscape by expanding EMBL membership**
   To help develop and integrate Europe's life science landscape and harness the scientific potential of all European states, EMBL will continue to actively engage with its member states and their scientific communities and aims to expand its membership to encompass as many European countries as possible.

2. **Forging strategic interactions with countries outside Europe**
   EMBL will continue to engage in strategic international cooperation with countries outside Europe and seek to modestly expand its associate membership by integrating the scientific communities of non-European countries with a well-developed molecular life science programme.

3. **Shaping science policy by working closely with European policy-making bodies**
   Working actively with the European Commission and Parliament, as well as various scientific advisory bodies and interest groups, EMBL aims to actively shape tomorrow's science policy and create the best conditions for excellent life science research in Europe. A policy priority for 2017–2021 will be to promote gender balance in research at EMBL and beyond.

European Molecular Biology Laboratory

www.embl.org
info@embl.de

@emblorg
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EMBL member states:
Austria, Belgium, Croatia, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Israel, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom.

Associate member states:
Argentina, Australia

Prospect member states:
Hungary, Lithuania, Poland, Slovakia

Status November 2016